

REPORT

OF THE

GOVERNOR OF ARIZONA

TO THE

SECRETARY OF THE INTERIOR.

1899.

STANFORD UNIVERSITY

WASHINGTON:
GOVERNMENT PRINTING OFFICE.

1899.

CONTENTS.

	Page.
Population	3
Taxable property	3
Finances	6
National and Territorial banks	7
Customs	9
Settlement of lands	10
Commerce and railroads	11
Stock raising	13
Agriculture and horticulture	15
Forests	19
Educational	21
Indians	29
Ethnology and archæology	36
Public buildings	37
Legislation	40
Judiciary	40
Labor	41
Mining	42
Climate of Arizona	153
The flora of Arizona	155
Natural scenery	158
Hot springs	158
Hunting and fishing	159
The National Guard	160
Undeveloped resources	162
The arid lands and water storage	162
Rainfall and floods	166
Some reservoir sites and storage projects	168
Statehood	178
Recommendations for Congressional legislation and action of the Interior Department	179

APPENDIXES.

A.—Official roster	181
B.—General condition and progress of the Territory as reported by counties	183

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REPORT
OF THE
GOVERNOR OF ARIZONA.

EXECUTIVE DEPARTMENT OF ARIZONA,

Phoenix, Ariz., September 1, 1899.

SIR: I have the honor to submit the following report of the affairs, development, and resources of Arizona for the year ended June 30, 1899, in which I have deemed it proper to embrace reliable and exhaustive information upon all subjects material to the industrial, social, and economic progress of the Territory:

POPULATION.

As near as can be estimated from the school census completed in July of this year, Arizona's population exceeds 100,000 people, and it is confidently believed that the general census of 1900 will sustain this estimate.

The probable increase during the year has been 5,000, and, as previously stated, the great and varied resources of Arizona invite strong, courageous characters who come seeking investments and permanent homes. Social and moral conditions here compare favorably with any portion of the Union.

The increase has been distributed very evenly, the mining districts probably receiving the major share, although the agricultural valleys have gained. The nationality of the immigrants can not be reliably determined until after the census is taken, but it is safe to say that a large majority are Americans from all parts of the Union, principally from the north and middle West. Our citizens are industrious, intelligent, patriotic, and brave, such people as make up the bone and sinew of the nation.

TAXABLE PROPERTY.

From the following statement of the taxable property of the Territory, which is compiled from the assessment rolls and the report of the Territorial board of equalization for the current year, it will be seen that the assessed valuation of the property in the Territory has materially advanced during the year, notwithstanding that under the present system a large amount of the taxable property is not returned to the various assessors, and the values of the property assessed are usually very low, which causes a higher rate of taxation than would be necessary were all the taxable property properly assessed and valued. As the community grows older and the disadvantages arising from the present system of low valuations and high rates of taxation are better understood by the people generally, the laws upon the subject will, no doubt, be so altered as to secure approximately full and

correct returns of all property in the Territory subject to taxation. When assessments are had upon a just and equitable system of valuation, the rate will be as low here as in any of the States. I have endeavored to present the importance of this subject clearly to the legislative branch of the Territorial Government, and it is expected that the commission now engaged in codifying and revising the laws, as authorized by the twentieth legislature, will correct serious faults in the revenue system.

Statement of assessed valuation of property.

County.	Land.	Value.	Value of improvements.	Value of city and town lots.	Value of improvements.
	<i>Acres.</i>				
Apache.....	784,150	\$188,565.89	\$69,300.00	\$16,999.00	\$46,505.50
Coconino.....	703,605	235,981.31	31,099.00	159,114.50	229,422.50
Cochise.....	96,895	1 148,124.00	152,204.00	27,727.00	344,369.00
Graham.....	39,710	1 599,771.35	650,352.25	54,541.00	102,119.00
Gila.....	3,002	1 169,474.00	128,470.00	66,430.00	136,867.00
Maricopa.....	251,729	1 3,330,267.00	506,673.00	2,464,002.00	1,205,214.00
Mohave.....	647,396	1 201,965.39	114,920.00	46,037.00	-----
Navajo.....	1,036,497	1 269,658.56	38,267.10	87,463.83	173,540.00
Pinal.....	55,854	1 404,209.50	209,997.00	44,276.50	56,285.00
Pima.....	74,034	1 228,883.00	126,013.00	719,177.00	881,205.00
Santa Cruz.....	59,227	1 77,199.00	17,515.00	63,317.00	170,130.00
Yavapai.....	392,394	1 601,783.51	734,033.00	476,627.50	569,457.00
Yuma.....	34,519	1 76,945.79	83,128.00	63,064.00	73,035.00
Total.....	4,179,012	6,532,828.30	2,861,971.35	4,288,776.33	3,988,149.00

County.	Horses.		Mules.		Asses.	
	Number.	Value.	Number.	Value.	Number.	Value.
Apache.....	2,854	\$52,082.03	53	\$1,350.00	179	\$862.00
Coconino.....	3,520	69,580.00	24	960.00	70	350.00
Cochise.....	3,919	64,557.00	119	2,975.00	191	1,018.00
Graham.....	3,698	89,706.88	112	2,872.27	262	2,647.00
Gila.....	3,101	53,126.00	98	2,450.00	357	1,785.00
Maricopa.....	4,498	96,040.00	222	5,550.00	45	370.00
Mohave.....	2,514	75,255.00	14	490.00	85	425.00
Navajo.....	2,207	42,070.00	61	1,995.00	78	390.00
Pima.....	4,132	63,482.00	209	5,285.00	23	115.00
Pinal.....	2,095	29,447.00	112	2,800.00	96	431.00
Santa Cruz.....	1,933	26,730.00	139	5,060.00	39	274.00
Yavapai.....	6,489	127,735.00	74	2,105.00	201	1,882.00
Yuma.....	586	13,161.00	44	1,100.00	13	87.00
Total.....	41,546	803,021.91	1,281	34,972.27	1,639	10,636.00

County.	Cattle.		Sheep.		Goats.	
	Number.	Value.	Number.	Value.	Number.	Value.
Apache.....	8,125	\$85,304.00	109,104	\$218,208.00	3,001	\$6,002.00
Coconino.....	15,627	164,728.05	164,000	328,000.00	901	1,802.00
Cochise.....	66,780	671,744.00	6,710	13,420.00	427	854.00
Graham.....	57,076	578,278.00	1,231	2,462.00	3,885	7,765.00
Gila.....	40,766	407,660.00	13	26.00	4,411	8,822.00
Maricopa.....	22,800	288,870.00	7,006	14,012.00	1,305	2,610.00
Mohave.....	22,347	224,385.00	14,573	29,146.00	800	1,600.00
Navajo.....	9,220	114,476.15	88,445	176,910.00	530	1,060.00
Pinal.....	23,213	273,666.00	4,034	8,068.00	-----	-----
Pima.....	40,881	412,805.00	2,990	5,980.00	482	964.00
Santa Cruz.....	14,394	143,727.00	20	40.00	10	20.00
Yavapai.....	47,665	479,545.00	51,938	103,876.00	3,870	7,640.00
Yuma.....	982	10,765.00	-----	-----	-----	-----
Total.....	369,876	3,855,953.20	450,074	900,148.00	19,620	39,140.00

¹ Also includes value of patented and unpatented mines assessed.

Statement of assessed valuation of property—Continued.

County.	Swine.		All other property.	Railroads.		Total valuation.
	Num-ber.	Value.		Miles.	Valuation.	
Apache	172	\$619.00	\$185,422.65	54.48	\$136,205.00	\$1,007,425.07
Coconino	201	1,005.00	370,646.05	123.66	283,650.00	1,876,338.41
Cochise	90	325.00	555,632.20	177.85	991,948.50	2,974,897.70
Graham	579	1,737.00	275,162.73	41.00	128,246.80	2,495,662.28
Gila	377	1,885.00	271,912.00			1,248,907.00
Maricopa	4,369	10,922.50	824,438.09	97.09	563,513.91	9,312,482.50
Mohave	105	368.00	263,252.55	108.076	270,190.00	1,228,093.94
Navajo	247	1,113.00	161,094.55	57.208	143,020.00	1,211,058.19
Pinal	195	585.00	200,918.50	80.29	476,316.64	1,707,000.14
Pima	339	1,017.00	537,189.00	64.75	394,417.40	3,376,512.40
Santa Cruz	81	293.00	237,655.00	52.04	195,976.00	937,986.00
Yavapai	558	1,674.00	1,021,328.85	60.552	103,051.46	4,230,738.32
Yuma	569	1,422.50	77,230.50	82.5	502,539.55	902,478.34
Total	7,882	22,966.00	4,981,882.67	999.496	4,189,075.26	32,509,520.29

According to the foregoing table the Territory has the following assessed taxable property:

4,179,012 acres of taxable land	\$6,532,828.80
Improvements thereon	2,861,971.35
City and town lots	4,288,776.33
Improvements thereon	3,988,149.00
41,546 horses	803,021.91
1,281 mules	34,972.27
1,639 asses	10,636.00
369,876 cattle	3,855,953.20
450,074 sheep	900,148.00
19,620 goats	39,140.00
7,882 swine	22,966.00
999.496 miles of railroad ¹	4,189,075.26
All other property	4,981,882.67
Total	32,509,520.29

The average valuation is:

Land, per acre	\$1.56
Horses, per head	19.33
Mules, per head	27.30
Cattle, per head	10.43
Goats, per head	2.05
Sheep, per head	2.00
Asses, per head	6.49
Hogs, per head	2.91
Railroad, per mile	4,191.19

¹ There are 454 miles of new railroad in the Territory exempted from taxation for a term of years.

FINANCES.

Statement of the bonded and floating indebtedness of the Territory, June 30, 1899.

Date.	Title.	Time (years).	Rate, per cent.	Amount.
July 1, 1885	Insane asylum bonds	20	7	\$74,000.00
November 1, 1885	Wagon road and bridge bonds	15	8	12,000.00
May 15, 1885	Gila bridge bonds	15	8	8,000.00
January 1, 1887	Arizona University bonds	20	7	12,000.00
January 15, 1888	Territorial funding bonds	25	6	140,000.00
July 1, 1892	World's fair bonds	20	5	30,000.00
July 15, 1892	Territorial funding bonds	50	5	2,000,000.00
January 15, 1896	Territorial funding bonds	50	5	300,000.00
June 1, 1898	Capitol building bonds	50	5	100,000.00
Total				2,676,000.00
Deduct county and city indebtedness funded				1,634,027.57
Bonded debt account of Territory				1,041,972.43
Floating debt (general-fund warrants)				136,338.44
Total				1,178,310.87
Cash on hand				152,836.90
Less amount paid for interest on old warrants				53,719.31
Less amount paid for interest on Yavapai County bonds				971,754.66
Net debt of Territory				23,836.90

Statement of Territorial receipts and disbursements for seven months, January 1 to July 31, 1899.

Cash on hand December 31, 1898.....\$351,139.98

RECEIPTS.

Sale of bonds	\$31,716.44
Counties account, tax levy	215,946.18
Counties and municipalities, account funded debt interest	36,312.15
Chairman of investigating committees	108.00
E. J. Bennett, secretary	790.08
Insurance tax	5,638.16
Herbert Brown, superintendent	711.00
United States Government (agricultural college fund)	25,000.00
Escheated estate	160.35
Rent of school lands	912.73
	<u>317,295.09</u>
	668,435.07

DISBURSEMENTS.

General fund warrants paid	\$94,217.30
Interest on above	\$12,907.63
General fund warrants funded	84,320.23
Interest on above funded	24,331.88
Insane asylum warrants funded	1,121.45
Interest on above funded	278.31
Gila bridge bonds funded	7,000.00
Six per cent funding bonds funded	10,000.00
Interest on above 6 per cents funded	250.00
Insane asylum bonds funded	8,000.00
Interest on above funded	46.64
Insane asylum bonds paid	8,000.00
Interest on above	256.64
University of Arizona bonds paid	2,000.00
Interest on above	38.90
Interest on funding bonds	123,975.00
Interest on bonds other than above mentioned	12,480.00
Total interest paid	<u>174,564.50</u>

Warrants other than general funds paid	\$96,163.63
Expense (mostly bond and warrant calls)	613.74
Total expenditures	\$486,000.85
Cash on hand July 31, 1899	182,434.22

NATIONAL AND TERRITORIAL BANKS.

The following comparative tables, showing the increase of business in the banks of Arizona during the three years ended June 30, 1899, are especially interesting and instructive, as they are very significant of the Territory's progress and its remarkable increased strength financially:

NATIONAL BANKS.

Statements made to the Comptroller of the Currency, July 14, 1896.

RESOURCES.

	Loans, dis- counts, and overdrafts.	Stocks, se- curities, and claims.	United States bonds and prem- ium.	Cash and due from banks.	United States redemp- tion fund.	Banking house, furni- ture and fixtures.
Phoenix National Bank, Phoenix	\$180,989.15	\$39,751.77	\$75,000	\$60,161.29	\$1,125.00	\$6,000.00
National Bank of Arizona, Phoenix	156,981.57	15,275.27	25,000	60,652.46	1,125.00	3,500.00
Prescott National Bank, Prescott	201,735.95	20,781.60	27,000	136,721.70	1,225.00	2,200.00
Consolidated National Bank, Tucson	73,855.34	33,082.81	13,500	104,809.21	562.50	3,072.54
Arizona National Bank, Tucson	45,287.77	44,491.93	12,750	122,420.17	562.50	640.00
Total	658,849.78	153,383.38	153,250	484,764.83	4,600.00	15,412.54

LIABILITIES.

	Capital stock.	Surplus and undivided profits.	National bank notes out- standing.	Deposits.	Total.
Phoenix National Bank, Phoenix	\$100,000	\$23,448.54	\$22,500	\$217,078.67	\$363,027.21
National Bank of Arizona, Phoenix	100,000	21,321.17	22,500	118,713.13	262,534.30
Prescott National Bank, Prescott	100,000	19,401.07	22,200	248,063.18	389,664.25
Consolidated National Bank, Tucson	50,000	8,484.67	11,250	159,147.73	228,882.40
Arizona National Bank, Tucson	50,000	9,886.61	2,600	163,665.76	226,152.37
Total	400,000	82,542.06	81,050	906,668.47	1,470,260.53

Statements made to the Comptroller of the Currency, June 30, 1899.

RESOURCES.

	Loans, dis- counts, and overdrafts.	Stocks, se- curities, and claims.	United States bonds and prem- ium.	Cash and due from banks.	United States redemp- tion fund.	Banking house, furni- ture and fixtures.
Phoenix National Bank, Phoenix	\$477,750.71	\$58,764.06	\$77,250	\$287,705.37	\$3,375.00	\$4,000.00
National Bank of Arizona, Phoenix	282,138.65	13,276.93	25,000	64,691.17	1,125.00	3,500.00
Prescott National Bank, Prescott	211,578.87	17,575.35	50,000	263,720.57	2,250.00	1,000.00
Consolidated National Bank, Tucson	209,610.24	36,183.17	13,500	443,269.07	562.50	18,859.61
Arizona National Bank, Tucson	92,754.95	27,042.80	13,750	178,997.16	562.50	609.42
Total	1,273,833.42	152,842.31	179,500	1,238,383.34	7,875.00	27,969.03

Statements made to the Comptroller of the Currency, June 30, 1899—Continued.

LIABILITIES.

	Capital stock.	Surplus and undivided profits.	National bank notes outstanding.	Deposits.	Total.
Phoenix National Bank, Phoenix	\$100,000	\$49,178.85	\$87,500	\$892,168.29	\$908,845.14
National Bank of Arizona, Phoenix	100,000	36,037.18	22,000	231,094.57	389,731.75
Prescott National Bank, Prescott	100,000	38,204.74	36,650	371,270.05	546,124.79
Consolidated National Bank, Tucson	50,000	8,658.01	11,250	652,076.58	721,984.59
Arizona National Bank, Tucson	50,000	13,251.49	2,900	247,565.34	313,716.83
Total	400,000	145,330.27	140,300	2,194,772.83	2,880,403.10

TERRITORIAL BANKS.

Statements made to the Territorial bank commissioner February 21, 1896.

RESOURCES.

	Loans, discounts, and overdrafts.	Stocks, securities, and claims.	United States bonds.	Real estate, furniture, and fixtures.	Cash and due from banks.
Bank of Arizona, Prescott	\$147,017.49	\$29,562.53	\$60,000	\$26,722.50	\$58,023.66
Valley Bank, Phoenix	255,340.06	4,350.00	-----	8,755.00	54,067.40
Arizona Central Bank, Flagstaff	75,752.62	19,718.31	-----	2,900.00	25,131.74
International Bank, Nogales	12,688.78	1,035.08	-----	3,261.14	14,886.67
West. Investmt. Banking Co., Phoenix	17,843.09	11,046.35	-----	1,969.00	13,960.84
Farmers and Merchants' Bank, Tempe	76,923.30	2,380.70	-----	1,212.50	38,292.46
Mesa City Bank, Mesa	16,732.54	2,067.91	-----	9,499.75	5,675.78
Total	602,347.88	70,160.88	60,000	53,719.89	210,008.55

LIABILITIES.

	Capital stock.	Surplus and undivided profits.	Deposits.	Total.
Bank of Arizona, Prescott	\$50,000	\$14,154.70	\$257,171.48	\$321,326.18
Valley Bank, Phoenix	100,000	27,912.15	194,570.31	322,482.46
Arizona Central Bank, Flagstaff	20,000	10,743.22	92,159.45	122,902.67
International Bank, Nogales	5,000	39.10	23,832.57	31,871.67
West. Investmt. Banking Co., Phoenix	15,200	1,143.79	28,475.49	44,819.28
Farmers and Merchants' Bank, Tempe	25,000	6,569.30	87,239.66	118,808.96
Mesa City Bank, Mesa	20,400	3,589.11	10,036.87	34,025.98
Total	235,600	64,151.37	696,485.83	996,237.20

Statements made to the Territorial bank commissioner June 30, 1899.

RESOURCES.

	Loans, discounts, and overdrafts.	Stocks, securities, and claims.	United States bonds.	Real estate, furniture, and fixtures.	Cash and due from banks.
Bank of Arizona, Prescott	\$213,015.65	\$6,304.69	\$75,000	\$36,000.00	\$249,206.94
Valley Bank, Phoenix	350,952.37	40,447.33	-----	22,570.07	113,071.76
Arizona Central Bank, Flagstaff	194,155.51	6,991.15	-----	3,810.00	77,373.09
International Bank, Nogales	40,822.95	2,095.15	-----	4,457.57	35,966.62
West. Investmt. Banking Co., Phoenix	16,824.91	-----	-----	-----	7,412.85
Farmers and Merchants' Bank, Tempe	80,049.45	2,050.60	-----	4,261.00	23,132.95
Mesa City Bank, Mesa	21,180.20	3,056.34	-----	4,752.75	8,063.89
Total	917,001.04	60,945.26	75,000	75,851.39	514,278.10

Statements made to the Territorial bank commissioner June 30, 1899—Continued.

LIABILITIES.

	Capital stock.	Surplus and undivided profits.	Deposits.	Total.
Bank of Arizona, Prescott.....	\$50,000	\$15,000.00	\$514,527.28	\$579,527.28
Valley Bank, Phoenix.....	100,000	26,953.83	400,087.70	527,041.53
Arizona Central Bank, Flagstaff.....	20,000	10,500.38	251,829.37	282,329.75
International Bank, Nogales.....	15,000	3,551.95	64,790.34	83,342.29
West. Investmt. Banking Co., Phoenix.....	300	105.61	23,832.15	24,237.76
Farmers and Merchants' Bank, Tempe.....	24,000	2,667.90	82,876.10	109,544.00
Mesa City Bank, Mesa.....	10,400	121.06	26,532.12	37,053.18
Total.....	219,700	58,900.73	1,364,475.06	1,643,075.79

CUSTOMS.

Following is a statement by the collector of customs, port of Nogales, of the business of the district of Arizona for the current year:

Statement of imports into the district of Arizona during the fiscal years ending June 30, 1898, and June 30, 1899, respectively.

CONSUMPTION.

When imported.	Free.	Dutiable.	Total imports.	Duties collected.
1898.				
July.....	\$200,445	\$6,745.00	\$207,190.00	\$2,496.41
August.....	176,931	11,069.00	188,000.00	3,656.88
September.....	210,317	2,253.00	212,570.00	1,031.28
October.....	184,698	6,606.00	191,304.00	2,178.14
November.....	242,547	48,665.00	291,212.00	31,180.76
December.....	325,835	70,674.00	396,509.00	36,104.73
1899.				
January.....	295,877	5,962.00	301,839.00	2,063.43
February.....	193,259	15,969.00	209,228.00	5,775.93
March.....	225,730	18,822.00	244,552.00	6,551.47
April.....	243,914	10,179.00	254,093.00	3,766.05
May.....	228,491	71,808.00	300,299.00	24,045.13
June.....	325,106	21,985.00	347,091.00	7,686.51
Total 1898-99.....	2,853,150	290,737.00	3,143,887.00	126,566.72
Total 1897-98.....	3,432,230	282,734.35	3,714,964.35	138,965.48
Decrease.....	579,080		571,077.35	12,398.76
Increase.....		8,002.65		
Additional duties pertaining to 1898-99.....				1,320.64
Total decrease in duties collected.....				11,078.12

Warehouse and immediate transportation.

When imported.	Values.	Duties.
1898.		
July.....	\$99,571	\$38,780.59
August.....	183,913	43,073.57
September.....	217,123	48,037.80
October.....	270,082	59,811.95
November.....	220,470	52,886.88
December.....	69,524	22,127.80
1899.		
January.....	69,259	16,185.76
February.....	37,525	11,408.39
March.....	62,963	19,999.86
April.....	50,996	15,138.00
May.....	52,318	13,213.91
June.....	58,893	16,160.23
Total 1898-99.....	1,392,637	356,824.74
Total 1897-98.....	803,728	245,702.13
Increase.....	588,909	111,122.61

Number of cattle imported, free and dutiable, with value of dutiable.

Year ending June 30—	Dutiable.	Free.	Value of dutiable.
1899.....	18,937	903	\$167,244
1898.....	32,231	6,428	212,422
Decrease.....	13,294	5,525	45,178

Duties levied and collected on cattle.

Year.	Number of head.	Duties collected.	Average duty per head.
1898-99.....	18,937	\$61,664.73	\$3.25
1897-98.....	32,231	93,227.52	2.89

Exports.

Year.	Total value.
1898-99.....	\$1,518,980
1897-98.....	1,188,381
Increase.....	330,599

Comparative statement of percentage of dutiable and free importations for consumption, and the average rate of duty collected on dutiable merchandise.

Year.	Imports.	Dutiable.	Free of duty.	Average rate of duty collected.
1897-98.....	\$3,714,964.35	<i>Per cent.</i> 7½	<i>Per cent.</i> 92½	<i>Per cent.</i> 48.7
1898-99.....	3,143,887.00	9½	90½	43.5

SETTLEMENT OF LANDS.

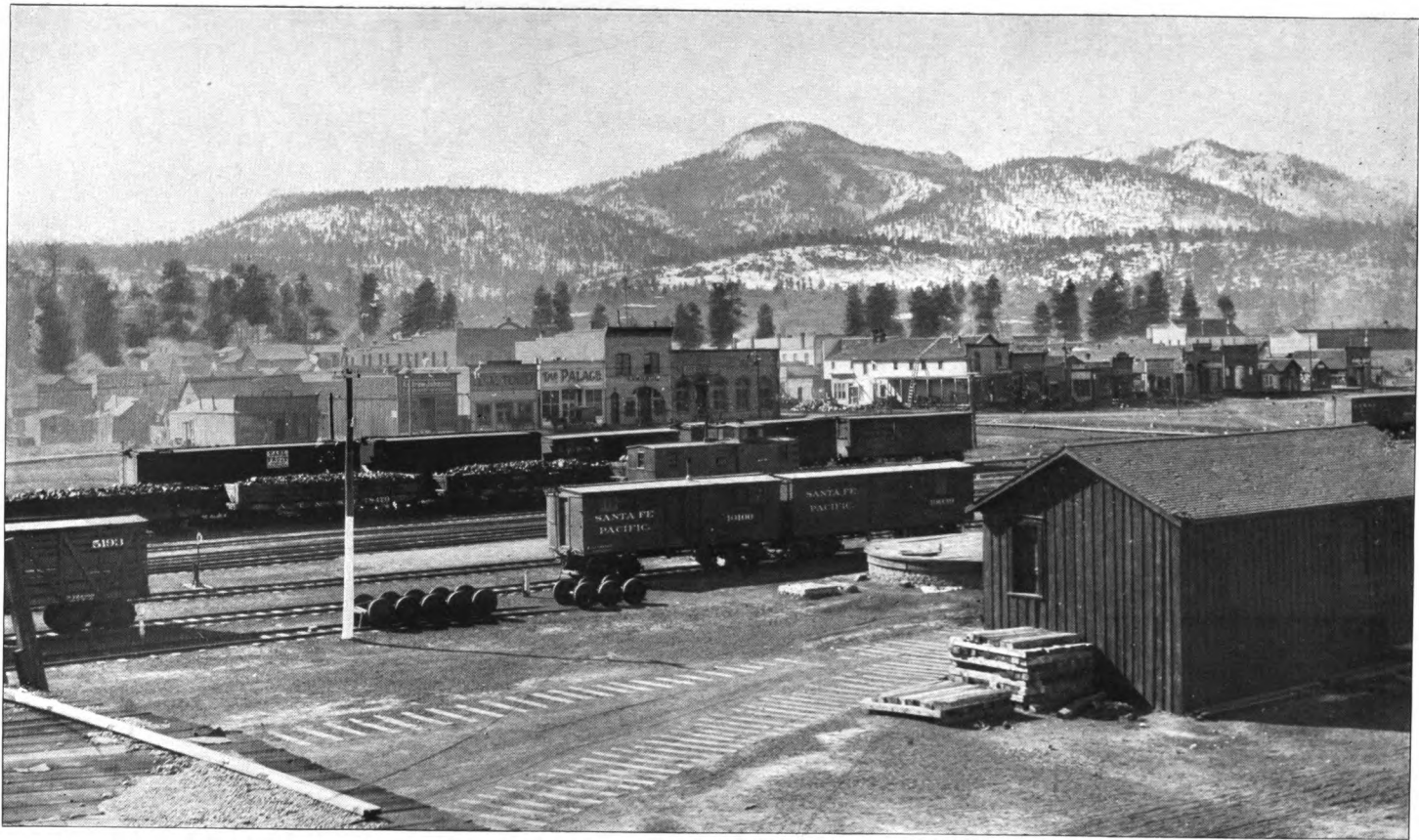
The following statements from the land offices at Tucson and Prescott show the amount of land taken up in the Territory during the past year, giving amount of land covered by original and final entries:

Transactions for fiscal year ending June 30, 1899, in the United States land office at Tucson.

Class of entry.	Entries.	Acres.
Original homestead entries.....	240	31,712.41
Final homestead entries.....	73	9,205.67
Original desert-land entries.....	51	6,945.54
Final desert-land entries.....	20	4,235.29
Cash entries.....	35	2,304.57
Final timber-culture entries.....	5	600
Land-warrant entries.....	2	320
Lieu-land entries.....	44	4,154.66
Mineral entries.....	19	1,060.5794
Total.....	489	60,536.7194

During the fiscal year 162,850.74 acres of public land were surveyed (not including reservations).

One hundred and sixty-two lode claims and 4 mill sites were surveyed in this district for patent during the fiscal year.



WILLIAMS, COCONINO COUNTY.

Transactions for the fiscal year ending June 30, 1899, in the United States land office at Prescott.

Class of entry.	Entries.	Acres.
Sales of mineral lands	29	1,877
Sales of lands under act of August 23, 1894	6	399.57
Homestead entries commuted to cash under section 2301, Revised Statutes	9	1,355.33
Original homestead entries	70	9,998.72
Final homestead entries	39	5,519.67
Original mineral applications	26	999
Original desert-land applications	10	2,041.39
Final desert-land entries	1	240
Total	190	22,430.68

Statement showing the status of the lands in the Territory, as compiled from the records of the United States land offices.

County.	Surveyed.	Unsurveyed.	Total.	Appropriated.	Reserved vacant.	Total.
	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>
Apache	1,053,263	708,166	1,761,429	1,222,900	4,182,866	7,170,000
Cochise	1,391,941	2,196,671	3,588,612	258,311	1,135,077	3,982,000
Coconino	614,781	8,488,205	9,102,986	699,469	3,427,545	13,230,000
Gila	83,166	1,687,530	1,770,696	34,870	1,123,934	2,929,500
Graham	775,705	2,096,924	2,872,629	255,371	1,010,000	4,138,000
Maricopa	1,333,639	3,900,418	5,234,057	626,903	193,040	6,054,000
Mohave	984,099	5,721,942	6,706,041	45,969	383,990	7,136,000
Navajo	1,270,085	633,000	1,903,085	1,011,095	3,465,820	6,380,000
Pima	866,797	4,535,604	5,402,401	439,885	91,414	5,933,700
Pinal	810,050	2,126,315	2,936,373	242,157	295,970	3,474,500
Santa Cruz		450,428	691,801	22,499	66,000	780,300
Yavapai	856,233	3,718,182	4,574,415	498,455	184,130	5,257,000
Yuma	617,825	5,063,291	5,681,116	334,784	311,600	6,327,500
Total	10,898,865	24,326,776	52,225,641	5,695,478	14,871,386	72,792,500

As will be seen from the foregoing table, there are 24,326,776 acres of unsurveyed land in the Territory. It is very important that these lands be surveyed, especially the unsurveyed railroad-grant lands, so that they may be assessed for taxation. Considerable revenue would accrue to some of the northern counties if these lands could be taxed.

COMMERCE AND RAILROADS.

The traffic of the railroads of the Territory has materially increased during the past year, and there is every indication of a continued increase. They are continually demonstrating their confidence in the development of the Territory by making many improvements to their property of a permanent character.

During the year the Santa Fe and Grand Canyon Railway Company has actively commenced construction of a standard-gauge road from Williams, on the Santa Fe Pacific Railroad, to the Grand Canyon of the Colorado, a distance of 64 miles, and it is expected that it will be completed and in operation by January 1, 1900. It is stated that the construction of this road will materially assist in the development of mining properties, and will afford rapid transportation of tourists to the Grand Canyon of the Colorado, the wonders of which are so well known.

The Arizona and Utah Railway Company has constructed and has in operation a road from McConnico Junction, near Kingman, on the

Santa Fe Pacific Railroad, to Chloride, in Mohave County, a distance of 23 miles, and it has in contemplation an extension to the White Hills mining district, a distance of about 40 miles, and later to Utah. The road as now constructed provides transportation facilities for the gold and silver mines of the Chloride district, and farther extension will supply the mines of northwest Arizona with facilities much needed.

It brings direct rail transportation to the rich and prolific mining camps of Chloride, Mineral Park, Todd Basin, Union Basin, Cerbat, White Hills, etc., all sections abounding with strong veins of lead, silver, gold, and copper, and destined to become, under the stimulus of improved facilities, one of the greatest mining districts of the West. These are not new and untried camps. Their values have been proven for many years, and large development has only awaited the advent of the railroad.

The Santa Fe, Prescott and Phoenix Railway Company contemplates the construction, in the near future, of a branch line northwest of Hot Springs Junction, in Maricopa County, to Castle Creek Hot Springs, in Yavapai County, and to the mining districts in that section, which have recently developed sufficiently to attract the attention of that company.

The Prescott and Eastern Railroad Company has in contemplation the construction of other branches to further serve and develop other meritorious mineral sections.

A company has been incorporated to construct a road from Phoenix to Globe, in Gila County.

The roads now in operation in the Territory are as follows:

	Gauge.	Miles
Southern Pacific of Arizona, extending along the southern part of the Territory from Yuma, on the Colorado River, to the eastern boundary of Cochise County, passing through the counties of Yuma, Maricopa, Pinal, Pima, and Cochise	4. 8 1/2	383
Santa Fe Pacific, crossing north of the center of the Territory, near the thirty-fifth parallel, and passing through the counties of Apache, Navajo, Coconino, Yavapai, and Mohave	4. 8 1/2	393
Santa Fe, Prescott and Phoenix, running from Ash Fork, on the line of the Santa Fe Pacific, through the counties of Yavapai and Maricopa to Phoenix	4. 8 1/2	197
Gila Valley, Globe and Northern, running from Bowie, on the Southern Pacific, in Cochise County, to Globe, Gila County	4. 8 1/2	140
New Mexico and Arizona, running from Benson, on the Southern Pacific, in Cochise County, to Nogales, in the same county, at the Mexican line	4. 8 1/2	87
Arizona and New Mexico, running from Clifton, in Graham County, to the Southern Pacific at Lordsburg, N. Mex	3	71
Arizona and Southeastern, running from Bisbee, Cochise County, to Benson, on the Southern Pacific, in the same county	4. 8 1/2	54
Maricopa and Phoenix and Salt River Valley, running from Maricopa, Pinal County, on the Southern Pacific, to Phoenix, Maricopa County, with a branch from Tempe, Maricopa County, to Mesa, in the same county	4. 8 1/2	43
Prescott and Eastern, running from a point on the Santa Fe, Prescott and Phoenix, Yavapai County, to Mayer, in the same county	4. 8 1/2	27
United Verde and Pacific, running from Jerome Junction, on line of Santa Fe, Prescott and Phoenix Railway, to Jerome, Yavapai County	3	26
Congress Gold Company, running from Congress Junction, on Santa Fe, Prescott and Phoenix, in Yavapai County, to the Congress Mine	4. 8 1/2	4
Arizona and Utah, running from McConnico Junction, on the Santa Fe Pacific, in Mohave County, to Chloride, in the same county	4. 8 1/2	23
Total		1,452

Railroads are also projected from Morenci, Graham County, to Guthrie, same county, 18 miles, and from Helvetia Camp, Santa Rita Mountains, to Tucson, Pima County, 35 miles.

TAXATION OF THE SANTA FE PACIFIC RAILROAD (FORMERLY ATLANTIC AND PACIFIC).

Under the act of Congress of July 27, 1866 (c. 278, 14 Stat., 292, 294), it is claimed that the exemption from taxation in the Territories of the United States of the right of way of the Atlantic and Pacific Railroad Company included the track, land, and structures thereon within the right of way.

The questions involved have been contested until the Supreme Court of the United States has decided in favor of the railroad company and holds that the track, land, and superstructures thereon are not taxable within the meaning of the law. (United States Reports, vol. 172, p. 171.) Ever since the completion of the railroad, in 1883, until the decision of the Supreme Court, in 1898, fifteen years, taxes have been paid by this railroad company upon varying valuations per mile, under compromise agreements with the counties through which the road passes (latterly upon a valuation of \$5,000 per mile). To cut this source of revenue off altogether is very severe upon the counties of Apache, Navajo, Coconino, Yavapai, and Mohave, comprising the northern tier of counties of the Territory. It compels a readjustment of assessed values upon other property and is felt to be a hardship by the people.

It is contended that when Congress granted the franchise the present developed condition of the Territory was not anticipated, and it assumed that the exemption only covered a barren and unoccupied country, which was the case when the act of 1866 was passed.

Section 20 of the act of July 27, 1866, closes with the words:

Congress may, at any time, having due regard for the rights of said Atlantic and Pacific Railroad Company, add to, alter, amend, or repeal this act.

Amendment by Congress of the act in question so as to make the track and superstructure within the right of way taxable would be of great benefit to Arizona. The railroad company has shown a commendable desire to meet the question fairly, but unless Congress affords relief in the manner suggested full taxation of this property can not be secured until Arizona is admitted as a State.

STOCK RAISING.

Of the four great industries of Arizona—mining, agriculture, horticulture, and stock raising—the latter continues to hold second place on the assessment rolls, with an aggregate valuation for this year of \$5,666,837.38. These figures fail to convey a proper idea of the magnitude of the industry. The official figures of 369,876 cattle, 450,074 sheep, 41,546 horses, 1,281 mules, 1,639 asses, 19,620 goats, and 7,882 swine, fall very far short of representing the actual number. This is especially true of cattle and sheep, and it is doubtful if the assessors' returns give more than 50 per cent of the real number.

As in all other branches of business, the past year has been a prosperous one for the grazers. Prices have been well maintained. The rains on the open ranges were unusually copious in July and were fairly well distributed during the succeeding months. There has been range feed for a much greater quantity of stock than in former years. Shipments of cattle to Kansas for fattening continues to be an important feature of the industry. The shipment of beeves ready for market to California, Denver, Kansas City, and Chicago from the alfalfa fields of the valleys has grown to be a business of

large proportions. It has been demonstrated beyond question that the bringing of range cattle to the valleys for fattening on the growing alfalfa is a decided success. The beef so produced is excellent. The business is profitable alike to the cattle owner and to the alfalfa grower.

The policy of improving the grades of live stock by importing the best blooded animals for breeding purposes has proven very profitable, and the operation of large alfalfa farms for the breeding and fattening of calves is becoming a popular and money-making business in the southern valleys.

The climatic conditions are always favorable to stock raising in Arizona. Cold and blizzards and deep snows are never a menace to the prosperity of the stockmen here, and the greater portion of the ranges is open every day in the year.

The raising of high-bred horses in the Salt River Valley is an industry that has a promising future. Enough progress has been made to prove the excellence of the locality for all the requirements of the business. But outside of this branch the raising of horses has ceased to be profitable. There are still thousands of horses on the ranges, but usually they are of the small and hardy Western variety, used principally for riding by cowboys. They are not in great demand and their value is inconsiderable.

In hogs Arizona has a great field for development. The hog raisers of the Salt River Valley and other farming regions of the Territory have found that the general conditions are exceedingly favorable. Hogs raised and fattened in the alfalfa fields and hardened with barley are shipped out in increasing numbers each year, and already the main supply of pork for southern California is furnished by Arizona.

Perhaps no other line of live-stock industry has been so profitable to stockmen of small means as have sheep. They require more experience in handling, but the returns to those in the wool-growing business have been exceedingly satisfactory.

One of the most vexatious problems connected with the cattle and sheep business is that of satisfactorily dividing the ranges between the cattle and sheep men. There is a constant conflict of interest between the owners of cattle and the owners of sheep, on account of there being no authoritative method of limiting the respective ranges on the public domain. No improvement can be expected in this respect until some systematic mode of controlling the open ranges has been devised and adopted. The question under present conditions frequently proves a serious menace to law and order. There are some 30,000,000 acres of grazing lands in the Territory, and the problem would be solved very quickly, and permanent harmony established between these two branches of the grazing industry, if a system of leasing the ranges were adopted. A cession of all the public lands to the Territory would enable the Territorial government to formulate and carry out a system of leasing. Such a system would not only be satisfactory to the stockmen, but it would yield a substantial revenue to the Territorial treasury. And since the grazing lands are a source of no revenue to the Government, the same argument applies to them that is urged in favor of the proposition of ceding the irrigable lands. Unquestionably it will become necessary at no distant day for the Government to adopt such regulations as will properly control grazing on the public domain and protect the equitable rights of both sheep and cattle men.



SCENE ON SUPAI TRAIL, CATARACT CREEK, COCONINO COUNTY.

AGRICULTURE AND HORTICULTURE.

The wisdom of maintaining an agricultural experiment station in connection with and under the auspices of the Territorial university has been fully demonstrated. The scope of the station's work grows wider each year, and with it is seen an added efficiency. The bulletins issued from time to time are widely circulated, and have an added value from the fact that the agriculturists of the Territory manifest a keen interest in all the subjects treated. The intellectual average of the farming population of Arizona is exceptionally high, and in such a community such work as is being done by the experiment station can not fail of intelligent criticism and good results.

The following report from the director of the station for the current year is submitted as giving a fair résumé of the conclusions which have been reached:

One of the most encouraging signs of the times in connection with Arizona is the growth of her agricultural interests. These interests, by creating a settled population and certain sources of wealth, insure the Territory, as a whole, against those excessive fluctuations in population and finance which are so often observed in purely mining communities. Although but a small percentage of the total area of Arizona is under cultivation, yet when the actual amount and productiveness of these lands is considered, the place of agriculture among the industries of the Territory is very important. Arizona has and always will have land in excess of the water supply available for irrigation, without which agriculture can, excepting in rare instances, hardly be considered. Out of about 72,800,000 acres in the Territory only 5,700,000 acres are privately owned, of which about 450,000 acres are under irrigation ditches. For the total amount of land under ditch, there is not sufficient water in all instances to insure crops; but in time there can be little doubt that the storage and development of water will lead to the successful irrigation of much more than the area under ditch.

The future of agriculture in Arizona is, without question, more than usually good, and for the reason that the conditions of soil, irrigation, and climate combine to produce an uncommon variety and amount of marketable produce. The soil of Arizona, as is usual with the soils of arid regions, are rich in the elements of fertility, requiring only the ever-needful water, skill, and industry in their management to secure abundant returns. The fertility of cultivated soils in irrigated regions is further assured by the deposit of silt brought upon the land with irrigation water. The problems of fertilization, which become so serious in humid sections, are therefore of much less importance here and not to be so carefully reckoned with in connection with the future of our agriculture.

The most marked advantage in connection with agriculture and horticulture, especially in southern Arizona, is the climate. From January to June the temperature resembles that of spring and early summer in the latitude of Kentucky. From June to September the climate is of subtropical fervor, while from September to November there is a second mild season of temperate weather. The winter season, from November to January, though subject to sharp frosts in southern Arizona, is not seriously or even uncomfortably cold.

Owing to this combination of seasons a remarkable variety of crops may be found in the same locality at different times of the year. Strawberries, which flourish in Greenland, may be found on the same land with dates and palms from Sahara. Alfalfa, the great forage of the arid West, flourishes alongside with wheat, corn, and sorghum, respectively characteristic of Minnesota, Illinois, and Kansas. Oranges, lemons, and olives from California may be found in the same neighborhood with peanuts and sweet potatoes from Virginia. In brief, many of the leading crops of both temperate and subtropical countries, which are not affected by a too arid atmosphere or by the frosts of winter, flourish in southern Arizona. In northern Arizona, where the temperatures more resemble those of northern Illinois, many of the more distinctively temperate-region crops flourish, such as potatoes, apples, and various small fruits.

When, with this diversity of products is coupled a healthful, and for the most of the year agreeable, climate, it will be seen that agriculture in Arizona possesses distinct advantages.

STAPLE CROPS.

ALFALFA.

Probably the most important crop in Arizona is alfalfa. With at least five cuttings a year possible, it may be stated that probably nowhere in the United States does this plant yield more abundantly.

It has several values in our agriculture. First, as hay there is a constant market at good prices in the adjoining mining country. During the past two years the short crop in California, with resulting high prices, has led to an annual output of hay from Arizona. This fact, among other things, illustrates the advantage of an irrigated region over one depending for crops upon rainfall. A more profitable use for alfalfa ordinarily is as a stock fattener. It is so employed in feeding hogs and cattle; also, in connection with a growing dairy industry. It is estimated that during 1898 about 35,000 head of cattle fattened on alfalfa were shipped from Salt River Valley. With improved methods of feeding, this output can doubtless be greatly increased.

With butter now being shipped into Arizona from Kansas, it is also evident that there is yet room for the growth of the dairy industry. There are now three creameries and cheese factories in the Territory, with probably more to come in the near future.

Another very important use of alfalfa is a soil renovator. Our semiarid desert soils are commonly dense and deficient in humus and nitrogen—circumstances leading to a condition of poor tilth, which often makes successful culture of ordinary crops a difficult matter. Alfalfa, however, flourishes in these soils, and in so doing loosens them to considerable depths by means of its roots; and through its process of growth and decay, contributes the much-desired humus and nitrogen to the soil. In this way alfalfa serves as a preparation for other crops; and it is a matter of common observation that orchards, wheat, sugar beets, and other crops all flourish best on ground which has previously been in alfalfa.

CORN.

It is only within the past few years that it has been known that fine crops of corn may be grown in the warmer regions of Arizona. Large crops of this product are annually grown on the upper Gila, in Graham County, and the acreage in Maricopa County is annually increasing. In order that the grain may properly fill, corn must be planted in July, or sufficiently late, so that in maturing it will just escape the fall frosts. The poor varieties of Mexican corn formerly grown in Arizona are giving way to the improved white Dent varieties from the north and east. Our seasons are sufficiently long to grow a crop of corn after harvesting a crop of wheat or barley.

In connection with alfalfa, and together with other forages of like nature, corn will probably prove more valuable in helping to make out a more perfect ration for cattle. Sorghum, root crops, and Kaffir corn are likely to prove valuable for the same purpose.

WHEAT.

The acreage and amount of wheat produced in Arizona is increasing each year. It is largely a winter and spring crop, maturing before the extremely dry weather of summer, when water is scarce. Large flourishing mills at Phenix, Tempe, Tucson, Solomonville, and Safford, are supplied by Arizona grown wheat. The chief variety cultivated heretofore has been the Sonora wheat, but there is room for useful experiment in securing other successful varieties for Arizona, in order to obtain a better milling combination than is afforded by the Sonora wheat alone. A number of experimental plots containing the most promising foreign varieties have been grown this year at the experiment farm near Phenix, yielding promising results in some cases. The average yield in the principal wheat-growing sections of the Territory is stated to be from 20 to 30 bushels per acre.

BARLEY.

Barley is chiefly grown in Arizona as a hay crop, being cut and baled for this purpose before maturity. Certain varieties of beardless and hull-less barley have recently been introduced in a few places, and are attracting some attention. The yield of grain per acre is stated to be from 30 to 50 bushels.



CATTLE AND ALFALFA.



ALMONDS.

OATS.

Oats are grown chiefly in the small valleys of northern Arizona, where this crop is of considerable importance. In some places the oats are also cut before maturity and converted into hay.

ROOT CROPS AND VEGETABLES.

Many of the most important root crops thrive in Arizona. The common potato grows wild in certain parts of the Territory. In the northern valleys, where irrigation is possible, heavy crops of potatoes are grown. During the long mild spring season potatoes may also be grown with marked success in the irrigated portions of southern Arizona. The chief difficulty in southern Arizona, however, is to preserve the potatoes after they are once grown, since in this warm section their tendency is to sprout and continue their growth shortly after maturity.

Sweet potatoes of excellent quality and in great quantity can be grown. Peanuts have also produced well, although their culture has as yet hardly passed the experimental stage.

Sugar beets and field beets yield abundantly if planted early enough in the year to mature before the extremely hot weather of midsummer.

Garden vegetables in unusual variety may be produced if skillful attention is paid to the planting season. As mentioned above, there are two mild, temperate seasons in southern Arizona—one extending from January to June, the other from September well into November. Certain of the more quickly growing vegetables, therefore, may be made to produce both in the spring and fall, this double season being recognized by the more experienced residents of this section. Among the vegetables most successfully grown are watermelons, which ripen about the 1st of July, and constitute a profitable crop in some sections of the Territory. Other vegetables which will succeed in northern Arizona are cabbages, peas, onions, cauliflowers, and various others which are gradually being added to the list from time to time as the methods of culture are becoming better understood.

FRUITS.

In northern Arizona, where the climate is temperate in character, peaches, grapes, and apples of superior quality are grown, but only in small quantities, since the irrigated area in northern Arizona is only limited in extent. Apricots and grapes are grown and shipped in large quantities from Salt River Valley. Raisins are also produced in considerable amount in this part of Arizona. Oranges and lemons of superior quality are produced in Salt River Valley. They have the advantage of a season earlier than that of southern California, while in addition the fruit is uncommonly bright and attractive in appearance. This is due to the fact that the scale insects perish from the effects of the dry, hot atmosphere, leaving the fruit unmarred by their presence. In certain favored situations protected from frost lemons have proved a success in Salt River Valley, and are said to be also a promising crop in the vicinity of Yuma. Strawberries in skillful hands have proved a profitable crop in Salt River Valley, the entire product thus finding a ready market in Arizona. Figs grow luxuriantly in southern Arizona, but require a constant and abundant supply of water in order to yield well. Almonds have been grown with varying success in southern Arizona. The great drawback of their culture is the late spring frosts, which are so likely to destroy the crop. For the past two years, however, the growers have in some instances succeeded in warding off the disastrous frosts by smudging their orchards at critical times. During this time valuable crops have been secured, especially in the vicinity of Mesa City.

Olives are a promising crop in southern Arizona. This tree requires comparatively little water, and the scale, which is so abundant upon the tree in California, is not found upon it in Arizona. Experts state that the trees grown in Arizona are unusually bright and attractive in appearance and their fruit of good quality. The product of the olive tree also, either in the form of pickles or oil, may be held for the best market and is of small weight and bulk in comparison with its value, shipping charges being thus economized. It is not improbable that this fruit has a growing future in Arizona, since the demand for olive products is at present, throughout the United States, far in excess of the supply.

NEW CROPS.

SUGAR BEETS.

The experiment station has continued its work with sugar beets during the past year with fair success. The following is a table of the results obtained thus far :

Sugar beets from Phoenix experiment station farm.

Variety.	When sown.	Harvested.	Irrigation.	Weight.	Yield per acre.	Sugar in juice.	Purity of juice.
				Ounces.	Tons.		
Kleinwanzlebener	Sept. 27, 1898	Mar. 31, 1899		9	7.9	12.13	79.3
Do	Jan. 18, 1899	June 12, 1899		11.4	11.5	13.5	79.2
Do	do	June 26, 1899	3	13.2	14.6	13.4	82.4
Vilmorin	Feb. 13, 1899	do	1	6	5.5	15	79.5
Do	do	do	2	5.4	4.8	16.5	88.4
Kleinwanzlebener	do	do	2	7.7	7.3	13.2	77.5
Do	Feb. 25, 1899	do	1	7.3	7.2	16	81.9
Do	do	do	1	8.6	8.8	15.45	79.9
Do	do	do	1	8.6	8.8	5.7	83.4
Do	Feb. 7, 1899	June 27, 1899	2	8.4	10.9	13.6	84.9
Do	do	do	3	10	10.4	11.9	79.5

The leading precautions observed in this work have been, first, to plant early in the year so that the beets could mature before the extremely warm weather of midsummer; second, to conduct the experiment on a sufficiently large scale to avoid the well-known loss of sugar and purity observed in small plantings; third, to give the growing crop the best and most skillful attention in connection with culture and irrigation. It will be noticed by the table that in many cases but one, but in no case more than three, irrigations were made. The results, however, show that, even with only one irrigation, some of the plots produce as much as 8.8 tons per acre. In comparison with the usual expense of water in raising crops in Arizona this is certainly a remarkable showing, and suggests what skillful culture may be made to accomplish in economizing irrigation water.

This year, at last, the Kleinwanzlebener beet has done better than the Vilmorin in southern Arizona. The year's experience, taken in connection with that of beet growers in California, also shows the advantage of an irrigated region over one depending for crops upon rainfall. The factories of California last year, on account of the drought for the past two years, were able to run but a fraction of their usual working time, while the factory at Lehi, in Utah, which depends upon irrigated beets, has prospered during the past season. It is hoped that the results with beets in southern Arizona may lead investors to make the most of the latter advantage and establish a factory in Arizona.

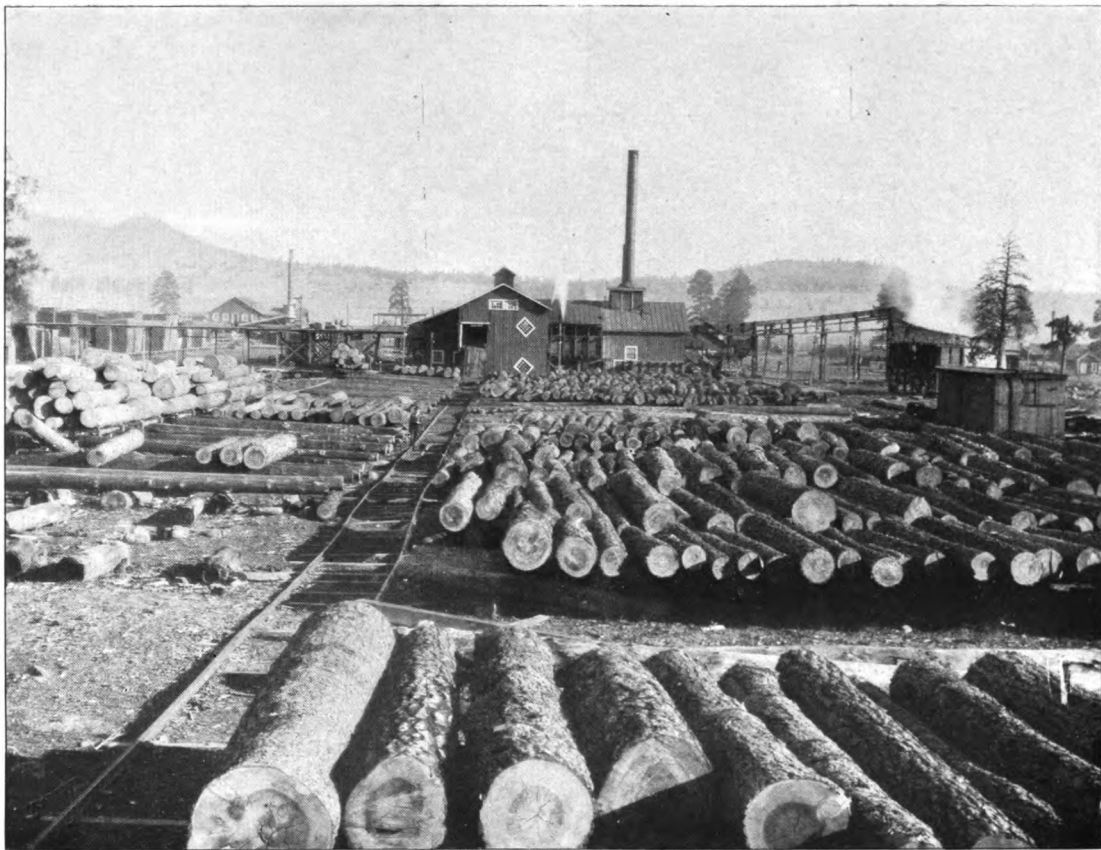
CANAIGRE.

At present little more can be said concerning canaigre than that it is an attractive proposition. Tannic acid, upon which the leather industry depends, is obtained chiefly from the barks and woods of various kinds of trees, especially chestnut, oak, hemlock, and quebracho, and others. Should the forests, however, affording this supply be once destroyed, it would require many years to restore the supply of tanning materials. Canaigre, however, is a crop which may be matured in from one to three or four years, according to circumstances, so that it promises to afford a means by which tannic acid may be agriculturally produced, as are many other staples. The green root contains from 8 to 12 per cent of tannic acid, which is from 25 to 35 per cent in the dry material. The plant is a winter grower, and on this account, possibly, has a future in the irrigation of great areas in the arid Southwest hitherto unreclaimed.

Although many prominent tanners have stated that canaigre is capable of producing excellent grades of leather, and although various concerns have been engaged during the past six or seven years in the culture of canaigre and the manufacture of extracts, it can hardly be said as yet that definite agricultural results have been obtained. This fact, however, does not necessarily reflect upon the merits of the article, which, with good management and favoring conditions, may yet win a place among standard tanning materials.



GRAPES



VIEW OF YARDS, SAWMILL, AND BOX FACTORY OF SAGINAW LUMBER COMPANY, WILLIAMS. MONTHLY PRODUCT 2,500,000 FEET SAWED LUMBER.

DATE PALMS.

Bulletin No. 30, of the Arizona agricultural experiment station, by J. W. Toumey, published June, 1898, attracted general attention to the date culture in the arid Southwest, especially in Arizona. Following up his study for this subject, Mr. Toumey went to Washington some months after publishing his work and interviewed the Secretary of Agriculture for the purpose of obtaining an appropriation which should be especially devoted to the importation of the best varieties of palms from the Old World. The varieties at present growing in Arizona are largely seedlings and consequently in most cases are of inferior quality. In the Old World, however, through centuries of culture and selection, the very best possibilities of the tree have been realized. The quickest way, therefore, to reap the benefits of date culture in Arizona is to import these long-established and well-tried varieties from Arabia, Egypt, Algiers, and elsewhere, and set them to growing in this locality. A suitable tract of land was secured 3 miles south of Tempe, Ariz., through the public spirit and generosity of Mr. John Jungermann, and title conveyed to the station for the same, on condition that it should be devoted to the culture of date palms. This experimental tract comprises 15 acres, having room for nearly 2,000 palms. It has already been partly planted with male trees from the adjoining localities, while the first shipment of foreign palms is now on the road. In view of the natural advantages possessed by southern Arizona for palm culture and the generosity of the Secretary of Agriculture in furthering this project, it may be stated that the outlook for date-palm culture in Arizona is very satisfactory.

VARIOUS OTHER NEW CROPS.

The value of various other crops is being tried from time to time through private enterprise and at the experiment station.

Different varieties of sorghum, introduced some years ago in Arizona, various kinds of forage corn, teosinte, sweet and crimson clover, mangels, and various other crops are among those under observation.

Tobacco grows well in Arizona under irrigation. Some of the product is worked up by local manufacturers, more particularly for the Mexican trade. Sugar cane about equal to that raised in Louisiana and Texas can be grown in southern Arizona, both in the vicinity of Tucson and near Yuma.

In conclusion it may be stated that from an agricultural and horticultural point of view the past year has been an unusually prosperous one for Arizona. This is due in part to the increasing experience of the agricultural public with the conditions under which they are working, and in some cases to unusually good markets for agricultural products. On the whole there is good reason for belief in the growing future of agriculture in Arizona.

FORESTS.

Arizona has the largest unbroken pine forest in the United States, covering an area of over 6,000 square miles. This timber is usually found at an altitude between 5,500 and 7,500 feet. The total quantity of pine timber fit for sawing purposes within the boundaries of the Territory amounts to 10,000,000,000 feet, which can supply the needs of a populous State for more than a century. The principal forest area is in Coconino County and borders the Grand Canyon of the Colorado, although Gila, Apache, and Yavapai counties have considerable timber. In the Mogollon Mountains in Yavapai, Coconino, and Gila counties there are large bodies of oak timber suitable for the manufacture of farm machinery, wagons, etc., and for finishing lumber, but at present it is too inaccessible to be of great commercial value. The Government has created some large forest reserves in northern Arizona and promulgated rules for their regulation with a view to their preservation from spoliation and to prevent destruction by fire. The principal lumber mills of Arizona are situated at Flagstaff and Williams, in Coconino County, on the line of the Santa Fe Pacific Railway, and their equipment is modern in every way. The Arizona Lumber and Timber Company at Flagstaff and the Saginaw Lumber

Company at Williams have as complete plants for the manufacture of lumber, boxes, etc., as can be found in the United States.

The forests of Arizona are Sonorian in character and belong to the interior forest area, which covers all that region embraced between the forests of the Pacific and the extreme western limit of the Atlantic region. The forests of much of this area, when compared with those of more humid regions, are more stunted in growth, fewer individuals to a given area, and with much less variation in their composition. However, the forests of the southern portion of this area, which includes Arizona, are heavy, dense, and valuable, when compared with other portions of the interior region.

In this Territory the valuable forests are confined to the higher portions of the Colorado plateau and to the slopes and canyons of our numerous mountains. They attain their highest development in the high San Francisco Mountains, and from here stretch away with more or less extended interruptions to and beyond the Grand Canyon of the Colorado to the north, to Bill Williams Mountain in the west, and southward to the great rim where the Colorado plateau breaks down to the southern plains.

To the southwest, with a number of interruptions, they become dense and heavy in the higher ranges of the White Mountains, and from here extend into western New Mexico. Long arms of forest area also extend into all the mountains immediately south of the Colorado plateau which reach an elevation of more than 7,000 feet. The isolated ranges farther south are also timbered above 7,500 feet. The great forest area embraced in the Coconino and San Francisco region is considered by our greatest authority on American forests as one of the largest unbroken forests in the United States. It is almost entirely of yellow pine (*Pinus ponderosa*) and its varietal forms. This species of pine is the most widely disseminated and abundant tree of the interior forest area, and in Arizona, where it reaches its highest development, is practically the only tree of commercial importance in the manufacture of lumber.

On the higher mountains of northern Arizona, above the area of yellow pine, are a number of trees usually considered valuable for lumbering purposes, but their restricted area and inaccessibility render them as yet of little commercial value.

INDIGENOUS TREES AND SHRUBS FOR SHADE AND ORNAMENTAL PURPOSES.

The people of Arizona do not properly appreciate the value of nature's trees and shrubs to plant about their homes for ornamental and shade purposes. We can not expect to bring trees and shrubs from regions where they have been accustomed to humid atmosphere and grow them with any degree of success in Arizona.

We are inclined to look to foreign countries and other States for our ornamental trees and shrubs when, with a little care in selection, we can find in our own flora a variety of such plants that will grow with a minimum amount of care and in a few years surpass in appearance anything which we may bring in from outside. Generations of exposure to the conditions of an arid region enable them to survive and even flourish where plants unaccustomed to such environment perish.

The ash is one of our most valuable trees for street planting. Its growth is rapid and it is but little affected by insects. The cotton-



VIEW OF ENGINES AND LOG TRAIN OF SAGINAW LUMBER COMPANY ON SAGINAW SOUTHERN RAILROAD, WILLIAMS.

wood, although not so desirable as the ash, gives dense shade during the summer, grows with great rapidity, and requires little care. If in planting care is exercised to plant only staminate trees, no cotton will be produced and the chief objection to them removed. The desert willow, a beautiful tree with catalpa-like flowers, one of the most graceful trees in America, grows along the water courses of southern Arizona, and should take the place of many trees which we now get from outside.

It is hoped that the people of Arizona will give more attention to our native trees and shrubs, as they are more in harmony with our surroundings and better adapted to the purposes of landscape gardening. Many of our shrubs are evergreen, while others have attractive flowers or fruits. By proper care in selection they are in the end much more satisfactory and less liable to die than imported plants.

EDUCATIONAL.

Arizona has as fine educational advantages as any State in the Union.

The Territory has two normal schools and a thoroughly equipped university, and the common school system is not excelled anywhere. The Territory is especially noted for its fine district school buildings, surpassing in this respect the oldest States.

UNIVERSITY OF ARIZONA.

BOARD OF REGENTS.

Exofficio: Hon. N. O. Murphy, governor of Arizona; Hon. R. L. Long, superintendent of public instruction.

Appointed by the governor of the Territory: Hon. William Herring, chancellor, Tucson; Hon. H. W. Fenner, secretary, Tucson; Hon. Herbert B. Tenney, treasurer, Tucson; Hon. Charles R. Drake, Tucson.

President of the faculty: Millard Mayhew Parker, A. M., professor of civics.

The University of Arizona is located near Tucson, the county seat of Pima County, and one of the largest towns in the Territory.

Tucson is on the main line of the Southern Pacific Railway, 312 miles west of El Paso, Tex., and 500 miles east of Los Angeles, Cal. It is easily reached from east and west without change and has railway connections with the central and northern portions of the Territory via Maricopa, and with northeastern States via Deming. The town lies in a broad, flat valley, at an elevation of 2,400 feet above sea level, and is surrounded by mountains. Its dry, healthful situation, with its mild and equable climate, has made Tucson a famous health resort, particularly for pulmonary patients.

The winter climate is especially good. Its temperature is cool and strengthening without being severe. The lowest temperature recorded during the average year is about 20 degrees above zero, Fahrenheit. But little rain falls during the winter; fogs are unknown; cloudy days are rare, the percentage of sunshine throughout the winter being greater than that recorded at any other place in the United States. In the summer the temperature ranges high, but the dry heat of this region differs greatly from the moist and oppressive heat of the Eastern and Gulf States. Owing to the extreme dryness of the air the highest temperatures known are less oppressive to the senses and less dangerous to the health than the summer heat of the Upper Mississippi Valley States.

The total amount of rainfall averages less than 12 inches. Of this amount fully one-half falls during July and August, yet the amount is so small as not materially to increase the atmospheric humidity, and the summers are found to be remarkably healthy. In general the climate may be described as well suited to nearly all people, but is particularly beneficial to the young, and to those who can not endure with comfort or safety the extremes of temperature and the sudden changes of northern climate.

The university was established by an act of the Territorial legislative assembly passed in 1885. A tract embracing 40 acres of land lying just outside the city

limits was selected as a site and was donated by the citizens of Tucson. A contract for erecting the main building was let in October, 1887, but owing to financial delays the building was not opened to students until October 1, 1891. The site selected is upon high ground about a mile from the business center of the city. On every side it commands a view of mountain scenery of remarkable extent and grandeur. The location can not be surpassed for healthfulness. The university possesses its own water system. The supply is drawn from a well on the premises 100 feet deep, and is of unusually good quality.

The main building is 200 by 105 feet, 2 stories in height, the lower story of gray stone, the upper of red brick, and is completely surrounded by a wide 2-story veranda. This building contains the offices, recitation rooms, laboratories, and apparatus rooms of the various departments; an assembly room; the libraries of the university and experiment station, and the Territorial museum. Adjoining the main building is the mining annex, 80 by 60 feet, filled with metallurgical machinery.

Three cottages have been built. They are of brick, 2 stories in height, and were intended to accommodate each two families. They were originally designed as homes for instructors, but owing to the pressure for accommodation for students on the university grounds, two of the cottages have been converted into homes for young ladies and furnish excellent accommodations for twenty-five persons, while the third is used as a residence for the president.

A dormitory built of a fine quality of gray stone, 2 stories in height, has been provided as a home for male students. It contains a students' dining room, kitchen connected therewith, and 20 rooms, each large enough to accommodate two students.

A substantial brick building contains a suite of rooms for the use of the assaying department, and also a carpenter shop. The assay rooms contain a large smelting furnace, with necessary muffle furnaces and other accessories, while the carpenter shop has an engine for power work, with lathes and other machinery for convenient operation.

Other buildings are the boiler house, which also contains the well and pumps whereby the water supply for irrigation and general purposes is obtained; the new greenhouse, 80 by 21 feet, built wholly of glass; the old greenhouse, now used as a propagating house, also of glass; the cottage occupied by the assistant horticulturist, and a temporary wooden building used as a young men's dormitory. It is expected that in the near future the university will be able to add another wing to the stone dormitory, nearly doubling the present dormitory accommodations, and thus relieving the pressing demands in that direction.

The library is a department of the university that is increasing in efficiency with the growth of the institution. The books have been selected with great care, with a view both to the requirements of the various departments of instruction and also to the building up of a well-balanced symmetrical collection of books. All the books are new and standard. The scientific works represent the highest and latest authority, while the literary and historical works are the writings of the best known and most thoroughly tried authors. A main object in making the selection has been to furnish students with books of the highest class and to encourage them in habits of careful reading. Complete bound sets of the leading American periodicals, both literary and scientific, are being collected every year, so that the library is already valuable as a means of research in present-day problems.

The latest editions of the best cyclopedias and dictionaries are constantly at the students' disposal. The leading American scientific and literary publications, as well as the Territorial newspapers, are found in the reading room. The reading room and library are open to students for an average of 8 hours each day.

Aside from Government publications and pamphlets, the library contains 3,600 bound volumes, of which 500 have been added during the present year. Of the whole number about three-fifths are scientific works, the remaining belonging to general literature, biography, and history.

A complete card catalogue of authors and title is maintained.

The chemical laboratories are two in number. The smaller one on the upper floor of the main building is for the use of students and is equipped for teaching the theory and practice of chemical science. The room for laboratory work is well lighted, provided with gas, water, working desks, ventilating hoods, an abundance of apparatus and chemicals with which to carry on experimental work, and can be made to accommodate about 24 students. Adjoining the large room is a small storeroom stocked with apparatus for demonstrating the principles of chemistry and containing well-selected collections of chemical substances.

The experiment station laboratory occupies three large working rooms and two small storerooms on the lower floor of the main building. This laboratory is

devoted to analytical work and chemical investigations relating to the agricultural interests of the Territory. It is excellently equipped for the special lines of investigation in which it is engaged, and although not primarily intended for the use of students, it has educational value to those who desire to witness the operations of a working laboratory. The equipment includes chemical balances, chemical apparatus and supplies, machinery for preparing samples, and special appliances for the analysis of milk, agricultural products, tanning materials, and soils.

The biological laboratories occupy three rooms in the southwest half, second floor, of the south wing of the main building. These rooms are piped for gas and water, and liberally provided with apparatus for research and for giving instruction on biological subjects. Students pursuing histological work are provided without expense with simple and compound microscopes, as the nature of their work demands. The laboratory is equipped with microtomes, culture baths, oven and other accessories used in modern methods of research.

An herbarium, containing nearly 10,000 sheets of plants, mostly indigenous to the Southwest, a large percentage being from Arizona, is an important factor in the equipment. Some fifty cases of insects, including one large cabinet, are of value in giving instruction in entomology and to illustrate the economic insects of Arizona. The work in general and systematic zoology is greatly facilitated by the Herbert Brown collection of birds, and by other zoological material which has been brought together during the past five years.

To aid in the study of human and comparative anatomy and physiology there are provided articulate and disarticulate human skeletons, plaster and papier-mâché models of the important organs, and microscopical preparations illustrating the structure of the various tissues. The equipment also includes special apparatus for use of advanced students in the department.

Two rooms upon the first floor and near the central part of the main building are used for the work in the study of agriculture and horticulture, and for the agricultural experiment station headquarters. The equipment is fairly complete. There have been imported from Europe several of the best Azoux models of portions of the domestic animals, showing normal and morbid conditions; also several cases of products of the vegetable kingdom. A very large collection of garden and farm seeds has been secured and arranged in jars and properly labeled. There is also a selection of garden tools and instruments used in veterinary surgery. Recently there has been imported from Germany a collection of charts illustrating the anatomy and physiology of some of the fruits and grains. Specimens of the best fruits, grains, and other farm products are constantly received for examination; also specimens of an abnormal nature.

The old greenhouse, about 14 by 20 feet in area, is used as a propagating house, and a new one has just been built, 21 by 80 feet in size, constructed of glass throughout. Laboratory work is provided for in these greenhouses and in field work upon the university grounds. The general library contains many of the standard and most valuable of the recent publications upon agriculture in its various branches and the science upon which it is based. All the bulletins and reports of the experiment stations of the United States and foreign countries are on file in the station library, and the principal agricultural and horticultural journals are upon the table of the reading room.

Recognizing the fact that the first actual engagement secured by the engineering student will be either in the field with a surveying party or in the shop or drafting office, the equipment of this department has been chosen with a view to developing the highest skill in these fundamental lines of work. Already liberal, it is constantly being enlarged. It embraces surveyors' and engineers' chains; standard field and pocket tapes; plain and solar compasses and transits; engineers' levels; stadia, level, and transit rods; aneroid barometers; odometers; pedometers; automatic water registers; hook gages; three forms of current meters; stop watch; meteorological instruments; drafting instruments; mechanical calculators; blue-print apparatus; 4-inch astronomical telescope with equatorial mountings and accessories; celestial sphere; a 75-light Mather dynamo; a Westinghouse high-speed engine; pumps, steam gauges, indicators, calorimeters, etc.

The department of mining and metallurgy is well equipped for giving both theoretical and practical instruction in the arts of mining, metallurgy, and assaying in all its branches.

Attached to the main building is an annex, or mill, containing machinery and appliances for crushing, sampling, concentrating, amalgamating, leaching, chloriding, cyaniding, and the electrical treatment of various kinds of ore in large or small lots. Power is furnished from a 70-horsepower boiler, detached from the main building, the steam being carried underground to the engine room, which contains a 35-horsepower engine, built by the Walburn-Swenson Manufacturing

Company, of Fort Scott, Kans., and a 16-horsepower Westinghouse automatic engine, the latter being used for running the dynamo.

The mill building has a storage capacity for ore of 50 to 100 tons. From the bins the ore passes to the crushing floor above. A 7-inch by 10-inch Blake crusher is used for coarse crushing, and a Dodge crusher for finer work. Beneath the Blake crusher is a set of 14-inch by 20-inch Cornish rolls, from which the ore passes by a conveyor to the main elevator, which carries it up 31 feet to the top of the mill. By means of slides and chutes the crushed ore may be sent at will to various machines to be tested by different methods. For concentration there are provided revolving sizing screens giving facilities for preparing six sizes, besides hydraulic separators for classifying slimes into three grades. The coarser sizes may be worked upon full-sized jiggling machines of the Hartz pattern, the finer sizes being jigged upon bottom discharge machines, and the slime worked upon a double Rittinger percussion table, or otherwise as desired. A small apparatus, run by an electric motor, is also provided for dry concentration. Amalgamation tests may be made upon a working scale by different methods including plates and riffles, plans and settlers, etc. A 5-stamp gold mill with silvered plates and aprons of the latest and most improved construction, by Frazer & Chalmers, of Chicago, has recently been added to the mill, thus permitting the working of free-milling gold ores by the usual methods and on a large scale. Several lots of ore have been successfully worked and returns made in gold bullion, thus familiarizing the mining students with all the details of seeding, stamping, cleaning up, retorting, smelting, and assaying.

In addition to the 5-stamp mill, a smaller prospecting mill of three stamps has been added so as to work small lots of ore of from 100 to 500 pounds. A sampling mill permits of rapid crushing and mixing large samples preparatory to assaying.

The assay laboratory is equipped with assay furnaces for crucible work, for scorifying and cupelling, and for retorting mercury from amalgam. An adjoining room, supplied with water, gas, and electric current, has a roomy hood for work involving fumes, with tables and desks for student work, besides all needed appliances for assaying by dry and wet methods, including electrolysis.

The laboratory also has desks and fittings for the chemical work required in the metallurgical and mineralogical investigation and analysis of ores, mineral fertilizers, and qualitative tests of minerals.

Three large rooms in the basement of the main building are set apart for the teaching of physics. The facilities for experimental demonstration of all important phenomena are very complete. The lecture room is fitted with shutters, so that it can be darkened. A beam of sunlight, directed by a fine clock heliostat outside, may be thrown steadily across the lecture table for experiments on light, or used in connection with the solar lantern for a variety of other work. The lecture table is supplied with gas, water, electric currents from primary and storage batteries, and from the large dynamo.

Adjacent to the lecture room are the physical laboratory and the apparatus room in which are kept the many instruments owned by the university, among which may be mentioned an Atwood's machine, Kater's pendulum, whirling table, many balances, barometers, an air pump and accessories, a hand dynamo, motors, six storage cells, a large number of primary batteries, induction coils, Deprez-D'Arsonval tangent, and sine galvanometers, rheostats, Wheatstone's bridges, a fine testing set, a Wimshurst electric machine, Leyden jars, Geissler's and Crooke's tubes, diapasons, a sonometer, lenses, prisms, and mirrors of all kinds, a polariscope, steam gauges, indicators, calorimeters, and a full equipment of simple pieces of apparatus for the use of elementary classes.

THE TERRITORIAL NORMAL SCHOOL, SOUTH.

The legislative enactment providing for the organization of this school also stated the design and purpose of its establishment to be, "that a normal school for the Territory of Arizona is established at Tempe, in Maricopa County, Ariz., the purpose of which shall be the instruction of persons, both male and female, in the art of teaching, and in all the various branches that pertain to a good common-school education; also to give instruction in the mechanical arts and in husbandry and agricultural chemistry, in the fundamental laws of the United States, and what regards the rights and duties of citizens." With the approval of the board of education, after a careful consideration of concomitant conditions, the faculty has, up to the present time, limited the work of this school to the instruction and training of teachers, notwithstanding the fact that the legislature has provided for a much broader field of activity.

LOCATION.

The location of this school at Tempe seems very fortunate. Tempe is situated in the beautiful valley of the Salt River, 7 miles from the capital. It has railroad connection with the Southern Pacific and Santa Fe systems by the Maricopa and Phoenix and Salt River Valley Railroad. The climate here is delightful during the whole of the school year, and the cost of living is less than at any other place in the Territory. The school is in the midst of an intelligent and moral community engaged in farming and fruit raising.

CAMPUS.

The campus includes 20 acres, and is under a high state of cultivation. The north half is set with shade and ornamental trees and shrubs, which form a beautiful grove, many of the trees reaching a height of 40 feet. The great variety of plant-life forms found on the campus and on the cultivated and desert lands in the vicinity is a great aid to the students in the study of botany.

BUILDINGS.

The building heretofore used for school purposes was erected in 1886 at a cost of \$8,500. It is a one-story brick structure, 70 feet long and 60 feet wide, with a broad veranda entirely surrounding it, and was a comfortable home for the school the first seven years of its existence.

The new normal school building was completed in the summer of 1897, and has been occupied by the school the past year. It is a commodious structure, 136 feet long, 80 feet wide, and three stories high. The lower story is of brown sandstone, the other two of red pressed brick with sandstone trimmings. This edifice is beautiful in architectural design, convenient in arrangement, and substantial in construction. Its appointments embrace all the modern school conveniences, such as cloakrooms, closets, recitation rooms, study hall, assembly hall, laboratories, etc. Its fixtures comprise a complete outfit of tables and cases sufficient to accommodate 36 students working at the same time, tablet-arm chairs to seat 160 students, recitation seats for 100 students, tables and chairs to accommodate 40 students in drawing at the same time, besides desks and sittings for 175 students in the normal department proper. In addition to this, the school of practice is furnished with adjustable seats and desks and other modern appliances to accommodate pupils of the several grades to the number of 70. The assembly hall is seated with 400 tablet-arm opera chairs, and will accommodate 500 persons when seated to its full capacity. All things considered, the building is excellently equipped for the purposes of normal school work.

ATTENDANCE.

This school has had a steady, healthy growth from its opening for the reception of students in January, 1886, to the present time. In the first half decade of its existence the attendance increased from 26 in 1886, to 54 in the school year 1890-91.

During the last five years the total enrollment of this school has been as follows: Seventy-six in the scholastic year 1891-92, 87 in 1892-93, 91 in 1893-94, 94 in 1894-95, 134 in 1895-96, 158 in 1896-97, 173 in 1897-98, and 205 in 1899. This is exclusive of the school of practice department, whose number is limited to 80 in all grades. The greatly increased attendance for the past three years is a good index of the estimation in which the work of this institution is held by the public. Every county in the territory has been represented by students in this school during the year just closed.

COURSE OF STUDY.

The work of the normal department of this school is laid out in two courses of study and practice—the elementary and the higher. The elementary course has been considerably strengthened during the past two years. It now comprises three years' work, as formerly, but requires one year's work more of preparation for admission to it. The higher course has been formulated and will be put in effective operation as soon as available funds will warrant the employment of a sufficient teaching force to do so. It requires four years for its completion and gives better preparation for teaching the higher branches. It carries the academic work through the requirements for admission to the best universities of our country.

Each of these courses requires a year of professional work and practice teaching. These courses also include systematic training in light gymnastics for all students and military drill for the young men. The advantages of such training to the bodily health and carriage of the student is unquestioned. Sufficient training is given along these lines to enable the students to introduce these exercises into the schools in which they may be employed as teachers. It should be borne in mind, however, that the main aim and effort of all the work in the normal school is professional training; that instruction in other lines of the curricula is incidental, but nevertheless necessary, for methods in teaching can not be imparted apart from the subject-matter. For a more minute analysis of the course of study and fuller details of the condition of this school, reference is here made to the annual catalogue published in 1898. These courses have been formulated with a fixed purpose to give the student the greatest possible advantages, the educational status of the Territory and the financial ability of the average student being carefully considered. The scope of these courses of study gives this school a creditable rank with similar institutions in the older communities of our country. The course of study in the school of practice covers the work of the eight grades of the primary and grammar school curricula of the public schools.

In addition, there is much work designed to develop and strengthen the faculties of the child and to render him more self-helpful from day to day and to give added zest to the routine of the school. Nature study is made a prominent feature of this work.

The practice school fits its pupils for the normal department proper, and is open to pupils of school age from any part of the Territory, who are admitted in the order of their application until each grade is filled to its maximum, which has been fixed by the board of education at ten. This department has become so popular that there are always more applicants than can be accommodated.

SCHOLASTIC YEAR.

The school year comprises forty weeks of actual work, divided into four terms of ten weeks each. The subdivision of the calendar gives students who can not attend school consecutively for a whole year a better opportunity to arrange their work and receive credit therefor toward the quantum requisite for graduation.

BRANCHES OF STUDY PURSUED.

The academic work during the past year was distributed as follows: Algebra, 74; arithmetic, 81; botany, 61; bookkeeping, 26; chemistry, 19; composition, 72; civics, 25; drawing, 112; elocution, 24; English literature, 68; ethics, 34; political geography, 37; physical geography, 11; geology, 28; geometry, 64; grammar, 48; United States history, 38; music, 95; orthography, 146; general history, 62; physics, 28; physiology, 52; psychology, 68; school law, 40; reading, 42; writing, 48; word analysis, 26; zoology, 21.

The professional work was pursued by the students in classes whose numbers are indicated below: History of education, 21; methods of teaching, 50; observation of critic teacher's work, 25; school management, 18; practice teaching, 23; theses on professional topics, 21.

There were 68 members in the class in military drill and 27 in special work in physical culture. The whole school had training in free gymnastics during the winter months.

LIBRARY.

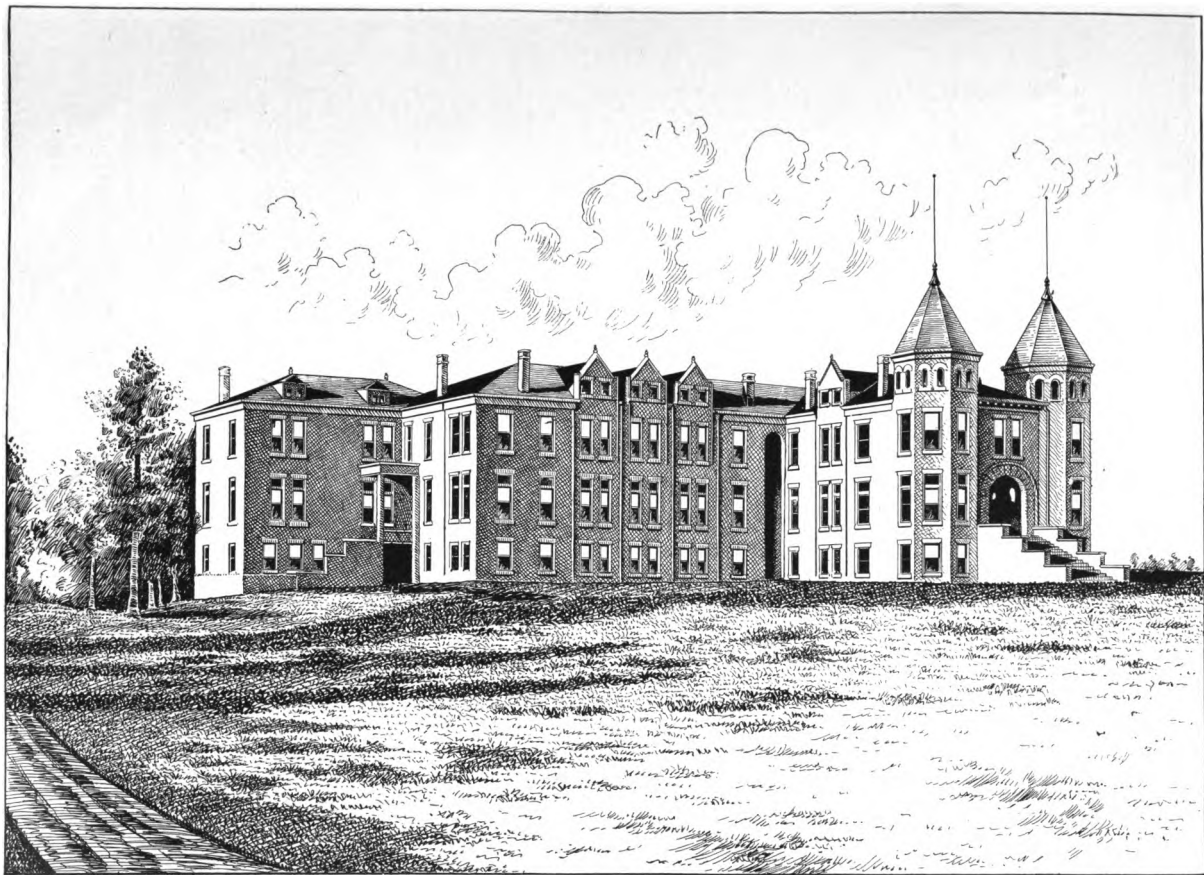
The library now contains more than seven hundred volumes, comprising works on history, science, education, and general literature. Many of the valuable publications of the Smithsonian Institution, and other publications of the Department of the Interior, are found on its shelves. Appleton's new edition of Johnson's Cyclopaedia, Appleton's Scientific Library, and a few other books have been added to it the current year. It contains a fair supply of reference books for the present needs of the school.

MUSEUM.

The museum already contains many valuable archæological relics and quite a number of interesting specimens of animals, plants, and minerals characteristic of Arizona, such as copper, silver, gold, and lead ores, native insects, birds, small animals, and plants, and also many specimens from other parts of the world.

NORMAL SCHOOL, NORTH.

A second normal school was created by the twentieth legislative assembly in March last. The new institution is located at Flagstaff,



NORMAL SCHOOL, NORTH FLAGSTAFF.

in Coconino County, and is an important addition to the educational system of the Territory. It is located on a tract of 130 acres of land previously acquired by the Territory and known as a "Home for the Insane," although never used for that purpose. The building is of stone, and commodious and convenient in its appointments. It is the finest public building in Arizona so far constructed.

The northern Arizona normal school opens its first term at Flagstaff September 11. This, the first high grade educational institution in northern Arizona, will start its work under the most favorable circumstances. The school building is architecturally beautiful, and is located in one of the most scenic spots of a scenic region. It is more than ample in size, and has been fitted up for the use of the school in a manner that will conduce most effectually toward convenience in all departments.

The range of studies to be pursued in the new institution is to be a broad one, for, by the act creating it, there must be maintained preparatory and high school courses. The normal course will be a parallel one with that pursued at the older school at Tempe, and completion of the prescribed work will secure a diploma granting a life license to teach in any of the schools of Arizona. There will be, as well, academic work qualifying the student for entrance into any of the universities of the Union.

The school system of the Territory is modeled after that of California. The school district is the unit of the system, and is controlled by a board of trustees, three in number, one of whom is chosen annually by those residents of the district who pay a school tax or are parents of children of school age. The trustees have the detailed management of the schools in their districts, employ the teachers, have charge of the buildings and grounds, etc. The districts are supervised by a county superintendent, who is required in most instances to visit each school in his county. He apportions all school moneys on the following basis: To every district having more than 10 and less than 20 census children \$400, and \$500 to every district having more than 20 children, and in addition thereto not less than \$20 per capita upon the average daily attendance in excess of 25. He also audits all school accounts. The superintendent of public instruction, with the board of education, exercises general control over school affairs in the Territory.

The support of the schools is by taxation, no revenue being derived from the school lands except a small rental for their use. The territorial tax is 3 cents on each \$100 of value, while the county tax rises from 30 cents, the minimum rate, to 80 cents, the maximum rate, on each \$100 of valuation in the county. To the sums thus raised are added the receipts from poll taxes, gambling licenses, fines, and escheated estates.

The schools are divided into primary, grammar, and high schools. The subjects taught and the methods pursued are similar to those of like grades in the States. A uniform series of text-books is adopted and their use is compulsory in all the schools, so that children in changing residence from one district to another can enter their proper grades in the school and use the same books.

A full and complete manual and course of study for the use and guidance of the teachers and pupils is in course of preparation, and will be ready for distribution about October 1 of the present year.

The teachers in charge of the schools are in number 373, of which 251 are women and 122 men. Of the total number 120 are graduates

of normal schools. The average monthly salaries paid men is \$74.70 and the women \$64.40.

The following tables show the school population, school attendance, receipts, expenditures, and value of school property at the close of the school year ending June 30, 1899:

Receipts.

Counties.	Balance on hand at beginning of school year July 1, 1898.	Territorial tax.	County taxes, fines, etc.	District taxes.	Miscellaneous sources.	Total.
Apache	\$595.37	\$502.07	\$6,193.42			\$7,290.86
Cochise	9,255.59	770.14	18,017.92	\$2,400.69	\$904.42	31,348.76
Coconino	308.97	512.21	14,537.97		95.47	15,254.62
Gila	1,320.99	322.31	17,215.69			18,818.99
Graham	2,159.14	1,303.05	18,484.20			21,946.39
Maricopa	9,050.78	2,292.30	69,513.48		69.40	80,925.96
Mohave	1,139.47	149.99	5,000.01		446.50	7,395.97
Navajo	2,533.02	400.05	11,512.02			14,525.09
Pima	2,518.30	2,135.41	17,074.53		586.67	22,314.91
Pinal	1,357.91	403.15	9,053.49		28.00	10,842.55
Santa Cruz	1,046.94		6,882.32			7,929.26
Yavapai	3,409.64	973.83	33,626.17		24.55	38,034.19
Yuma	102.06	375.49	8,551.10			9,028.65
Total	34,818.18	10,000.00	236,382.32	2,400.69	2,155.01	285,756.20

Expenditures.

Counties.	Teachers' salaries.	Rents, repairs, fuel, and contingent expenses.	School libraries	School apparatus.	Sites, buildings, and school furniture.	Total expenditure.
Apache	\$5,429.35	\$1,306.47		\$39.50		\$6,775.32
Cochise	17,146.75	4,589.36	\$20.00	136.10	\$3,902.47	25,794.68
Coconino	7,300.50	2,147.88	54.22	125.00	546.40	10,074.00
Gila	6,933.75	1,352.21	90.00	170.00	831.53	9,317.49
Graham	12,983.20	4,732.15			208.90	17,964.25
Maricopa	51,199.60	18,212.04	80.10	820.45	837.02	77,149.21
Mohave	4,744.25	1,521.15				6,265.40
Navajo	8,632.65	1,380.09		274.74	1,623.27	11,910.75
Pima	14,954.84	3,602.77	5.00	121.55		18,684.16
Pinal	7,331.53	1,777.05		113.00	124.00	9,346.18
Santa Cruz	7,211.25	951.97	35.22	71.50	153.70	8,423.64
Yavapai	27,387.50	5,969.33	62.25	565.40	229.20	34,213.68
Yuma	6,949.15	1,146.01			757.17	8,852.33
Total	178,114.32	48,688.48	286.79	2,437.24	2,914.26	238,741.09

Valuation of school property.

Counties.	Lots, school-houses, and furniture.	School libraries.	School apparatus.	Total school property.
Apache	\$10,332	\$200	\$853	\$11,385
Cochise	22,541	1,485	1,745	25,771
Coconino	29,100	160	810	30,070
Gila	5,925	30	170	6,125
Graham	18,846	4	1,478	20,328
Maricopa	119,740	2,059	5,256	207,055
Mohave	8,880	260	1,040	10,180
Navajo	13,630	128	1,667	15,425
Pima	83,161	260	776	84,197
Pinal	16,689	120	1,160	17,969
Santa Cruz	6,575	129	620	7,324
Yavapai	41,518	667	3,690	45,875
Yuma	8,100	500	200	8,800
Total	465,037	6,002	19,465	490,504

Census statistics.

Counties.	White children between 6 and 18 years.			Colored children between 6 and 18 years.			Census children between 6 and 18 years.	Children between 8 and 14 years.	
	Boys.	Girls.	Total.	Boys.	Girls.	Total.		White.	Colored.
Apache	496	430	923	-----	-----	-----	923	531	-----
Cochise	790	734	1,524	6	2	8	1,532	1,008	4
Coconino	348	336	684	-----	-----	-----	685	372	1
Gila	347	324	671	13	4	17	688	352	9
Graham	1,518	1,467	2,985	7	3	10	2,995	1,595	6
Maricopa	2,260	2,180	4,440	15	8	23	4,463	2,356	13
Mohave	138	153	291	-----	-----	-----	291	134	-----
Navajo	432	437	869	13	14	27	896	481	14
Pima	1,335	1,328	2,663	4	8	12	2,671	1,410	-----
Pinal	413	405	818	5	10	15	833	448	9
Santa Cruz	565	569	1,134	2	1	3	1,137	601	-----
Yavapai	1,019	882	1,901	32	40	72	1,973	1,107	45
Yuma	387	346	733	1	2	3	736	455	2
Total	10,045	9,591	19,636	98	89	187	19,823	10,850	108

School attendance.

Counties.	Schools.	Grade of school.		Enrolled on register.		Total enrolled.	Average number belonging.	Average daily attendance.	Months school was maintained.
		Gram-mar.	Primary.	Boys.	Girls.				
Apache	19	6	13	490	420	910	629	564	5
Cochise	28	5	23	689	640	1,329	917	840	7.35
Coconino	12	5	7	278	271	549	362	331	6.16
Gila	15	12	3	279	250	529	360	316	7.25
Graham	41	8	33	989	984	1,973	1,308	1,152	5.50
Maricopa	91	32	59	2,236	2,031	4,267	2,812	2,600	7
Mohave	11	6	5	135	147	282	210	193	6.30
Navajo	24	6	18	457	474	931	720	654	6
Pima	17	2	15	808	647	1,455	905	806	6.65
Pinal	18	4	14	334	339	673	435	410	6
Santa Cruz	16	3	13	430	446	876	538	303	6.50
Yavapai	54	13	41	873	783	1,661	1,043	957	6.80
Yuma	15	4	11	248	215	463	300	270	6
Total	361	106	255	8,246	7,652	15,898	10,579	9,396	6.34

INDIANS.

The Indians on the various reservations have been quiet throughout the year, and there is every reason to believe that Indian depredations and disturbances of consequence within this Territory are permanently at an end. One of the surprising and gratifying features of the situation is the substantial progress toward civilization which is being made by the Apaches, long considered incorrigible. No longer influenced and led by vicious renegades, they are tractable and are exhibiting proofs of a general desire for advancement. This is especially true of the San Carlos Apaches. The construction of a railroad through their reservation has had manifestly beneficial effects. It is possible to further improve the conditions on that reservation by developing a better water supply in the valley of the San Carlos River and affording opportunities for extensive agriculture—an industry for which many of the tribe are showing a commendable aptitude. Employment on their own farms, seconded by the influence of the Indian schools, would ultimately raise this tribe to a fair degree of civilization.

On the Moqui Reservation, one of the most remote sections of the Territory, smallpox existed in epidemic form during the early part of the year, but the disease was finally brought under control and stamped out.

A few months ago some disputes arose between the Navajo Indians and the white residents of Tuba City, in Coconino County, over the title to certain lands and water. The controversy has been amicably adjusted, however, and a satisfactory arrangement has been made for an extension of the western boundary of the reservation.

The following report upon the Indians of the Territory by Prof. S. M. McCowan, of the Indian school at Phoenix, is interesting and reliable :

The following tables regarding our Indian population, etc., compiled from the latest reports of the various Indian agents, furnish the closest approximation of the facts obtainable and present an interesting epitome of present Indian life :

Agency and tribe.	Population.	Civilization.									
		Citizen's dress.		Indians who can read.	Indians who use enough English for ordinary conversation.	Dwelling houses.		Per cent of subsistence obtained by—			
		Wholly.	In part.			Built for Indians during the year.	Occupied by Indians.	Indian apprentices.	Labor in civilized pursuits.	Hunting, fishing, root gathering, etc.	Government rations.
<i>Colorado River Agency.</i>											
Mohave	683	600	83	180	150	8	70	---	50	---	50
Mohave at Needles	1 700	---	---	---	---	---	---	---	---	---	---
Mohave at Fort Mohave	1 000	1,200	200	300	400	---	---	---	100	---	---
Chimehuivi	150	---	---	---	---	---	---	---	---	---	---
<i>Fort Apache Agency.</i>											
White Mountain Apache	1,838	87	43	30	50	2	2	---	70	10	20
<i>Under industrial teacher.</i>											
Hualapai	598	350	248	60	400	---	60	---	50	25	25
Yava Supai	261	190	71	60	65	---	---	---	75	25	---
<i>Navajo Agency.</i>											
Navajo	20,500	---	1,000	250	500	75	150	---	100	---	---
Moquis Pueblo	2,641	---	16	28	24	4	67	---	100	---	---
<i>Pima Agency.</i>											
Pima	4,260	} 6,469	870	188	971	---	360	7	90	10	---
Maricopa	340										
Papago	693										
Papago, nomadic	2,046										
Papago at San Xavier	531										
<i>San Carlos Agency.</i>											
Apache	2,206	} 500	2,400	400	900	---	---	---	5	67	33
Mohave	697										
Apaches on San Pedro River	300										
Apaches near Mohawk, on Lower Gila River	300										

¹ Taken from last year's report.

Agency and tribe.	Religious.						Marital.		Vital.		Criminal	
	Missionaries.		Indian church members.	Church buildings.	Amount contributed by religious and other societies.		Marriages during year.	Divorces during year.	Births.	Deaths.	Indians killed.	
	Male.	Female.			For education.	For church work.					By Indians.	Suicides.
<i>Colorado River Agency.</i>												
Mohave.....						2		20	26			2
<i>Fort Apache Agency.</i>												
White Mountain Apache.....	1				\$1,217	6	21	41	27			
<i>Under industrial teacher.</i>												
Hualapai.....					\$150	215		(1)	22			
Yava Supai.....								10	9			
<i>Navajo Agency.</i>												
Navajo.....	2	3										2
Moquis Pueblo.....	1	2						350	(1)			1
<i>Pima Agency.</i>												
Pima.....			174	4	20,000	4,100	6	1	154	112		
Maricopa.....	5	2										
Papago.....			210	1								
Papago, nomadic.....							7		25	23		
Papago at San Xavier.....		2										
<i>San Carlos Agency.</i>												
Apache.....									46	128		1
Mohave.....	1											

Agency and tribe.	Lands.					Families actually living upon and cultivating lands allotted in severalty.	Crops raised.				
	Cultivated during the year by Indians.	Broken during the year by Indians.	Fences.		Wheat.		Oats, barley, and rye.	Corn.	Vegetables.	Hay.	
			Acres under.	Made during year.							
<i>Colorado River Agency.</i>	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>	<i>Rods.</i>		<i>Bu.</i>	<i>Bu.</i>	<i>Bu.</i>	<i>Bu.</i>	<i>Tons.</i>	
Mohave (on reserve).....	181	20	110	415		500		500	50	40	
<i>Fort Apache Agency.</i>											
White Mountain Apache.....	1,218	120	1,218	1,200			300	6,000	30	448	
<i>Under industrial teacher.</i>											
Hualapai.....	150		150			10		400	70	10	
Yava Supai.....	325	50	325	4,200		50		1,000	1,100	6	
<i>Navajo Agency.</i>											
Navajo.....	8,000										
Moqui Pueblo.....	10,000		500					50,000	9,075		
<i>Pima Agency.</i>											
Pima, Papago, and Maricopa.....	3,000		5,000			116,667	1,152		500	100	
Papago on San Xavier Reserve.....	950	50	8,200	650	76	4,000	300	400	130	3,000	
<i>San Carlos Agency.</i>											
Apache and Mohave.....	2,000	75	2,500	300		6,652	13,246	3,000	1,410	83	

¹ Not reported.

Agency and tribe.	Butter made.	Miscellaneous products of Indian labor.					
		Lumber sawed.	Wood cut.	Freight transported by Indians with their own teams.		Value of products of Indian labor disposed of.	
				Amount.	Earned by freighting.	To Government.	Otherwise.
	Pounds.	M.ft.	Cords.	M. lbs.	\$	\$	\$
<i>Colorado River Agency.</i>							
Mohave (on reserve).....			600	173	\$131	\$833	\$250
<i>Fort Apache Agency.</i>							
White Mountain Apache.....		101	2,807			25,785	1,200
<i>Under industrial teacher.</i>							
Hualapai.....			200			165	1,500
Yava Supai.....				36	181		4,000
<i>Navajo Agency.</i>							
Navajo.....		191	50	582	1,421	4,808	
Moqui Pueblo.....			260	125	1,563		8,000
<i>Pima Agency.</i>							
Pima, Papago, and Maricopa.....			1,500	24	482		7,692
Papago on San Xavier Reserve.....	150						118
<i>San Carlos Agency.</i>							
Apache and Mohave.....			1,218			11,601	12,000

Agency and tribe.	Stock owned by Indians.						Roads.		
	Horses, mules, and burros.	Cattle.	Swine.	Sheep.	Goats.	Domestic fowls.	Made (miles).	Repaired (miles).	Day labor by Indians.
<i>Colorado River Agency.</i>									
Mohave (on reserve).....	300	100				600		6	40
<i>Fort Apache Agency.</i>									
White Mountain Apache.....	4,724	735		1		243	15	5	1,200
<i>Under industrial teacher.</i>									
Hualapai.....	890					20			
Yava Supai.....	414	3						9	75
<i>Navajo Agency.</i>									
Navajo.....		100,500	1,200	1,000,000	250,000		50	150	
Moqui Pueblo.....	2,200	500		4,000	1,500	500			
<i>Pima Agency.</i>									
Pima, Papago, and Maricopa.....	7,400	5,000				4,000			
Papago on San Xavier Reserve.....	245	275				700	1	21	260
<i>San Carlos Agency.</i>									
Apache and Mohave.....	2,955	1,446		45	12	100	10	20	840

School.	How supported.	Capacity.	
		Boarding.	Day.
<i>Colorado River Agency.</i>			
Colorado River boarding	By Government	80	
Fort Mohave training	do	120	
<i>Hualapai Reservation.</i>			
Hualapai day, Hackberry	By Government		60
Hualapai day, Kingman	do		80
Supai Reservation day	do		60
<i>Navajo Agency.</i>			
Navajo boarding	By Government	120	
Little Water day	do		30
Keams Canyon, Moqui boarding	do	90	
Oreiba day	do		40
Polacco day	do		40
Second Mesa day	do		40
Phoenix training	do	600	
<i>Pima Agency.</i>			
Pima boarding	By Government	150	
San Xavier day	Catholic Church		110
<i>San Carlos Agency.</i>			
San Carlos boarding	By Government	100	
<i>Fort Apache Agency.</i>			
Fort Apache boarding	By Government	65	

During the year the Indians have been peaceful and law-abiding. Education is having its natural and inevitable effect on the red man, as is shown by his great improvement in his manner of living, dress, construction of homes, cultivation of the soil, and desire for work that pays. It is extremely gratifying to ride over the great Pima Reservation and see their well-kept farms, all fenced with wire, the stumps cleared out, and scientific irrigation everywhere in evidence. Many of these Indians—and especially is this true of returned Indian students who have homes—have excellent adobe houses of 2 and 3 rooms, floors, doors, and windows, sewing machines, tables, and chairs, pictures on the walls, wells of water near the house, chickens, horses, wagons, buggy, etc. If the Government proceeds with the construction of the water reservoir near Florence the Pima tribe, numbering nearly 5,000 souls, will be permanently self-supporting and can accept their allotments of land in severalty. The Papagoes, living in the southern portion of the Territory, are nomadic of necessity, there being no permanent water supply in their district. If these Indians could be furnished with small bands of sheep or goats (the kind of stock for which their lands are well adapted) they would soon develop into expert grazers, as they are good workers and a worthy people.

The Apaches, erstwhile the wildest and meanest Indians in the Southwest, are taking kindly to stock and agricultural pursuits, and are doing well. While not entirely self-supporting, they could soon be made so by proper guidance. Contrary to general opinion, the reservations of the San Carlos and White Mountain Apaches are extremely rich in natural resources. They are watered by numerous large creeks of pure, sweet water, along which are wide borders of fertile bottom land, capable of maintaining a population many times that of these Indian tribes. Their country is also rich in minerals, grass land, and timber. Many of these Indians are now taking to stock-raising and agriculture, which is the natural vent for their love of outdoor life. If the Apaches are properly guided and controlled there is absolutely no reason why they should long remain dissatisfied, suspicious, and defiant.

The Yumas, Chimbueves, and Mojaves, occupying the fertile bottom lands of the Colorado River, from Yuma to the mouth of the Grand Canyon, have always been self-supporting and peaceful.

The Navajoes, the most numerous, powerful, and conservative tribe in the Territory, remain, as in the past, suspicious and defiant. There is occasional friction between the roving bands of their young men and isolated whites over stock and pasture, but nothing of a serious nature has happened during the year. They

laugh at the white man's laws and scorn his customs, and ask nothing of their white brother except to be left severely alone. If these people could be made to send their children to our best Indian schools it would not be long ere the new ideas, hopes, and aspirations of the returned students would break down the walls of conservatism surrounding this ignorant tribe, and make a way for the advance of enlightened thought, which is the forerunner of intellectual hospitality.

The people of Arizona are pleased by the attention the office of the Interior Department is giving to Indian school matters in the Territory. For years our Indians were almost entirely overlooked and neglected, while vast sums were each year appropriated for Northern Indians no more deserving.

The following observations regarding some of the religious rites of the Moqui Indians are furnished by Dr. J. Miller, of Phoenix, who has devoted considerable time to studying the Pueblo Indians and their customs:

THE PUEBLO INDIANS OF ARIZONA.

Of all the Pueblo Indians in the United States the people of only one tribe are residents of Arizona, viz, the Moquis or Hopi. The name "Moqui" should be discontinued as it is a misnomer and means "dead." The Hopi live in the northeastern part of Arizona, in a district known as the "Province of Tusayan." There are seven villages situated on three mesas. The total population is about 2,500. The linguistic stock with which they are classed is the Shoshone, but this classification is arbitrary and has more conjecture than evidence for a basis.

For many years the Hopi have attracted the attention of the ethnological and archaeological students from all parts of the world. The features of attraction consists entirely in their peculiar religious ceremonies, of which they have many, and all are interesting.

The snake dance, or *Chu-ah-Ti-vi*, is the one ceremony that attracts alike the tourist in search of strange sights, and the scientist in search of knowledge. There is an abundance of literature on this subject, but in none of it is there any attempt to explain its symbolism, or to compare it with any other ancient religious ceremony. It seems that it has been taken for granted that it is a wild, weird ceremony of an uncivilized people, and that it has no meaning; and this is true of many who visit the Hopi and witness the ceremony, which consists of a dance by the antelope and snake priests, the latter dancing with rattlers and other venomous snakes in their mouths and hands. This ceremony lasts about forty minutes, at the conclusion of which the wildest and most exciting scene imaginable is enacted, by the priests depositing all the snakes in one heap, where they are sprinkled with consecrated meal. After this ceremony of consecration each priest gathers in his hands as many snakes as he can carry and runs down the mesa and deposits them on the plain below, free and unharmed. No poisonous effects ever result from the handling of these reptiles.

It has been my good fortune to spend some time, on two occasions, with these people, and during my last visit (August, 1899) to have been honored by being initiated, along with my interpreter, Frank Chuah whia, into the Snake-Antelope Fraternity. By virtue of my initiation and a good interpreter I had exceptional advantages for study and observation, the results of which are briefly stated in this communication.

It has been stated repeatedly that the relation of the rising sun to some object on the distant hills determined the time for the snake dance. Not believing this, I determined to ascertain if possible what it was, and after five days of perseverance I was told by an antelope priest to come to the Kivi at 3 o'clock in the morning and he would show me. I slept at the Kivi and at 3 a. m. he called me, and through my interpreter he told me that it was the conjunction or relation that Orion, the Pleiades, and the Milky Way assumed toward the earth and toward one another during the last days of July, and that the observation was taken in the latter part of the night or the early morning. He stated that these relations occurred but once in a year and that twenty days after this conjunction was the time for holding the public ceremony or snake dance. The observation was taken this year at priest Wi ki's house, there being two chiefs each from the antelope and the snake fraternities.

There is another ceremony celebrated in December of each year, the time for which is determined by the constellation of Orion and the sun. This celebration is known as *Pa-lu-lu-kan*, or the serpent ceremony, the call for which is made when the sun is at the horizon in the east and Orion is at the bottom in the west. Although this ceremony is a part of the ceremonies of the snake-antelope fraternities, it has no relation to the snake dance and is subordinate thereto.

The snake dance dominates all other ceremonies, and is the summer solstitial celebration; the *Pa-lu-lu-kan* is the winter solstitial celebration, leading all ceremonies and celebrations for the latter half of the year.

The Hopi are looked upon by the great majority of white men as being ignorant and uncivilized. It is true that they have lost a great deal of their former knowledge, but they still retain enough to interest the profoundest student. When asked for an explanation as to why they do certain things they reply, "Our fathers did it." But who of the white race has not lost and forgotten the symbolism of his cult? Few of them can explain the astronomical significance of Easter or explain any better than the Hopi the common source of their racial legends.

The Hopi have a calendar system of their own. They have 13 months in the year of 28 days each, making a year of 364 days. These months are named as follows: First, *Kel-mi-ya*; second, *Ka-mui-ya*; third, *Pah-mui-ya*; fourth, *Por-wa-mui-ya*; fifth, *Assa-mui-ya*; sixth, *Qui-ya-mui-ya*; seventh, *Ha-ki-ton-mui-ya*. At the end of these seven months they begin again at the beginning, leaving out the seventh month at the end of the year. All of these calculations are based on the changes of the moon. Their weeks are of seven days and are recognized by the changes of the moon, *Mu-ya-uh*. The names of the weeks are: New moon, first quarter, *Mu-ya-ka-ci*; second quarter, *Mu-ya-chung*; third quarter, full moon, *Mu-ya-sap-tu*; fourth quarter, *Mu-ya-chung-u-ma-sulla-lu-la*. They have no enumeration of the years and for this reason they can not give ages or fix dates.

They have tolerably complete legends or myths relating to their religious ceremonies, the relation of which in detail I omit here, and shall make only brief mention of those connected with the snake ceremony, that the interpretation of the symbolism of this peculiar rite may be understood.

Prayers are offered to but two deities except the Great Spirit, or God. These two are *O-mau-uh*, or the rain god, and *Ma-sau-uh*, the god of death and fire. To these, prayer sticks, or prayer bearers, are made and deposited in shrines located in the four cardinal points of the compass. A prayer stick, or *pa-hu*, is the means of communicating the wishes of the people to the deity. These *pa-hu*s are made in the *Ki-vi*, which is an underground room in which all secret ceremonies are performed. The *pa-hu* is there consecrated by smoke, consecrated meal, and prayer. When finished it is deposited in a shrine, where it is supposed to be found by the Deity. Everything connected with the manufacture, consecration, and deposition of these prayer sticks is of the most solemn nature, and strictly ritualistic. The priest, when preparing for this work, disrobes, leaving nothing on except his loin cloth. His hair is taken down and thoroughly brushed. He sits upon his blanket, both in the work of preparing the prayer sticks and at the "sand altar" during the singing of the sixteen songs. The flowing hair, the blanket, the position in which he sits, all symbolize the four days spent with *Ma-sau-uh*, the god of fire and death.

Briefly told, the legend runs thus: When the Antelope Gens (family) was journeying westward in search of a place to live, they camped in the valley between the first and second mesas (table lands), where they now live, where they found some large tracks of a man. The first morning the chief sent out squads to the four cardinal points to hunt for the author of these tracks. At night they returned without any information; the hunt was pursued for four days, and when on the morning of the fifth day they were about to break camp and proceed on their journey they saw the object of their search approaching from the east, or first mesa, in the person of *Ma-sau-uh*, who spent this and the three following days (making four days) with them, giving instructions and commands. Ceremonial smoking was indulged in, and they all sat upon their blankets, with flowing hair, in the manner described.

The ritualistic work in the *Ki-vi* is the same each day, except the last two, when the dramatization of *Ti-go*, the snake hero, and the "snake virgin" takes place at sunrise. This is an exceedingly interesting narrative, the symbolism of which represents the harvest. The rain symbolizes the menstrual epoch and the corn and vines the conception or nine months' gestation from the harvest until the next seed time. During my leisure from work in the *Ki-vi* other lines were investigated and symbols studied. One of the most important and sacred of these was their son of God, *E-sau-uh*. He was with God when he created the world. Some time after the creation he killed a beautiful virgin, who lay four days in the grave. On the morning of the fifth day she was seen by her mother alive and dressing her hair. The number four, represented by four lines, is a constant symbol with the Hopi. It is found on all decorated articles manufactured by the Hopi. It is used in baptismal rites and in the most sacred ceremonies. Everything is counted by 4, 8, 16, 32, and so on. They have an imperfect tradition of the flood, but do not know the name of the man who had charge of the "big boat." This may be known by the chief of some other gens or family, as one

gens holds traditions unknown by the member of another *gens*. We have been taught to look upon the Eastern Continent as the birthplace of man. The Mayas of Yucatan have a tradition that the Nagas, their wise man, or serpent men, went to the East to teach the astronomy, astrology, and philosophy of the West. The Hopi have a tradition that their wise men went to the East for the same purpose, and relate a prophecy that "the white man would again return to them." Sidi Mahommed Te-eiber, a Hindu philosopher, now living in this country, tells me that in India they have a sect who have a snake dance almost identical with the ceremony as given by the Hopi. In both cases the object of the ceremony is the same, namely, a prolonged prayer or invocation for rain, good crops, increase in population, wealth, and general well-being. In the temples of Hindustan, he says, the priests have kept records for twelve thousand years. In these records is to be found a record of this tradition. If this be true (and it seems to be a strange coincidence if not), it would establish the Hopi as a people of very great antiquity.

THE YAVA SUPAIS OF CATARACT CANYON.

By Maj. J. H. McCLINTOCK.

One of the most important of the scenic parts of the Grand Canyon region is the valley of Cataract Creek, lying north of Ash Fork. It is a mere cleft, thousands of feet deep, cut in a juniper-clad plain, drained by a stream that sinks deeper and deeper until its waters at last mingle with those of the Colorado in the wildest part of that river's mighty gorge. The valley's base, to an unknown depth, is a deposit of petrified vegetation. The creek, heading in the mountains near Williams, sinks, to reappear in the canyon a giant spring, with a steady flow approximating 50,000 gallons. In its underground course of more than 60 miles it must have leached away caverns of great extent, for its waters have gathered all the lime and silica they can carry in solution. These mineral elements are to a degree deposited after the stream again finds the light. The twig that is laved by the clear running stream is soon transformed to stone, its woody fiber washed away, though the form remains. There are cataracts of wondrous beauty, where the stream falls over cliffs of its own making.

At Bridal Veil Falls, 144 feet high, the water descends in a lace-like film 100 feet broad. Below, a few miles, are Mooney Falls, where the water in closest compass leaps 250 feet to a churning pool beneath. Under each of the falls are networks of caves, full of nature's rarest carvings, hung with dripping draperies of fossilized fern and moss.

Though the valley is only a stone's throw wide, it is the home of an Indian tribe numbering 300 souls, the Yava Supais.

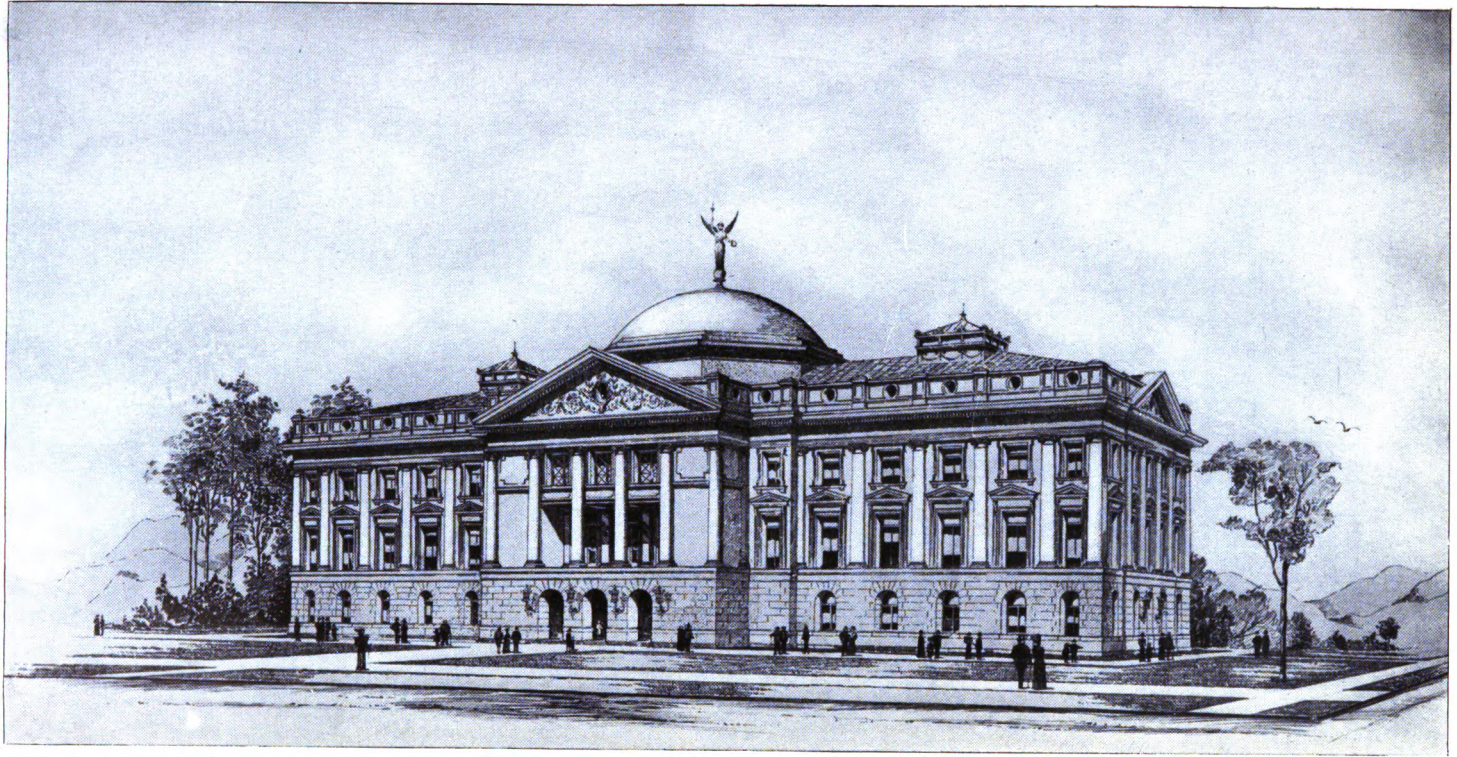
The tribesmen are of the original Apache stock and speak a dialect of the Apache tongue. Yet they are peaceful and hospitable. They have cornfields and melon patches and apricot and peach orchards, all irrigated from the ever-living creek, and of the nation's bounty receive nothing save schooling for their children. On the mesa above they graze their herds of ponies. Among the tribes of the north they are separate and alone, proud of their independence and well content in their isolation. Yet, in the fall time, down the three trails that lead into the valley, come welcomed Navajoes, Moquis, and Hualpais, to trade with the men for dried fruit and ponies, and with the women for woven baskets, the best in the southwest.

The canyon is now difficult of access, yet the visitor is well repaid for his arduous journey. It has been called the "Yosemite of the Southwest." The title is suggestive, though little more. Its scenic features are titanic, its natural marvels nowhere else to be found.

ETHNOLOGY AND ARCHÆOLOGY.

I renew the statements and recommendations of my last annual report on the subject, as follows:

Arizona presents far more profitable and interesting fields for the scientist and ethnological explorer than any other part of the country. Evidences of a large population, now lost to history, or even tradition, exist in many localities; ruins of immense buildings and of cities which once were occupied by hundreds of thousands of people, prehistoric waterways, etc., furnish good reason for the belief that quite a high state of civilization had been reached by these people who are



CAPITOL AT PHOENIX.

gone and whose record is lost. There is also much to be learned of the living, especially the Moquis, Zunis, and other Pueblo Indians of northeastern Arizona and northwestern New Mexico. Similarities of language are declared to exist between these people and the Asiatic races. The art of mummifying is unquestionably known to the Moqui priests. Hieroglyphics are found in all respects like those of Egypt, and within the inner circles of Moqui secrecy I am reliably informed that Masonic signs are inscribed upon the emblems and insignia of the priests. All this is strange and interesting and deserves more searching investigation. I believe that startling discoveries can and will be made here affecting the history of the human race, and I strongly recommend that an ethnological commission be appointed, to consist of the ablest scientists whose services can be obtained by the Government, for the purpose of thorough, careful, and extended ethnological and archaeological research in this section of the country. Liberal appropriation should be made to defray the expenses of the commission, and ample time should be given, possibly extending over a number of years, for the prosecution of the work. I am positive that the knowledge gained by such action would more than justify the expenditure. I think it will be more productive to science to explore and excavate here than in foreign countries.

PUBLIC BUILDINGS.

The public buildings of Arizona comprise the capitol, situated at Phoenix; the Territorial university, at Tucson; the Territorial prison, at Yuma; the asylum for the insane, at Phoenix, and the normal-school buildings, at Tempe and at Flagstaff.

The capitol building is under construction, and will be ready for occupancy early in the coming year. Funds for the expense of construction were provided by a Territorial bond issue of \$100,000, ratified by Congress, to which was added an appropriation by the legislative assembly, making the total cost of the completed structure approximately \$130,000. The building is 184 by 84 feet in size, and 4 stories in height. The first story is of granite, and the superstructure of tufa stone—all Arizona products.

The rotunda is 44 feet in diameter, and extends from the ground floor through all the stories of the building to a height of 78 feet, being surmounted by a dome which is crowned by a statue of Liberty 16 feet in height.

The dimensions of the halls provided for the legislative bodies are 38 by 36 feet, and special attention has been given to the acoustic properties of these halls and to their ventilation. The gallery space in each hall has a seating capacity of between 200 and 300, and surrounding the halls will be the committee and other rooms required for the accommodation of the assembly.

Special offices are also provided for the governor and other Territorial officers.

The construction of the building is under the supervision of a capitol commission composed of three members, the president of the commission, Mr. E. B. Gage, residing at Prescott, and the other two members, Mr. Walter Talbot, and Mr. Frank Parker, the secretary, residing at Phoenix.

The capitol grounds comprise 10 acres lying 1 mile west of the business section of Phoenix. The design on the east side of the grounds is geometrical in style, and very attractive. The lawns on the west half of the grounds have not been completed. The principal deciduous trees with which the grounds are ornamented are the Arizona ash, the Russian mulberry, the umbrella tree, the Mexican chino, the eucalyptus, and a few elms. Among the palms are the California fan and date palms, the blue and Japanese fans, and a large variety of yuccas. The shrubs comprise specimens of Australian, Chinese,

Japanese, European, and native varieties, and there is a fine collection of cacti and a fair one of roses. When the work in contemplation has been carried out, the capitol grounds will form an admirable setting for the new building.

The Territorial prison buildings are inclosed by a wall, the front and rear lengths of which are 290 feet, the sides being 321 feet long. This does not include the women's department at the southwest corner, which is about 30 by 30 feet. The walls are 20 feet high, 8 feet thick at the bottom and 5 feet at the top, which is surmounted by a cement cap and coping. A guardhouse of frame construction and shingle roof is situated on each corner of the walls, two of the houses being 2 stories in height.

Inside the walls are the cell house, 134 feet long by 65 feet, built of rock and iron; a building of adobe, 167 feet long by 34 feet in width, comprising the engine room, boiler room, tailor and shoe shops, laundry, bath house, and library, and the kitchen and dining room building, also of adobe, 110 by 21 feet. The dining room is 75 feet long and 18 feet wide inside. A covered corridor connects this building with the east end of the cell house and with the office of the assistant superintendent.

Outside the walls are the office of the superintendent, the same building, 1 story in height and 38 by 38 feet in size, being also used for a storehouse; and a 2-story building for the sleeping accommodations of the guards.

The Insane Asylum consists of a main central building of brick, and 2 wings of 2 stories and basement. The main building is 100 feet long and 50 feet wide. A hall 12 feet in width runs the entire length of the building. On each side of the central structure there is a wing 100 feet long by 40 feet in width, separated from the main building by a vestibule 16 feet wide. The outbuildings consist of a general dining room, 100 by 40 feet, with 2 wings, each 16 by 20 feet. A building containing the engines, boilers, dynamos, and pumping plant, and the stables, carpenter shop, blacksmith and paint shops, comprise the other buildings of importance. The ornamental grounds in front of the asylum contain 4 acres tastefully stocked with trees, semitropical flowers, plants, and palms. The asylum is situated 2 miles east of the business section of Phoenix.

Descriptions of the University and Normal School buildings will be found under the head of "Education."

All of the public buildings have been constructed at Territorial expense, no aid having been extended by the General Government.

THE TERRITORIAL PRISON.

Following are extracts from the semiannual report of the superintendent of the Territorial prison for the fiscal year ending June 30, 1899:

STATISTICAL.

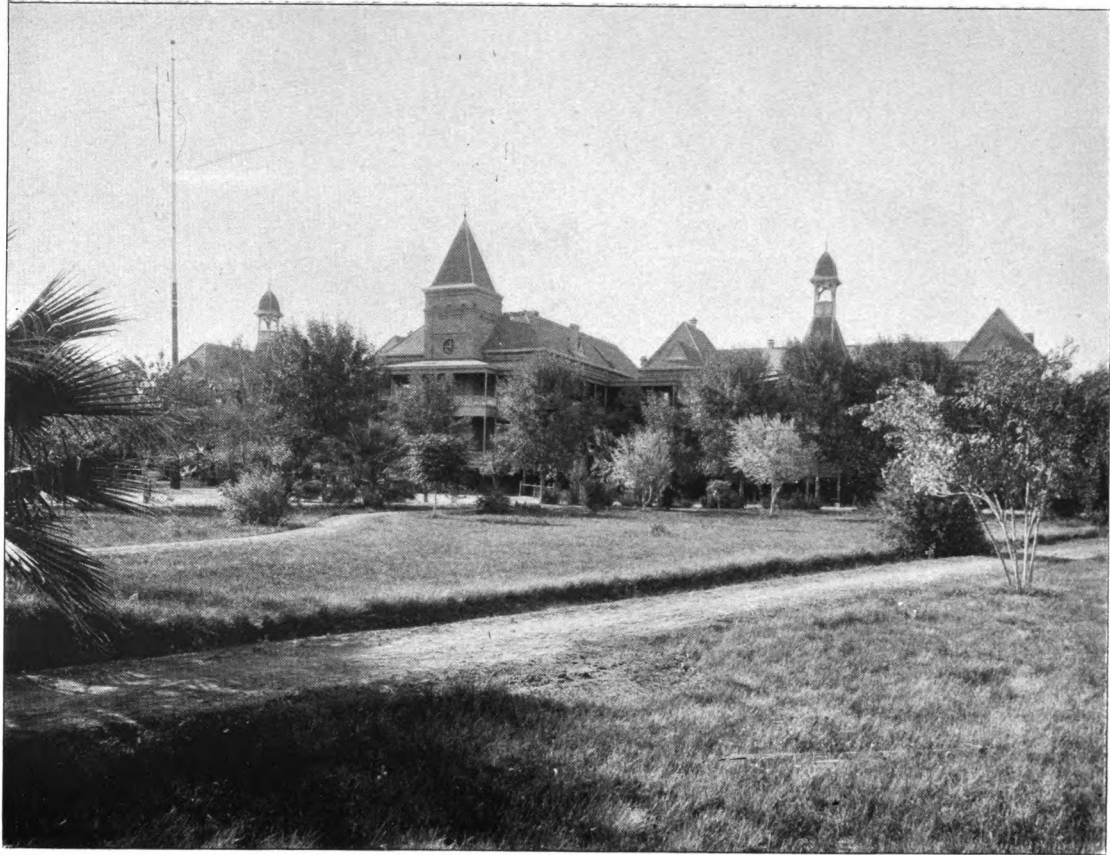
At the close of the year ending December 31, 1898, there were 214 male prisoners here, and on June 30, 1899, there were 218 in confinement. Forty additional convicts have been received, and 36 discharged. During the six months covered by this report there were 3 escapes, 2 of whom were recaptured at Aztec, and returned to prison.

FINANCIAL.

The gross expenditures for said six months were \$23,875.29, and the receipts and earnings \$2,801.13, thus leaving the net expenses \$21,074.16. The average number of prisoners was 216, and the net daily per capita cost 53 $\frac{7}{10}$ cents.



CAPITOL GROUNDS.



INSANE ASYLUM, PHOENIX.

REPAIRS AND IMPROVEMENTS.

The repairs and improvements made in said time were as follows: The prison buildings have been thoroughly renovated throughout, and whitewashed, and all necessary repairing done. The roofs of all the buildings, within and without the walls, have been repainted as a protection against the weather. A cement floor has been put in the room occupied as an adjunct to the hospital, and a new library and bath house have been built. The former is a splendid building, 49 by 30 feet, well lighted and ventilated. This building was a necessity, for the reason that during inclement weather there was no place of shelter for the men outside of their cells. The building is of adobe with corrugated iron roof, redwood ceiling, and cement floor. The new bathroom adjoins the library. It is under the same roof, and is nearly as well finished. The old bathroom adjoined the laundry, and on completion of the new one the intervening wall was taken out, and the bathroom added to the laundry. This additional space was much needed for washtubs and ironing boards. In due time the old library will be converted into cells, of which the prison is much in need.

THE PRISON FARM.

An effort at prison farming was made during the spring months, and a large acreage of vegetables for prison use was planted. All, however, were destroyed by an overflow of the Colorado River which submerged the island under 2 to 4 feet of water. When the flood subsides we will extensively replant.

A large force of men is being continually employed on the hill south of the prison. When sufficient excavation has been made, an additional yard, 100 feet square, will be added, together with probably eight or ten additional cells.

DISCIPLINE.

The discipline of the prison is good, there being but few minor infractions of the law. Of the 40 prisoners received during the six months covered by this report, 12 are Mexicans, 25 Americans, 2 negroes, and 1 Indian. Twenty-six have a sentence of 5 years or under; 7 of over 5 and under 10; 2 over 10 and under 20; and 4 for life.

Of the prisoners received, Mohave County furnished 1, Gila 2, Yuma 3; Pima, Graham, and Yavapai 5 each; Cochise 6, Maricopa 11, and 2 by transfer from prisons outside of the Territory.

Of the 36 prisoners discharged, 8 were by simple expiration of sentence; 3 by expiration of sentence, with wood-time credit; 9 by expiration of sentence, with canal-time credit; 6 by expiration of sentence, with wood and canal time credits; 4 by death; 2 by order of court; 2 by pardon; 1 by parole; and 1 by escape.

Of the 218 prisoners in confinement June 30, 1899, all are male; 104 white, 98 Mexicans, 8 negroes, 8 Indians, and 2 Chinamen; and of which total number 14 are United States prisoners. The average daily number, 216.

FINANCIAL.

From the following table will be found the monthly and total segregated expense

	January.	February.	March.	April.	May.	June.	Total.
Salaries	\$725.00	\$725.00	\$724.96	\$725.00	\$725.00	\$725.00	\$4,349.96
Wages	1,032.26	1,040.00	1,037.45	1,003.88	1,046.84	1,044.30	6,504.73
Provisions	1,135.25	1,008.85	1,076.30	1,649.27	1,280.08	1,196.72	7,346.47
Improvements	43.37	34.32	66.28	119.82	88.18	520.64	872.59
Clothing and bedding	101.53	47.80	84.74	52.26	44.22	69.66	400.26
Hospital	129.02	12.25	23.58	99.03	11.55	9.82	285.25
Shoe shop	35.09	61.54	18.09	83.73	79.77	78.20	347.42
Tailor shop	189.15	24.62	68.98	52.73	63.49	76.53	475.50
Stationery and printing	21.65	7.19	111.33	4.28	12.52	79.06	236.05
Water, fuel, and lights	615.75	318.66	292.93	196.01	408.52	151.31	1,983.15
Stable and grounds	36.42	54.44	36.76	56.43	203.57	24.43	412.15
Miscellaneous	142.30	32.72	143.25	395.28	126.05	121.63	961.93
Total	4,206.84	3,367.39	3,684.63	4,437.72	4,081.39	4,097.32	23,875.29

RECEIPTS AND EARNINGS.

The receipts and earnings for the six months covered by this report are as follows:

Maintenance of United States prisoners	\$1,973.00
Deductions from prisoners' manufactures.....	139.89
Sale of blue dirt.....	26.25
Sale of adobes.....	39.75
Sale of rock.....	350.06
Prisoners' labor.....	103.08
Sale of old iron.....	37.10
Sale of power to Yuma Water and Light Co.....	132.00
Total	2,801.13

LEGISLATION.

The twentieth legislative assembly convened on January 16 of this year and adjourned on March 16. The following are among the more important laws enacted:

An act appropriating the necessary funds for completing the capitol building; an act exempting, under certain restrictions, reservoirs and canals hereafter constructed from taxation for fifteen years; an act providing for a commission to codify the laws of the Territory; an act raising the "age of consent" from 14 to 17 years; an act creating the county of Santa Cruz; an act providing for six months' residence as a qualification for voters; an act requiring the payment of a poll tax by electors before they shall be entitled to have their names entered upon the register; an act limiting homestead values exempt from execution to the sum of \$2,500, and personal property to a value of \$500; an act declaring the property acquired by husband and wife to be common property; an act creating a second normal school; an act providing for free libraries in cities, and a compulsory school law.

JUDICIARY.

The judicial system of the Territory is unsatisfactory, and it is believed that Congress, in providing for Territorial courts, was building for sparsely settled communities during the Territorial condition, and did not make the judicial plan sufficiently comprehensive for a large population. At present the judiciary of Arizona consists of a chief justice and three associate justices appointed by the President. There are no county courts as such, except courts of probate with limited jurisdiction. The associate justices of the supreme court, including the chief justice, each have districts comprising several counties in which they hold court twice a year, as follows:

First district (Judge George R. Davis): The counties of Pima, Cochise, and Santa Cruz.

Second district (Judge Fletcher M. Doan): The counties of Graham, Gila, and Pinal.

Third district (Chief Justice Webster Street): The counties of Maricopa and Yuma.

Fourth district (Judge Richard E. Sloan): The counties of Yavapai, Mohave, Coconino, Navajo, and Apache.

There is a clerk and court commissioner in each county.

The Federal statutes are construed by some to mean that these judges designated as "associate judges of the supreme court of Ari-

zona" are only required to hold court at one place within the districts to which they are assigned, for the trial of United States and Territorial cases, and that the Territory, through its legislature, should provide county courts with jurisdiction coordinate with the district judges, and that the associate justices should only be required to transact their United States and district business, and sit as the supreme court of the Territory.

Be this as it may, whether the meaning of the statute is not sufficiently clear, or whether custom and circumstances have improperly developed these conditions, the judges now are compelled to serve as United States district judges, county judges, and judges of the supreme court.

In the hearing of cases before the supreme court, the judge before whom the case under consideration was tried in the court below is disqualified from participating, yet it is contended that it would be better if there were a supreme court distinctively as such, so that the judges could have no connection with trials had in the lower courts.

The judges are very poorly compensated for the work they have to do, and no provision is made by law to defray their actual expenses while traveling to and from the different counties in which they hold court and their living expenses while necessarily away from home on court business.

The fourth judicial circuit, containing five counties in which court must be held twice each year, extends entirely across the Territory from east to west and comprises a greater area than the State of New York. The judge is kept constantly busy, exclusive of his supreme court work, and the same is true, comparatively, of the other judicial districts. Their pay of \$3,000 per year is absurdly inadequate. The judges should receive at least \$5,000 per year; able jurists of high character, learned in the law, should not be expected to give up the lucrative practice of their profession for the honorable and very respectable position of associate justice of the supreme court in the Territory at an unreasonably low salary. It is clear to me that the interests of the Government and the people would be best served by the creation of a fifth judicial district in Arizona, and a proper increase in the salary of the judges.

The judges of this Territory are men of the highest ability and character, and command fully the respect and esteem of the people.

LABOR.

As previously reported, this question has never materially disturbed affairs in Arizona. Temporary strikes have in a few instances occurred upon the great transportation lines, but they have seldom been serious in their nature and have, with one exception, been quickly settled. Arizona is entirely free from contention caused by disagreements between capital and labor. Liberal wages are paid and labor is usually contented. Americans are principally employed. There are very few foreigners in the Territory not naturalized. A few Mexicans and some Indians work as section hands on railroads, and Chinese and Japanese are employed as house servants, but a very large percentage of our labor is American, especially in the mines.

Laborers in Arizona are, as a rule, intelligent and law abiding. The supply seems to equal the demand, and few men who care to work need be idle here.

MINING.

For the mining industry the past year has been the most prosperous in the history of the Territory, and the year's record clearly demonstrates that Arizona is sure to become the greatest and most profitable mining section in the country. In former years the phenomenal production of a few great copper, gold, and silver mines gave the Territory a reputation as a producer of precious metals, but the fact that Arizona possesses incalculable mineral wealth has had tardy recognition. The Territory has never experienced a mining "boom;" the development of this industry has been slow but sure and substantial. Inaccessibility and lack of transportation facilities have been the principal drawbacks. These obstacles have now been largely overcome by the construction of railroads into the most important mining districts. The mistaken idea has prevailed to some extent, also, that Arizona's mines do not "go down," and more or less prejudice has been created against the Territory on that account. This erroneous theory has been entirely exploded. Deep mining has proven that values frequently increase in depth. In the Congress mine, at a depth of 2,500 feet, the ore shows great value and strength. In the Gladiator and other mines in the Bradshaw Mountains values increase with depth, and it is not improbable that deeper mines will be worked in Arizona than on the famous Comstock lode of Nevada. During the past year the attention of investors and prospectors outside of the Territory has been enlisted as never before, and sales and contracts for sales have been numerous. There has been a notable increase in the production of gold, which will be still more pronounced during the coming year. One of the remarkable features has been the revival in silver mining. The building of new railroads has enabled the owners of silver properties to make shipment of ore at a profit, and in some sections of the Territory silver mining is active and profitable.

The prominence which Arizona has achieved as a steady producer of the precious metals, and the certainty that the production will be augmented in the future, justify me in urging that a Government assay office and branch mint be established in the Territory. Assay offices are generally conducted at a profit to the Government and there is every reason to believe that such would be the case with an office established in Arizona, while the substantial encouragement thus held out to the mining industry of the Territory would be very beneficial.

In copper mining, in the increased capacity of copper smelters, in the location and development of new discoveries, and in the influx of eastern capital for the purchase of copper mines and prospects, the year has been remarkable. The output of copper has increased at a marvelous rate, and if, as there is every reason to expect, this rate of increase is maintained, Arizona in a very few years will lead the United States in copper production. One of the features peculiar to Arizona copper mines is the continuity of the ore bodies.

The almost fabulous production of some of Arizona's great copper mines, and the remarkable success of mining ventures in this Territory, together with the high price of copper and the active trading in copper stocks, have afforded opportunities for speculators and stock jobbers to unload upon overcredulous Eastern investors a great deal of worthless mining stock, and companies have been organized upon quite a number of undeveloped prospects in Arizona, and capitalized far beyond any reasonable valuation, and through much advertising

and extravagant misrepresentations have sold stock throughout the Eastern States, amounting, I am told, in par value, to several millions of dollars and upon which no return whatever can be reasonably expected. No doubt such methods are more or less practiced always where mining is active and prosperous, yet the abuses had become so notorious, and so many inquiries and complaints were made to the executive office, that, to protect investors, and in behalf of honest and legitimate mining in Arizona, I felt it my duty in June of this year to issue a circular note of warning to the public on the subject. The immediate responses of approval which came from all over the country demonstrated the salutary effect of this action. The mineral wealth of Arizona is immeasurable, and honest mining is almost always a sure road to fortune.

Particular attention is invited to the report of the Territorial geologist, in which the mining industry of Arizona is ably and exhaustively treated. The reports from counties also contain valuable information in regard to mining.

[Report of Prof. W. P. Blake, territorial geologist.]

HISTORICAL SKETCH OF MINING IN ARIZONA.

THE PREHISTORIC PERIOD.

The prehistoric races who occupied the valleys and hills of Arizona, the builders of the great houses and now ruined cities, were the earliest miners. Evidences of their work have been found in all directions. The croppings of our chief mineral deposits, when first found by white men, were seen to have been dug into and stripped of their contents to a considerable extent at some remote period and by unknown hands. It would seem that the ancient prospectors and miners sought for materials for ornament and decoration rather than for the more useful materials and metals. At the croppings of the ores known to us as the United Verde, for example, the aborigines dug for the brilliant red, blue, and green oxides and carbonates of copper for paint. At other places they sought for the brilliant glancing scales of hematite, for this ore has been found in the ruins of their dwellings.

At two or more of the localities of the turquoise with which Arizona Territory is favored the lost races mined extensively for this gem under its ancient and more appropriate name of *chalchihuitl*. And in getting out this precious metal, of more value to them than gold, they dug shafts and tunnels, using stone implements in profusion, as shown not only at Turquoise Mountain, in Mohave County, but at the prehistoric mine in the Dragoon Mountains.

At the Cerrillos, in New Mexico, 25 miles from Santa Fe, immense excavations were made to secure this gem, which it appears was sought for and mined from Mexico to Santa Fe. Fragments of *chalchihuitl* and small objects carved in it, and ornaments overlaid with a mosaic of turquoise tesserae are found in the ancient ruins of Arizona, thus giving evidence of the racial unity of the ancient miners and the remnants of the Indian tribes of the present day.

Lead mines were not neglected. When the veins of lead ore at Castle Dome, upon the Colorado, were first seen by our modern prospectors it was evident that the ores near to the surface had been carried away: the croppings had been stripped; deep trenches along the croppings, partly filled in with debris and overgrown by the mesquite and palo-verde, gave abundant evidence of the industry of unknown miners. So, also, at the Montezuma lead mine, between Phoenix and the Vulture, there were ancient excavations showing a considerable extraction of ore, and in these excavations the prehistoric miners left their stone tools, such as hammers, sledges, and mauls. This fact should dispose of the theory held by some that this early work was done by the Padres or Spanish explorers.

We should not overlook the early aboriginal utilization of the waters of the Salt River and the Gila by the successful diversion of these streams over the high mesas through canals and acequias, showing great boldness of conception and engineering skill of a high order.

SPANISH COLONIAL PERIOD.

The early colonists of Mexico were stimulated and incited to conquest and occupation by the mineral riches of the country. They were alive to the reputed wealth of the then unknown northern regions and many expeditions were organized for the exploration of northern Mexico, including the regions since known to us as Sonora, New Mexico, and Arizona. A confirmation of the general belief of the existence of great riches in gold, silver, and precious stones at the north was found in the reports brought in by Cabeza de Vaca. This intrepid explorer, who accompanied Narveaz to Florida in 1538, and was one of the five men deserted there, made his way westward across the Mississippi and the Rio Grande and then southward to the colonies of his countrymen in Mexico. The negro Estevan was one of his companions on this long, weary march. They are said to have reached on their western journey the Lundi and Moquis villages, and to have carried back to Culiacan, in Sinaloa, exciting accounts of the great wealth of the region in silver, gold, and precious stones. Hamilton writes that they were the first foreigners to set foot on what is now Arizona soil. Their reports confirmed the general opinion of the great wealth of the Seven Cities of Cibola. The narrative of Castenada expressly states that in the year 1530 Nuno de Guzman had an Indian named Tejo in his service who was the son of a trader, who, in the boy's youth, had made journeys into the back country with fine feathers to trade, and returning had brought back a large amount of gold and silver. Tejo had seen seven very large towns which had streets of workers in silver.

A new expedition was organized under the leadership of Friar Marcos to penetrate the northern regions even to the Seven Cities of Cibola, and the negro Estevan was selected as the guide. This Estevan gave the good friars great anxiety by his grasping greed for turquoises and other valuables and his conduct with the Indian women. He constantly pushed ahead of the friars, and, arriving at one of the Zuni villages, was imprisoned and put to death, whereupon Friar Marcos hastened back to Mexico without seeing the treasure vaults of the Seven Cities, where the women were said to wear gold beads and the men golden girdles.

In the year 1582 Antonio de Espejo led an expedition to explore the region to the north known to the Spaniards as Arizuma. Traveling up the Rio Grande, he named the country Nuevo Mexico. Turning westward, he visited the Zunis and Moquis. Forty-five leagues southwest of the Moquis villages he discovered rich silver ore, said by Hamilton to be the first authentic account of the finding of precious metals within the limits of Arizona, and in his opinion the locality must have been in the region now known as the Black Hills, on the Rio Verde. Espejo retraced his steps to Zuni, and returned to Mexico by way of the Pecos Valley in 1583. It is related that among those who took up their abode in New Mexico were three Flemish men, but citizens of Mexico, who devoted their attention to mining, and discovered many new mines. Being much encouraged, they returned to Mexico for competent miners and refiners, and for machinery with which to work the mines. But when they returned the Spaniards, being opposed to the enterprise, set fire to the machinery and destroyed it. In the year 1599 Onate, having heard much of the great city of Quivira, made a trip to it, accompanied by 80 soldiers and Father Francisco de Velasco, then the commissary of the province, and a secular friar named Pedro Vergara. Onate was satisfied that the country abounded in gold, which the Indians refined by a process they called "tejas."

When Onate returned to Mexico he took with him two Indian boys whom he had made prisoners in one of the fights with the Indians. According to Davis, one of these boys built a furnace in the City of Mexico for refining gold, and showed a surprising degree of skill in this art. The silversmiths tried to deceive him with gilded and spurious articles, but he readily distinguished between the true and the false.

He was taken to Spain and presented to Philip III and the court. He made a map of his native country, and gave such a glowing account of its wealth in gold that the King gave orders for an expedition of a thousand explorers, but the projected enterprise was soon abandoned.

ESTABLISHMENT OF MISSIONS.

About one hundred years later, or in 1687, the Jesuit missionaries, Fathers Kino and Salvatierra, established the first mission within the region now known as Arizona. Thirty years later there were nine missions, all in a prosperous condition. The converts were mostly from the Pimas, who took the name of "Papago" (baptised). But the missions were subject to constant raids from the Apaches, who

doubtless interfered greatly with mining, and in the year 1757 there was an uprising of the Pimas, with the destruction of several of the missions and murders of the priests. This disaster was followed in 1765 by a royal decree of expulsion of the Jesuit Fathers and the substitution of eight Franciscan friars in 1768.

We may conclude that during the long period between the disastrous ending of the expedition of Friar Marcos and the colonization of southern Sonora prospecting for precious metals was actively carried on, and possibly some of the work upon the Castle Dome lead veins and at other places in Sonora and Arizona was done by these early adventurers from New Spain. The many places in the region where remains of the Mexican style of furnace are found, as well as piles of slag, and often of litharge, bear witness to the enterprise and industry of these early metallurgists.

NATIVE SILVER.

Near the beginning of the eighteenth century reports reached the City of Mexico of the discovery of great masses of native silver in the northern regions, in the district of Arizona, a locality since known to us as the *Planchas de Plata*, and not far from our present international boundary line, and between Nogales and Sasabi. Owing to the remoteness of the region, it is fair to presume that much of this silver was dug and taken away without the payment of the King's fifth, for we find that a prosecution was instituted by the royal fiscal against the discoverers of Arizona for having defrauded the royal treasury of the duties payable upon the masses of pure silver found there. A search made by the Mexican Government in the vice-regal archives nearly a century later showed that correspondence on the subject between the viceroy and the Court of Spain took place in the year 1736.

Philip the Fifth, of Spain, on the 28th of May, 1741, issued a decree terminating the prosecution, and declaring the district of Arizona to be royal property, as a "*criadero de plata*;" a place in which silver was created. This decree recited that the weight of the balls, sheets, and other masses of silver, "*bolas, planchas, y otras piezas de plata*," amounted in weight to 165 arrobas, 8 pounds, in all 4,033 pounds. One piece weighed 2,700 pounds and another 11 arrobas, upon which duties had been placed by one Don Domingo Asmendi. The King thought that this piece at least should have been sent to Madrid "*como cosa especial*." It is interesting to note this early official use of the name Arizona, which, according to Mowry, is of Aztec origin and was originally written *Arizuma*.

GADSDEN PURCHASE.

Much interesting information upon the early history of the region of the Gadsden Purchase was obtained from the archives of the Mexican Government by Capt. Charles P. Stone, of the United States Army. From a summarized statement of this information, published in the article upon silver and copper mining in Arizona in the *Mining Magazine* (second series, vol. 1, pp. 1-15) in 1859, the following is extracted:

As early as 1687 a Jesuit missionary from the province of Sonora, which in its southern portion bore already the impress of Spanish civilization, descended the valley of the Santa Cruz River to the Gila, which he followed to its mouth, now the site of Yuma. From this point he ascended the valley of the Gila and of the Salinas or Salt River and its branches, and reached the Mimbres and probably the Rio Grande and the Merilla Valley. Filled with the enthusiasm of his order he procured authority from the head of the order in Mexico and established missions and settlements at every available point. In a report to the viceroy of Spain, made during the early settlement of the province, we find the following statement: "A scientific exploration of Sonora with reference to mineralogy along with the introduction of families will lead to a discovery of gold and silver so marvelous that the result will be such as has never yet been seen in the world." A map of this and the adjoining territories was drawn by some of the Jesuit missionaries in 1757 and dedicated to the King of Spain.

The reports of the immense mineral wealth of the new country made by the Jesuits induced a rapid settlement. The sites of more than fifty towns and villages, some of them of considerable size, are indicated on the map. Then settlements and missions were founded by the side of streams and springs in fertile valleys which produced luxuriant crops of corn and beans, and in many parts grapes and other foreign fruits were cultivated. In the western part of the territory (Sonora) were the missions of St. Pierre, St. Paul, St. Matthias, St. Simond, St. Francisco Merçi, the ranches of Eau Cheri of San Xavier del Bac Santiago,

San Cayetano, and San Felepe, the towns of Tucson, Tubac Reyes, San Augusta, and many others. Upon the San Pedro River were the missions of St. Mark, San Salvador, Santa Cruz, and the towns of Quidura, Rasario, San Fernando, and others. To the eastward some small settlements were found in the Valle del Sanz on the Mimbres, at the copper mines north of the Mimbres; and to the south the immense grazing and stock-raising establishment of San Bernadino. The Indians in the vicinity of the missions were reduced first to obedience by the Jesuits and then to slavery by the Spaniards.

APACHE RAIDS.

The missions and settlements were repeatedly destroyed by the Apaches, and the priests or settlers massacred or driven off. The Indians, at length thoroughly cowed by the cruelties of the Spaniards, by whom they were deprived of their liberty, forced to labor in the silver mines with inadequate food, and barbarously treated, finally were joined with the tribes which had never been subdued and gradually drove out or killed their oppressors. This was the general uprising of the year 1680. The attempts at civilization disappeared before the devastation of the savages, and in place of the thriving settlements there were blackened ruins and deserted mines.

From the year 1757 to 1820 the Spaniards and Mexicans continued to work many valuable mines near Barbacera. The ancient records mention many silver mines, most of which contained some gold. Among them were the Dolores, San Antonio, Casa Grande, Cabrisa, San Juan Batista, Santa Ana (which was worked to a depth of 360 feet), Rosario, Cata de Agua, Quadalupe, Corilla, Prieta, Santa Catarina Guzopa, Hurstano, Arpa, Descubridora, Nacosari, Arguage, Churinababi, Huacal, Pinal, and a great number of others.

From the notes and the map already mentioned, dated 1757, found and copied by the late Gen. Charles P. Stone, in the City of Mexico, it appears more than 100 silver and gold mines were worked in the northern provinces with great success by the Spaniards.

These discoveries then and since have added largely to the prestige of Arizona as a land of fabulous wealth, especially in silver. Very little appears to have been put on record in those early days of its wealth of gold not only in placers but in veins. Mexico, also, was regarded as essentially a silver-bearing country, and silver at that time was less common and more sought for than gold. The silvery reputation of Arizona has since been fully sustained by such mines as the Tiger, the Stonewall Jackson, at Globe, with its nuggets of native silver, and by the Silver King at Pinal; the great mines of Tombstone, Cochise County, and the White Hills, Mohave County; but nearly all these mines are now idle. The production of silver has diminished, but the production of gold has been more than correspondingly increased.

AMERICAN OCCUPATION.

It was the fame of New Mexico and Arizona as a land of marvels and hidden wealth that appears to have drawn Humboldt northward from Mexico at the beginning of this nineteenth century. The people on the eve of revolution and independence of Spain do not appear to have been very actively engaged in exploring and developing the far-off mining regions of Sonora and New Mexico. Even Ward, who traveled extensively among the chief mining districts of Mexico in 1825, failed to reach the northern provinces or to give any satisfactory systematized account of the condition of mining at that time north of Chihuahua. A few desultory notices of the mines of Upper Sonora by Colonel Bourne are appended to one of the volumes. The remoteness of the region and continual incursions of the savages prevented any systematic and regular working of mines beyond the immediate vicinity of the settlements.

The discovery of gold upon the American River in California in 1848 marks a most important era in the history of mining in Arizona. The Territory, then a part of New Mexico, lay directly in the path of the gold seekers, not only from the Atlantic States, but from Mexico and Sonora. Mines in Sonora were deserted and the road into California by way of Yuma was crowded with Mexican miners and their families bound for the New Eldorado. The thousands who pressed westward across the desert-like stretches along the Gila gave little heed to the riches immediately about them, and mining in Arizona and in Sonora was long overshadowed by the marvelous development of California. New Mexico was ceded to the United States in 1848; southern Arizona, south of the Gila, was then Mexican territory. The Gadsden Purchase was perfected in December, 1853.

The work of the United States and Mexican Boundary Commission during the years from 1850 to 1853 and the explorations of Emory and of Bartlett greatly stimulated the interest in this then comparatively unknown land. So, also, the explorations in search of a good route for a transcontinental road largely added to our knowledge of New Mexico and promoted the development of Arizona. The reconnaissance of A. B. Gray should also be mentioned as one of the important contributions to the description of the country from San Diego to the Gulf of Mexico.

The overland mail route, commonly known as the Butterfield route, was established in 1858. This gave access to the before almost inaccessible interior and greatly promoted immigration and the development of the mineral resources of the region.

EXPLORATION OF SOUTHERN ARIZONA.

Upon the acquisition of the country under the Gadsden treaty active exploration of the mineral wealth of southern Arizona by citizens of the United States commenced.

About the years 1855-1857 the best known mining localities in the Gadsden Purchase were at Arivaca (also anciently famous as Aribac), Sopori, the Arizona Mountains, the Sante Rita Range, the Cerro Colorado, the region about Tubac, the Del Ajo or Arizona copper mines, the Fadronia copper mine, and the Gila River copper mines. As early as 1830 the Mines Cobre de la Slatá, near Fort Webstermouth, of the Gila, were worked to great advantage, and so rich was the ore that it paid for transportation on mule back more than a thousand miles to the City of Mexico.

In the month of March, 1856, a party of gentlemen who had spent several years in Sonora and the Gadsden Purchase formed an association in Cincinnati, Ohio, for the purpose of sending out a small party to secure by purchase or discovery one or more of the old deserted mining ranches. Col. Charles D. Posten, of Kentucky, with Mr. Hermann Ehrenberg and Mr. Frederic Brunckow, mining engineer, and a party of frontiersmen were fitted out and after several months of exploration purchased the Arivaca rancho, near Tubac, and established the headquarters of the company at the old mining town of Tubac, on the Santa Cruz and near the Santa Rita Mountains and the northern spurs of the Arizona or Arizuma.

Mr. Ehrenberg was an accomplished engineer, prospector, and miner, greatly interested in the promotion of the interests of Arizona. He was foully murdered while asleep in camp upon the banks of the Colorado by a Mexican who wanted Ehrenberg's saddle. This rancho, in addition to all its mineral wealth, contained large areas of agricultural land with permanent water, wood, and grass, contained twenty-five silver mines or openings which were worked by the Mexicans before the Apache war, and became famous for their rich ore. The best known mines were San Jose, Santa Margarita, Basura, Blanca, Azonias, Taftitos, Amado, and La Purisima. Titles were also acquired to many veins of silver ores in the Santa Rita Mountains, among which were the old mines of Salero and Ojero.

HEINTZELMAN MINE.

Several miles northeast of the Arivaca rancho, on the Cerro Colorado, other interesting and important mining localities were found, among which were the Heintzelman, Mina Carlos, Mina Cesario, Puertocito, Guadalupe, Amarilla, and Mina Longozenia. These results led to the permanent organization of the company known as the Sonora Exploring and Mining Company, of which Major S. P. Heintzelman, of the United States Army, who was several years stationed at Camp Yuma, was elected president. Attention was specially directed to the Heintzelman vein, which in 1857 had been opened to a depth of 50 feet. The Salero was opened to a depth of 80 feet. This mine is said to have been so named from the fact that silver saltcellars were made from silver taken from it for the use of the bishop. The development of the Heintzelman and other properties was actively promoted by Colonel Posten, who obtained capital from the Eastern States, largely from Col. Samuel Colt, of Hartford, Conn. The machinery and supplies were sent out at great cost, especially for transportation across the country from Yuma. Reduction works were erected on the Arivaca rancho, 8 miles from the mine, and at these works the barrel amalgamation process was introduced for the first time in the United States. Pumpelly, in writing of this property, says:

.. The results of an examination proved so satisfactory that considerable attention was drawn toward that part of New Mexico. Joint-stock companies with

little ready capital and immense expectations were formed. Speculators bought in stock for 1 per cent of its nominal value and sold out at from 50 to 90 per cent to tradesmen and widows too poor to meet assessments when means for working were absolutely necessary. Between the absence of available funds on the one hand and of protection of life and property on the other, enterprise was already beginning to stagnate when the withdrawal of the United States troops made the abandonment of the country absolutely necessary."

Mr. Pumpelly here refers to the domination of the Apaches after the withdrawal of the troops. Mining and prospecting were suspended and the miners fled. Piles of rich ore about the mines were hastily covered up with waste rocks and the country was abandoned.¹

Colonel Posten and Mr. Pumpelly were among the last to leave, and arrived in an Francisco in the winter of 1861, where Mr. Pumpelly joined the writer in the Sojage to Japan, and established a school of mining and science under the auspices and support of the Government by the Tycoon, and an exploration of a portion of Yesso was made.

PATAGONIA MINE OR MOWRY MINE.

About 1859-1862 the Patagonia mine, afterwards known as the Mowry mine, excited great attention, being extensively worked and made known in the East by its chief owner, Sylvester Mowry. These mines of argentiferous galena were discovered in the Santa Cruz Mountains. Twelve ordinary Mexican blast furnaces were erected, six of them being in blast alternately. The lead bars, weighing about 70 pounds each, were shipped to England, except some of them which were treated for the extraction of the silver with which to meet current expenses. This smelting was accomplished in the Mexican vaso. The silver bullion was cast into bars worth from \$2 up to \$300 each, and these were used as money. Twenty-five tons of products of the Mowry mines were sent to Europe as specimens in 1862. On the 8th of June, 1862, Mr. Mowry was arrested under the order of General Carleton on a charge of treasonable complicity with the rebels and his mining property was confiscated.

CAHUABI.

The mines of the Cahuabi and Fresnal region, southwest of Tucson, early attracted attention and were worked by Mexicans using the patio process. So, also, the copper mines at the Ajo excited the admiration of the pioneer prospectors who followed, or were connected with, the boundary survey.

AJO.

The old Arizona Copper Company (Ajo) was one of the first, if not the first, mining incorporations upon Arizona property. The marvelously rich copper ore from that property, consisting of heavy masses of native copper, red oxide of copper, and green carbonate mixed together, made it possible to transport it overland from the Ajo to the head of the gulf and to ship it from there to San Francisco and Swansea, England, at a profit. Much ore was sent abroad from these mines before 1860. At that time the cabinet mineral collections in San Francisco of Donald Davidson, of General Allen, and of Capt. R. L. Ogden, were adorned by choice specimens of these ores. These mines are now (1899) being reopened, deepened, and worked with promising results. The carbonated and oxidized ores give place to rich sulphides in depth. These require concentration, which is successfully accomplished, though want of sufficient water is a great drawback to the rapidity of development. By the courtesy of Peter R. Brady, sr., now of Florence, Ariz., I am able to add the following statement regarding the early history of this copper property. It was prepared at my request for this report, and being the testimony of an eyewitness and participant in the earlier working of the Ajo it is extremely valuable as an addition to the record of mining in Arizona.

"The Ajo mine was located in November, 1854, by a party of Americans from California. The organization was known as the Arizona Copper Mining and Trading Company. Maj. Robert Allen, U. S. A., deputy quartermaster-general of the Department of the Pacific, was the president of the corporation, and J. Downer Wilson, of San Francisco, was secretary and treasurer.

"At that date the present boundary line between Sonora, Mexico, and the territory of the United States had not been determined, and its position was not ascertained until the following year, 1855.

¹Raphael Pumpelly, "Mineralogical sketch of the silver mines of Arizona," Cal. Acad. Nat. Sci., 11, 1862.

"As soon as the region began to be occupied by citizens of the United States and work commenced on the Ajo mines, these mines were claimed by several wealthy residents of Sonora as being within Mexican territory. In the month of March, 1855, a Mexican company of cavalry was sent from the district of Altar and from Ures, the capital of Sonora at that time, to dispossess the Americans, to capture them, and take them to Ures as prisoners. But the miners refused to go and defended their position. With only 9 men against 110 dragoons and vaqueros, the mine was successfully held and the Mexicans were dispersed. For six months after this nothing was done beyond mere prospecting, but in the fall of the year 1855 the boundary line had been run, and it was found that the Ajo mining camp was at least 40 miles inside of the boundary on the United States side. Edward E. Dunbar, one of the pioneer residents of San Francisco, was then made the superintendent of the property and work was resumed in a formal manner. The mining locations, of which there were 17 made in that year, all had some work done on them. In the meantime 10 tons of selected ore had been taken from shaft No. 1. This ore consisted of red oxide of copper. It was shipped to Swansea and was sold for a little less than \$400 per ton. There were several hundred tons of sulphurets of copper extracted from the different workings. The principal portions were in a limestone formation, but the richest ores were all found near where the first work was done and were in porphyry.

"The company attempted to transport the ore to San Francisco and thence around Cape Horn to Europe, but the costs were so great that their plan of transportation had to be abandoned. For the first year, on every pound of ore transported from the mine by way of Yuma to San Francisco the freight alone amounted to 9 cents. A reverberatory furnace was built at a cost of over \$30,000, and not as much as 100 pounds of copper was ever produced in it. Finally, after several years of great expenditure, the company ceased operations. The property was left in charge of a keeper whose claim for services amounted to \$5,000, and the property was sold at sheriff's sale."

MOHAVE COUNTY.

Mohave County attracted the attention of United States prospectors as early as 1858 in a search for placer gold deposits. In the year 1880 the most important mining districts were the Aubray, Cedar Valley, Greenwood, Hualapai, Maynard, and San Francisco. Many claims are enumerated in the report by Mr. Burchard for 1880-81.

The discovery of placers at La Paz in 1863 drew many miners from California to Arizona, who penetrated to Weaver, beyond the Hassayampa, and helped to clean up the wonderful deposits of coarse gold in that camp and on the top of Rich Hill.

VULTURE MINE.

The same year (1863) was marked by the discovery of the great quartz vein, since known as the Vulture, by Henry Wickenburg, which was worked for a decade, but under great disadvantages, owing to the constant presence of the murderous Apaches. For a time the miners were paid off, not in coin, nor in promises, but in chunks of gold chopped off with a hatchet from the ingots and weighed out to them according to the figures on the pay roll. The stamped bars of gold from this mine were current all over central and northern Arizona, and it was the only mine in the Territory for a long time that kept up the reputation of the country and sent out regular shipments of bullion.

CÁSTLE DOME.

This district was organized in 1863, and for a time ores were shipped by water to San Francisco, or until the completion of the railroad to Yuma. Since then the ores are taken down the river by boat, and are then transferred to the railway. The freight to San Francisco from the landing on the Colorado River was \$12 per ton. The galena ores averaged 60 per cent lead, 35 ounces of silver, per ton. The selling price at that time was about \$60 per ton.

PLANET MINE.

The Planet Mine, on the Colorado River, in 1871 kept about 20 men at work and had shipped from 100 to 150 tons of copper ore of high grade to San Francisco monthly by way of the river to San Isabel, where the ore was transferred to vessels for San Francisco by way of the gulf.

Mining gradually extended up the Colorado and into the contiguous territory. The Hualapai district became prominent about 1870, 1871, and 1872.

HUALAPAI DISTRICT.

In the Hualapai district little was done in the year 1871 except to make locations and the amount of work essential to hold them. In 1872 a 5-stamp mill was erected and 2 furnaces. The furnaces were reported as total failures, but in December, 1872, a third furnace was completed, and being properly managed was successful. Most of the work even in 1872 was superficial, and few of the pits were over 30 feet deep. The oxidized ores soon gave way to the undecomposed pyritous ores rich in both silver and gold. The district in 1872 could boast of having some 2,700 locations, about 1,000 of them in separate lodes, the rest being the extension of the first locations. Several other districts were set off at that date, among them the Maynard, about 10 miles north, and the Cedar district, about 60 miles south.

SAN XAVIER.

The San Xavier, south of Tucson, had been developed to a considerable extent as early as 1875, and efforts had been made to smelt the ore. It is recorded that a quantity of the ore smelted in a Mexican furnace gave good results.

TOMBSTONE.

The discovery and development of the rich ore deposits of Tombstone mark an era in the history of mining in Arizona. In the latter part of the year 1877, A. E. Schieffelin and his brother left Camp Huachuca to explore the Mule Mountains, which were then dominated by the ruthless savage Apaches. He was advised to take his tombstone with him, and when he discovered the rich ores and named the claims the Tough Nut and the Goodenough, he gave the name Tombstone to the camp. This was in February, 1878. A wonderful development followed. Millions in value were produced. A large and thriving city grew up. The hills were covered with mining hoists and piles of ore and débris. The Tombstone Mill and Mining Company, the Contention, Grand Central, and the Girard were leading producers. At length the level of permanent water was reached, the ores changed in character, and the water was found too great in volume to be controlled by one property. United effort has not been secured, and these properties are idle, and Tombstone is practically to-day a deserted city. Schieffelin has passed away, but his tombstone, in the form of an imposing, massive masonry pyramid of granite boulders, towers over the scene of his discovery, a fitting monument to his courage and enterprise.

SILVER KING.

The Silver King, for years one of the most brilliant of the silver producers of Arizona, and which built up the prosperous towns of Pinal and Silver King, was discovered in March, 1875. It was worked for several years under the chief ownership of Col. James M. Barney, and paid some millions in dividends, but since the fall in value of silver, and for other reasons, it is now idle.

COMMONWEALTH.

The discovery of the value of the Pearce or Commonwealth mine in 1895 has resulted in the building up of a thriving community in the Sulphur Spring Valley near to the eastern base of the Dragoon Mountains. It is to-day one of the largest producers of gold and silver in the Territory.

COPPER MINES.

The great copper-producing camps of Arizona are comparatively of recent growth. The first location at Globe dates from 1875. It was long handicapped by the difficulty of access and of transportation, but is now (1899) connected by rail with the Southern Pacific.

The Rosemont copper mines, which were worked for a time by the late L. J. Rose, passed, in 1896, into the hands of the Lewisohn Brothers, of New York, and are being developed.

In the Sierritas, 18 miles south of Tucson, the year 1899 witnesses the erection of a copper smelting furnace at the azurite claims and the production of ingots of copper and copper matte.

The old San Xavier lead, zinc, copper, and silver mine, which has been idle for years, is now (1899) being worked and is producing.

COPPER QUEEN.

The Copper Queen mine at Bisbee was discovered by Hugh Jones in 1877. The honor of this discovery is also claimed for George Warren in 1878, who sold out his share in 1880.

For several years this mine was barely worked sufficiently to satisfy the requirements of the law. It was once sold with difficulty for \$1,250,000, and appeared at one time to be nearly worked out. It is now well known as one of the leading copper mines of the United States, and is connected by rail with the Southern Pacific at Benson. The value of the ore extracted up to September 1, 1883, was reported as \$3,000,000. The value of the annual production is now (1899) believed to be not less than 25,000,000 pounds.

GRAHAM COUNTY.

The extensive copper deposits in Graham County, in the valley of the San Francisco River, at Morenci, Longfellow, Clifton, and vicinity, were discovered about 1865, and were brought prominently to notice in 1871. These mines were among the earliest producers. Furnaces were erected and the copper bars were shipped out by ox teams overland.

UNITED VERDE.

The far-famed United Verde copper mine, although originally located back in the sixties, had a struggle for existence, as a paying property, until 1887, when capital and intelligence came to its rescue, and placed it among the foremost copper producers of the world. The property was purchased by Hon. W. A. Clark in 1888. Copper production began in March and continued during the summer at the rate of about 600,000 pounds per month, this being the quantity required by contract with the syndicate. (Vide Min. Res. U. S., 1888, p. 59.)

OLD DOMINION.

This mine at Globe was run with one furnace in 1888. Coke at that time cost \$48 per ton.

WOLFRAMITE.

The discovery of wolframite in 1898, in workable quantities, at Russellville in the Dragoons and at Gijas, Arivaca, and other places, added an important mineral to the list of Arizona's productions, and has introduced a new mining industry.

SCHOOL OF MINES.

The citizens of Arizona have not been unmindful of the importance of general education and especially of education in the art of mining, and in the sciences and arts, upon a knowledge of which the success in mining and metallurgy so greatly depends. In 1885 the Territorial legislative assembly passed an act establishing a university to include a School of Mines. This marks a new epoch in the history of mining in Arizona, and it was a fitting recognition of the importance of the mining industry to Arizona. A contract for the chief building for the School of Mines, located at Tucson, was let in October, 1887, but the building was not completed and opened until October, 1891. Since then, in the absence of any available funds for the university building, the School of Mines building has been used by all departments of the university. The instruction in the university is provided for by the General Government out of the income from the Morrill fund. Theoretical and practical instruction is given in mining, geology, mineralogy, assaying, and general metallurgy. Several of the students and graduates have entered actively into the work of mining and metallurgy, and occupy important and remunerative positions as assayers and metallurgists in different parts of the Territory.

TERRITORIAL MUSEUM.

In connection with the university and the mining school a museum has been established, in which specimens of the minerals, ores, and the building materials of Arizona and other regions are displayed and used for the educational work. There is also a superb collection showing all the birds of Arizona.

STATISTICS OF MINING AND PRODUCTION OF THE PRECIOUS METALS.

No provision has been made for the official collection of statistics of the mining industry in Arizona. The county commissioners of immigration have annually endeavored to supply the details for their respective counties. The former commissioners of mining statistics for the whole United States, especially for the States and Territories west of the Mississippi, also endeavored to secure the figures representing the annual production of the mines, and much valuable information is recorded in their reports. The Territorial geologist has also endeavored to secure full and reliable information upon the progress of mining, but a general indifference, particularly on the part of the larger and most successful mine owners and managers, render the task a difficult and thankless one. The slow but sure method of personal observation seems to be the best solution of the difficulty.

OUTLOOK FOR 1899.

Never before in the history of Arizona has there been such a general activity in prospecting and mining at all the chief districts and mines of the Territory.

DISTRIBUTION OF METALLIC WEALTH IN ARIZONA.

Arizona is essentially a mineral-producing Territory. There is no other part of North America of equal area where probably such a variety of minerals can be found. Many of these minerals are extremely rare and occur elsewhere but sparingly and as curiosities for the cabinet of the mineralogist rather than in commercial quantities, as in several instances in Arizona. But there is not only a great quantity of minerals, but the geological structure is varied and comprehensive. Representative outcrops, ridges, and mountains are found of nearly all of the chief formations and systems known to the science of geology. And so far there has been but comparatively little systematic study of these formations. The field is new, the harvest is ready, but the reapers are few. This results partly from the immensity of the distances, the great scale upon which the Territory is built, the absence till recent years of railway transportation, the presence of bloodthirsty savages, now happily restrained, and the failure, with but few exceptions, of any appropriation of money by the General Government or by the Territorial legislature to defray the expenses of exploration and publication. The unparalleled magnificence of such grand features of the earth as the canyon of the Colorado and the chain of extinct volcanoes towering above it have, we may say, compelled attention, as the monographs of Powell and of Dutton may testify. The rapid reconnaissances of Sitgreaves, of Whipple and Marcou, of Parke, Emory, Bartlett, Gray, and others, are not forgotten, but the fact remains that we yet know but little in detail of the structure of the mountain ranges of Arizona and of the treasures they contain.

An attempt to show the geographical distribution of the mineral wealth of the Territory of Arizona results in the generalized statement that all of the mountain ranges are mineral bearing. Even the plateau region of the northeastern portion has its deposits of value, of building stone and of coal and probably of other mineral substances of commercial value. This statement, penned in the report for 1896, has been notably verified in the discovery of deposits of copper ore and of veins of gold and silver and tungsten. But the chief region of occurrence of the precious metals, of copper, of lead, and of other metals and minerals, lies southwestward from the Grand Canyon region and of the great lava districts around the extinct volcanoes of the San Francisco Mountains, which we may assume cover from view important deposits of mineral wealth. The uplifted strongly scarped and eroded mountain ranges of the central and northern portions of the Territory are more accessible to the prospectors and reveal their treasures more completely.

The chief region of metalliferous minerals and mines thus commences on the northwest, in Mohave County, at the sharp bend of the Colorado River at Cornville, and it extends southeastward diagonally across the Territory for nearly 500 miles in a broad belt of high and ragged mountains, including the Bradshaw

Mountains, the Mazatzals, the White Mountains, the Apache and Pinal Mountains, the Santa Catalina Mountains, the Santa Ritas, Huachucas, the Chiricahuas, the Dragoons, the Mule Mountains (Tombstone), and other ranges. All these mountains, with their spurs and subordinate parts, are known as mineral bearing. They all invite and reward faithful prospecting. In support of this statement we need to refer only to the discovery in the granite rock of the Dragoons in 1898 of valuable deposits of tungsten, elsewhere noticed in detail, and to the late discovery, also, of a promising vein of the precious metals upon the western slope of the Baboquivari Range.

The chief towns, cities, mining camps, and mining districts are distributed along the course of these mountain ranges of central and southern Arizona in one broad belt, extending diagonally across Arizona from Nevada to Mexico. Commencing on the northwest end at the Colorado we have in succession southeasterly Mineral Park, Hillside, Congress, Jerome, Prescott, Phoenix, Florence, Pinal, Globe, Mammoth, Tucson, Tombstone, Bisbee, Pearce, Arivaca, and Oro Blanco. The Longfellow copper mines and others of Clifton lie upon the northeastern border of the belt, while upon the southwestern border we find the celebrated district of Harquahala, Weaver, Vulture, and many other districts. Passing farther westward we come upon the lower or piedmont region of broad and extensive valleys and plains, broken by numerous isolated ridges and ranges, all trending northwest and southeast, parallel with each other and with the main central axis of mountains.

These mountain ranges and valleys fill out the area of the Territory to the Colorado on the west and Mexico on the south. They are all mineral bearing.

The ancient district of Castle Dome, celebrated for its beautifully formed veins of argentiferous lead ores, lies about 20 miles north of Yuma, in the extreme southwest corner of Arizona. Silver district, with very large veins carrying silver ore, adjoins Castle Dome northerly, and there is a continuous series of mining camps and locations of gold, silver, and copper ores northward along the Colorado River to La Paz, Ehrenberg, Bill Williams Fork, Mohave, and beyond.

And directly across the Colorado River in California, but tributary chiefly to the development of Arizona, there are the gold-bearing districts of Picacho, the Black Range, and the Mohave Desert region, reached by the Atlantic and Pacific Railway.

COMMUNICATION—TRANSPORTATION.

The great trunk lines of railway, portions of two transcontinental systems, traverse Arizona from east to west and give convenient access to the mining regions on the north and on the south. The Southern Pacific, entering the Territory from New Mexico near San Simon, crosses the counties of Cochise, Pima, Pinal, Maricopa, and Yuma. The Atlantic and Pacific road, entering from New Mexico on the head waters of the Puerco, a tributary of the Little Colorado, crosses the counties of Apache, Coconino, Yavapai, and Mohave. It crosses the Colorado River to California at the Needles. These two transcontinental lines are connected from north to south by the Santa Fe, Prescott and Phoenix Railway and the Maricopa and Phoenix and Salt River Valley Railway. A branch road from Benson southward extends to the Gulf of California at Guaymas, and another road, the Arizona and Southeastern Railroad, extends from Benson to Bisbee. A branch from the Southern Pacific, at Teviston or Bowie station northward to Solomonville and beyond to San Carlos and Globe, and known as the Gila Valley, Globe and Northern Railway, has been completed and gives access by rail to the extensive copper-bearing district of Globe. The copper fields of Morenci and of Clifton are reached by the Arizona and New Mexico Railway, which connects with the main line of the Southern Pacific at Lordsburg, N. Mex. Those only who have lived and labored in Arizona before the construction of these roads can appreciate their inestimable value to the Territory and to civilization. They have rendered possible the proper development of the mineral and agricultural resources of Arizona.

CLIMATIC ADVANTAGES OF ARIZONA, WITH REFERENCE ESPECIALLY TO MINING.

The Territory of Arizona enjoys peculiar advantages in respect of climate for working mines and ores. Mining in the open air, without the protection of buildings, can be conducted every day in the year without hindrance from snow or extreme frosts. Even in the midst of the Bradshaw Mountains or central mountain ranges snow rarely falls to so great a depth as to seriously interfere

with mining work or to impede or suspend transportation. The air at all seasons is comparatively dry and bracing, and in midsummer a slight shade of brush or canvas suffices to keep off the excessive heat of the sun. Death by sunstroke is unknown. In midwinter the days are bright and clear and are highly favorable to protracted labor. In the region of Tucson, at an altitude of nearly 2,500 feet above the sea, while the nights in winter are frosty and bracing, severe and long-continued freezing weather is unknown. Water in open shallow pools freezes at night, but when covered or in pipes a slight protection by soil or wrappings is sufficient to prevent freezing. The great heat of the sun by day warms up the soil to such a degree, that frost does not penetrate deeply or freeze the ground if dry. The luxuriant growth of many of the cactacea and other plants among the cliffs and rocks of Arizona, which could not for a night withstand the frost of a Northern or Eastern winter, may be explained by the fact that the rocks absorb large amounts of heat from the sun by day and radiate this heat slowly at night. Some of the very dark-colored rocks, or those with a black surface, exposed to the sun on the deserts become so hot as to be uncomfortable to the hand. Cliffs of black lava thus become repositories of heat and exert an important influence upon the growth and distribution of plants.

The economic industrial advantages of being able to work the mine and mills or leaching works without hindrance or interruption by the weather may be best appreciated by those who have had to combat the furious freezing storms of Colorado, Montana, Idaho, or the Klondike. Expensive plants in Arizona for leaching out gold with cyanide solutions or by chlorine water do not require the costly protection of buildings or artificial heat. The work may be carried on continuously every day in the year without being frozen up.

Record of temperatures at University of Arizona, near Tucson.

Month.	Mean.			Highest.	Lowest.	Absolute range.	Greatest daily range.	Least daily range.
	Maximum.	Minimum.	Monthly.					
1898.								
January	60	32	46	73	17	56	47	18
February	75	40	58	83	32	51	44	19
March	71	40	56	82	25	57	45	14
April	83	51	67	95	34	61	51	13
May ¹	84	54	69	95	45	50	40	25
June ²	98	68	83	106	58	48	43	19
July ²	99	74	86	108	66	42	36	13
August	97	73	85	106	66	40	34	13
September	95	63	79	102	55	47	43	11
October	89	48	68	98	38	60	51	29
November	72	36	54	90	21	69	49	11
December	59	35	47	74	22	52	37	5

¹ First twelve days only recorded.

² Last twenty-three days only recorded.

GOLD, GOLD VEINS, MINES, AND PLACERS.

GOLD—ITS DISTRIBUTION IN ARIZONA.

Of all the metals, gold is the most widely and generally distributed in all parts of Arizona. It occurs either as placer deposits or in veins in nearly every mountain range from Yuma on the west to the Chiricahuas on the east, or over the whole breadth of the Territory. Locally, it is more generally spread along the course of the mountains and in the streams descending from them. Many of the placer deposits are but partly worked, owing to the scarcity of water.

CONGRESS MINE.

The Congress group of mines is located in Martinez mining district, Yavapai County, Ariz., near the line of the Santa Fe, Prescott and Phoenix Railway, about 70 miles north of Phoenix and 66 miles south of Prescott. The town of Congress and the mines and reduction works are located at the mouth of a short canyon, broad enough at the bottom to give ample room for the necessary buildings for town and works. The outcrops of the veins are on the mountain sides, giving abundant fall for waste dumps and the proper arrangements of mills. The water supply comes from Martinez Creek, 1 mile away. It is raised 500 feet by a steam pump to get over the ridge, and runs into the camp by gravity. Three hundred and fifty men are employed in the mines and surface works. The mills, mine, and all company buildings are lighted by electricity. The company owns and oper-

ates its own railroad from the junction to the camp. By a system of switchbacks the cars are taken up the mountain side so as to deliver coal, timber, and other mine freight directly at the mines. The company operates a general merchandise store and boarding house, and provides sleeping rooms lighted by electricity for its men. A hospital is also maintained, where the injured and sick are cared for. The wires of the Postal Telegraph and Cable Company run into the camp, and the Congress company maintains a regular office.

Claims.—Twenty-three claims are owned, and the greater part of the work has been done on only three, the Congress, the Niagara, and Why Not, although the others all carry promising veins, and will be explored in the future.

Geology.—The country immediately around Congress is all granite and granitic gneiss. This rock is cut through by a series of approximately parallel dikes of greenstone trap, having a general easterly and westerly strike and a dip of about 20 degrees to the north. The Congress vein is in one of these veins; or perhaps it may be said that the dike is the vein, for ore has been found in the dike in all possible positions from one granite wall to the other, but generally occupying a position near the foot wall and separated from it by a layer of vein selvage. The dike has a thickness of about 15 feet, measured at right angles to the walls; but this is uncertain, as we rarely see the hanging wall in the mine, the drifts hugging the foot wall, and their height not being sufficient to expose the hanging. These greenstone dikes are crossed by other more nearly vertical dikes, having a northeasterly and southwesterly trend. The cross dikes are apparently a kind of quartz porphyry. Very little is known of them, as they do not appear to be ore bearing, and have been but little exposed in the underground works. They do not seem to mark lines of faulting, as the greenstone dikes are not thrown at the intersection. They are apparently of more recent origin than the greenstone dikes, as they seem to cut the latter and occupy the space of intersection.

The following analysis of a specimen of greenstone was made at the Sheffield Scientific School, Yale University. No analysis of the quartz porphyry has yet been made:

	Per cent.		Per cent.
SiO ₂	52.20	MnO	1.90
Al ₂ O ₃	13.40	CaO	9.60
FeO	9.75	MgO	1.16

Besides the Congress vein, described above and upon which the greater part of the work has been done, there are several others of equal promise on the surface and holding out extremely well to the extent of the development work that has been done upon them. One of these crosses the Congress at an acute angle, and another, known as the Niagara vein, is parallel to and in the foot wall of the Congress. These veins are entirely inclosed in the granite without the accompanying dike, which is such a marked feature of the Congress vein. The Niagara vein is now being systematically opened by shafts over 3,000 feet apart, both of which show up a large continuous vein of excellent grade ore down to the present level of 300 feet with every promise of continuance to great depth. There are numerous smaller veins carrying good ore and running approximately parallel to the Congress and Niagara, but none of them has been explored to any extent.

Ore.—The Congress ore is white quartz, carrying very pure iron pyrite, generally disseminated through it in small particles, but at times in quite massive form. There is little, if any, gold in the quartz showing no pyrite and hardly any free gold exists in the ore.

The pyrite carries, on an average, about 8 ounces of gold per ton. Other sulphides so commonly accompanying iron pyrites are notably absent, a little galena of very rare occurrence being the only one identified, and chemical analysis of the concentrates from the ore showing hardly a trace of copper, arsenic, antimony, or, indeed, of anything but iron, sulphur, and silica.

The Niagara ore, on the other hand, shows considerable galena and some copper minerals besides the iron pyrite. This difference seems to be rather characteristic of the ore of this neighborhood, when the veins are entirely in the granite, as distinguished from those which are accompanied by the greenstone dikes.

As stated above, the ore in the Congress vein is generally near the foot wall. Its position and appearance suggest that it occupies what have been the exceedingly flat lenticular cavities produced by a fracture of the dike along the plane of its dip, followed by sufficient movement along the line of fracture to leave such cavities by reason of the inequalities of fracture. There is no evidence of the replacement of the greenstone by quartz, the whole appearance being that of the filling of preexisting cavities by deposition from mineral waters. The valuable contents of the vein have been quite likely derived from the greenstone by segregation and infiltration.

Underground works.—There are three principal shafts on the Congress, all sunk on the vein and conformably to its dip. No. 1 and No. 2 shafts are 600 feet apart and the No. 2 and No. 3 1,000 feet apart. Nos. 2 and 3 are connected on the 1,700-foot level and each have hoisting machinery capable of sinking to 3,000 feet. Sinking is still in progress with air drills, and a depth of 2,400 feet has been attained, proving the dike and ore to be continuous and strong to that depth, the ore in fact being larger and of better than average grade. The system of mining aimed at is to block out the ground by main levels, driven dead, approximately 300 feet apart. Stopes are then started at the shaft and rise above these levels. As the tops of the stopes reach the height decided upon as the proper distance for another level (generally 75 feet), the level is carried in, practically being already formed by the stope, with the exception of a little cutting of the roof to make room for the timbers. The ground stoped out is filled with waste as soon as possible, as the roof soon becomes heavy and the temporary supports put in during stoping would crush without filling. By this method of stoping a large part of the waste broken is kept underground, serving the purpose of supporting the roof, saving hoisting, and causing the air to circulate upward along the working breast of the stopes.

Reduction works.—The reduction works consist of a 40-stamp mill and a cyanide plant for treating the tailings. The milling process is as follows: The ore from the mine is dumped on grizzlies, the oversize passing through two 9 by 15 inch Blake crushers, and thence with the fines to storage bins of about 1,000 tons capacity. Tullock feeders draw their supply from these bins for the 40 stamps. The stamps weigh 850 pounds each, and drop 6 inches 90 times per minute. Steel wire screens are used of 20 holes to the linear inch, No. 24 wire. The pump is fed direct to 20 Frue vanners, equally divided between them. The resulting concentrates are dumped upon a sand filter to drain, and while still moist are loaded in bulk, without sacking, into cars for shipment to the smelter, at present the El Paso Smelting Works. The tailings pass to a Frenier & Le Blanc sand pump, which elevates them to settling tanks, and where the surplus water is removed and pumped back to be used over again, while the tailings are run in cars to the dump.

Fine crushing and concentration at one operation on such material as the Congress ore is not a clean operation, but is probably the best process available, considering the very small supply of water. The concentrating percentage is in the neighborhood of 80 on \$16 original ore, and the greater part of the loss is in the very fine slimes. It is quite probable that closer work could be done by hydraulic classifying previous to concentration, but the changes in the mill necessary to introduce this in a proper way would be quite extensive, as the necessary fall between the batteries and vanners is at present lacking. The rate of crushing is 100 tons per day or 2½ tons per stamp.

Cyanide works.—The tailings from the concentrating mills are reworked by the cyanide process at the rate of 110 tons per day. The plant comprises a large Brown mechanical roaster; seven leaching tanks, each 26 feet in diameter by 4½ feet deep; four solution tanks 15 feet in diameter by 10 feet deep, together with the necessary bins, boilers, engines, pumps, piping, zinc, boxes, etc., the whole being inclosed in substantial corrugated iron buildings covering an area of over 12,000 square feet. The tailings as they come from the concentrating mill are bedded and partially dried by plowing and exposure to the sun. They are then dumped into a Stedman pulverizer, going thence by elevator to a storage bin, from which they run by gravity to the self-feeder of the roasting furnace. The furnace is fired with California crude oil, using three No. 3 Claybourne burners. Emerging from the roasting furnace thoroughly desulphurized and oxidized, the tailings are automatically carried along on a sheet-iron cooling hearth, passing under a spray of water to lay the dust and assist in cooling, and thence go to the leaching tanks, where the gold is dissolved and collected on zinc shavings in the usual way.

Production.—The gross production of the mines to date is in the neighborhood of \$5,000,000, and notwithstanding the fact that the reduction works have been continuously operated at full capacity, the development of the mines has been kept so far in advance of stoping that there is now more ore in sight than at any time since the company began operations.

KING OF ARIZONA.

This gold-bearing property, known for a time as the Gleason, has been transferred to the King of Arizona Mining and Milling Company, a corporation organized under the laws of the Territory of Arizona, with a capitalization of 5,000,000 shares of a par value of \$1 each. This company owns four full claims—the Homestake, the King of Arizona, the Last Hope, and the Mucho Bueno. The bound-

aries of the district have not yet been defined nor has a name been given to it, but when it is organized it will probably be named the King of Arizona district. This district lies about 35 miles due east of Castle Dome Landing, on the Colorado River. It is north of the Gila River and about 48 miles from the Texas Hill Station, on the Southern Pacific Railroad. This is the nearest station on the railway. There are several other locations besides those conveyed to the King of Arizona.

The Homestake location covers the chief workings up to this date. There is on this claim a strong vein of gold-bearing quartz. This lode or vein has three well-marked divisions or layers. On the hanging wall there is a soft layer from 1 to 3½ inches wide, which averages about \$2,800 per ton in value. Next below this there is a middle layer or body of quartz about 20 inches thick, which will average about \$90 to \$100 per ton in value. The remainder of the vein, so far as it is exposed by the shaft, averages about \$24 per ton. Test holes have been drilled 3 feet deep into the foot wall, and all are in ore. The shaft by which the exposure of the nature of the vein has been made is 200 feet deep and follows the dip of the hanging wall a distance of 40 feet easterly and 30 feet westerly. These show a continuity of vein, having the same characters and values developed by the shaft. The hill rises rapidly both east and west of the shaft, so that the height of backs on the lode above the drifts is greater than at the shaft. At a point about 30 feet west of the shaft and on a level with the collar of the shaft the vein has been crosscut from wall to wall, showing it 18 feet wide at that point. The ore in the crosscut is of about the same grade as that in the shaft. The croppings of the vein may be followed for some 700 feet of the Homestake shaft to a second opening, known as "The King of Arizona Shaft." This shaft is about 50 feet deep, and by means of drill holes the vein is shown to be 11 feet in width and has an average value of \$10 per ton. At a point 300 feet east of the Homestake shaft a tunnel has been made which crosscuts the vein 160 feet below the surface. At this point the hanging wall vein is 18 inches wide and has an average value of \$50 per ton. The tunnel then passes through 30 feet of vein matter running about \$3 per ton, thence through 7 feet of ore carrying \$28 per ton to the foot wall. The total distance from hanging wall to foot wall along this tunnel is 40 feet. A drift has been run along the foot wall to the Homestake shaft at a distance of 300 feet, and the average value of the ore exposed is \$14 per ton.

At the commencement of operations, and in order to fully test the ores, 2,500 tons of quartz was taken to a 5-stamp mill, which the company owns, on Gila River, a distance of 35 miles south of the mine and 12 miles from Texas Hill. This ore yielded by plate amalgamation about \$75,000. The tailings were then treated by cyanide and \$30,000 more extracted, leaving in the tailings an average of about \$1.50 per ton. After repeated tests it was found that this ore could be treated en masse, after crushing, without running it over the plates or using amalgamation methods. Accordingly it was decided to erect a cyaniding plant at the mine.

In February last the company let a contract for the erection of a reduction plant, capable of treating 100 tons of ore each twenty-four hours, and for sinking wells from which a sufficient water supply could be obtained. This work has been successfully prosecuted. Water was found in abundance 1,000 feet below the surface of the ground at a point about 4 miles from the mines; also at another point 1,000 feet below the surface 15 miles distant from the mines. Pipe lines have been laid, pumps erected, and the reduction plant completed, and is now (August 25) being tested and will in all probability be turned over to the company by the contractors about September 1.

THE CROWNED KING MINE.

The Crowned King is undoubtedly one of the most valuable gold mines in Arizona. It has been producing steadily for more than ten years. It is opened by several tons on the vein, one beneath the other, connected by winzes and shafts. The ore body is regular and continuous and of remarkably even value, although occasionally very rich "strikes" are made. Within the current year considerable ore was encountered that assayed as high as \$50,000 per ton. Few mines are so well situated for economical working. The ores are reduced by a stamp mill and concentrators. A large percentage of the values is saved on the plates, the concentrates being shipped away to smelters; this much is known. The product of the mine and the average value of the ore can not be obtained for publication, as the owners consistently refuse to furnish information on these points. Several millions have been produced. It is safe to say, however, that the Crowned King is a magnificent property. It is situated in the Bradshaw Mountains, Yavapai County, about 35 miles from Prescott.

MAMMOTH COLLINS, LIMITED.

This mine in Pinal County, a few miles north of Oracle, is an important gold property. At the date of the report for 1897 it was lying idle, owing to a change of ownership and management, but it was reorganized in 1898, and work was actively resumed. In addition to the Mammoth Mine the company purchased the Collins Group, which adjoined the Mammoth on the west. There ore deposits occur in granite, and are marked by a strong mineralization of the rock traceable through the claims by excessive discoloration. The soil is very red over the whole area. The deposits are large, and very long stulls are required to span the spaces left by stoping. The mill is located on the San Pedro River, some 6 or 7 miles from the mine. Formerly the ore was hauled from the mine to the mill in large wagons, and water was taken back by the returning teams. Under the present management all this is changed. An automatic wire rope tramway has been put up between the mine and mill, and now the ore is regularly transported and delivered into the bins of the mill at a very small cost. In fact the weight of the ore in the descending buckets furnishes all the power necessary, and is also sufficient to take back in a part of the bucket a full water supply for the mine. This tramway effects a great saving of expense per ton and insures a regular and full supply of ore at the mill of 100 tons or more a day.

The tailings which accumulate in large quantities on the mill are now treated with success and profit. This plant has a capacity of 200 tons a day. The extraction is carried to a high percentage of the gold contents. The tailings are dug out of the tanks and are scraped away by mules. Zinc shavings in iron boxes of the usual form are used to precipitate the gold from the solution.

A large wood supply is necessary for the boilers of the mill. Wood costs over \$8 per cord delivered there, and the oak groves of the Catalinas at and around Oracle are being decimated by the wood contractors. This meets with regret and opposition, and the Government has made decided objections to this wholesale destruction of the timber.

A plan has been devised to utilize the water of the Arivaipa Canyon by putting in a dam, storing the water, taking it out in pipes under sufficient pressure to run dynamos, and to transmit the electrical energy to the mill in sufficient amount to run it and to do all the hoisting and lighting at both the mine and the mill. This scheme seems to be entirely feasible and if perfected will make a model plant worthy of the beginning of the twentieth century mining.

In association with the gold of this lode there are at places considerable bunches of galenite, lead ore, massive in character and sufficient to make shipments to smelting works. The partial decomposition of this sulphide ore gave fine specimens of massive lead sulphate—anglesite—in crusts and concretionary layers accompanied by olivenite and by cerussite and wulfenite—the molybdate of lead. Of this molybdate, in large masses and crystalline bunches, twelve tons of 90 per cent purity were shipped away in 1898. This was obtained by overhauling the waste dumps at the mine, and the demand and the supply also are now exhausted.

LA FORTUNA MINE.

In the early days of gold discovery in California, 1848, when the news reached the gold miners of Sonora, there was a general exodus of the able-bodied men who were able to get away northwest to the new El Dorado in California, and the State of Sonora contributed many men to the mining population. They took the old road, which was known as the "Camina Real," from Estancia and Altar northward nearly parallel to the Gulf, following the mountain ridge known as the Gila Range, just north of our present boundary. The road led to Yuma, and in passing by the Gila Range they went within a few feet or yards of a very modest outcrop of quartz which no one seemed to consider of sufficient value to merit any attention. That humble and insignificant quartz outcrop is to-day the outcrop of the great Fortuna mine.

It is situated on the westward slope and nearly at the base of the range of mountains called on some of the old maps the Gila Range. This trends northwestwardly and reaches nearly to the Gila River at the point now known as Blaisdell. The railway in its course to Yuma passes around the northwest point of this range. Where the rocks are exposed at that point they are mostly of homogeneous granite, of gray color and weathered out at the surfaces, which, however, are much pitted as if by decomposition of some soft substance. But beyond these low-lying hills of granite there are big outcrops of rock which to the experienced eye indicate stratified formations. They are indeed stratified, for the bulk of the range south-

ward and southeastward is composed of regular stratified, laminated, hard gneissic rock. I use the word "gneissic" in a very general and comprehensive sense, for you can describe these rocks with much more accuracy if you localize them as mica slates and hornblendic slates, with interpolations of quartzite beds, especially in the upper part of the series, with green stains, supposed to be stains of copper and decomposition of copper ore, which they probably are, although there are some peculiarities of color, and some yellow colors, which indicate to me the presence of some other mineral, possibly tellurium, which by its decomposition has given these colors. The fact remains, however, that the bullion from the upper part of the vein contains more copper than it now contains in the lower levels of the mine. The workings which have been carried on here have developed a condition of things which could not be foretold from an inspection of the outcrop. The vein or lode appears to be a chimney, not a continuous ore body nor a continuous vein with an ore body or chimney or chute upon it. As remarked the outcropping points indicate that there is no very great longitudinal extension of this ore.

The vein is remarkable, first, in this limited outcrop; second, in its continuity in depth, its continued and satisfactory richness, and the promise it gives of enrichment by further veins dipping into it on the foot-wall sides.

Some facts in regard to the product or yield: The ore paid from the surface. The product or ore extracted up to the time has been about 80 tons per day, which is sent to the 20-stamp mill, each stamp of which crushes about 4 tons in twenty-four hours. The extraction is chiefly and largely by power drills. A force of 80 men is employed by this mine and mill. The greater part of the labor underground and mining is done by compressed air. The lode, I was told, was 6 to 15 feet wide. This large space permits the use of power drills to great advantage. In the material hoisted there are fragments of the wall rocks, some of which are thrown out, but many pieces pass through the mill. They would prefer to reject most of this wall rock, but it would take more time and expense than it does to mill it, and there is a chance of some of it containing gold. From these 80 tons of rock crushed daily the average product is perhaps \$48,000 worth of gold per month. Some months they have produced as high as \$90,000.

In the region of the Fortuna Mine the formations appear to be wholly of mica slate and hornblende slate, with some arenaceous layers like old micaceous sandstone and quartzites. The mine is surrounded by black hornblendic slates and mica slates, dipping southward and southwestward at an angle of about 45 degrees, and these slates are very evenly laminated, ridge after ridge. There is apparently a continuous body stretching to a distance of 2 or 3 miles, and showing a thickness at right angles to the stratification of no less than 6,000 or 8,000 or perhaps 10,000 feet, and there is no evidence whatever of plication. The stratification is flat and as regular as the leaves of a book. Usually we detect more or less plication or folding in such a section, but there is no evidence of any folding whatever in this series. There is, however, a great difference in the composition of the layers of these rocky ridges, now all turned black upon the surface—a condition of coloring which seems to attend all the rock outcrops along the lower Colorado, and the origin of which, though discussed by Humboldt after noting similar blackening of the rocks along the Orinoco, has not yet been satisfactorily explained. This general blackening of the surface hides the changes of composition, which may be noted by careful and close inspection.

In some places hornblendic slates are more developed than the mica slate, and at others the micaceous schistose characters predominate and are accompanied by layers of quartzite interleaved and 3 or 4 feet in thickness, sometimes 3 or 4 inches, and some foliated quartz having little films of mica in it. These quartz beds are members of the series, but have been located as ledges, and, it is claimed, are gold bearing. The quartz has little or no resemblance to vein quartz, and yet at several points in the outcrop there are stains of green color, apparently from the decomposition of ore like that which has given green stains to the croppings of the Fortuna.

Several dike-like seams or veins of white albite or soda feldspar cut directly across the bedding of the mica-slate series. These feldspathic dikes do not appear to have any relation to the ore-bearing vein or lode of the Fortuna. These dikes are extremely irregular and appear to have filled cross fractures or breaks of the regular strata.

Coarse granite was noted at the northern point of the Gila range, along the railroad, but no evidences were found of the existence of stratified Paleozoic or secondary rocks. The mica-slates series referred to is the Huronian or Archæan.

VULTURE MINE.

This well-known gold mine is one of the oldest in the Territory. Its fame in early days was based upon its great production of the yellow metal and the difficulties under which the gold was obtained. Some or the greatest of these obstacles were the absence of water and the presence of the savage Apaches and the distance from civilization and supplies. Sold originally by Weaver for an old pipe, it repaid the purchasers by millions of dollars' worth of precious metal. Without banks upon which to issue checks to pay the men and without means of transporting coin to meet the pay rolls, the ingots of gold were chopped up with hatchets and chisels and distributed to the men in liquidation of their wages. Yet the property has seen dark days, and has at intervals stood idle, while not one of the shafts had been sunk much more than 300 feet. A victim of extravagant valuations and promises based upon its past record and of stock jobbing exploitations, the proper working and development of the property have been neglected.

The vein at the surface was divided up into parallel layers, which were more or less broken over and dislocated. These trifling displacements were sufficient to frighten some of the weak-kneed grass-root miners, and gave rise to the fallacious saying in California that the "veins in Arizona had no roots." But these little breaks have been passed and only serve to show the great breadth of the lode and to indicate the best position for more extensive and deeper work. Instead of some 400 feet in depth, as now, a shaft should be put down 1,200 feet or more, with proper drifts and connections with another shaft farther west. The property changed hands early in the year 1898, and it is hoped will now be worked upon its merits. It is understood that the cyanide plant erected upon the banks of tailings yielded a profit of \$75,000. This mine produced in its early history upwards of four millions of dollars, and it is believed that under modern methods of development and working it will be a great producer for many years.

SEXTON LODE.

This quartz lode, also known as the Leviathan and as Staunton's, is in the Weaver district, Yavapai County, about 25 miles from the Vulture, and is now well known for its great extent and prominence, though explorations upon at least a part of it have failed to show sufficient value to justify working. It remains to-day in nearly the same condition, save the prospect holes and cuts, in which it was left by Sexton. The discovery of this ledge appears to have been made in 1870 or 1871. It was announced in Raymond's report for 1872. The location was probably made by Mr. Sexton while he was engaged at the Vulture. The dominance of the Apaches in that section will account for the slowness with which the region was prospected. When Sexton left the Vulture he put Staunton—Lord Staunton—in charge. Staunton did the assessment work for some years, and, as presumably remittances to cover the costs were not regularly made, he relocated the ground in his own name. It is what is called a blanket ledge. The size of the lode and the quantity of quartz exposed are enormous. The quartz lies upon the northern slope of the hill and practically forms the surface of the hill. It extends to the crest of the hill and there outcrops in a continuous ledge, broken down into a confused mass of great blocks of white quartz. Considerable development has been had on this mine within the past few years. The ledge has straightened up, and such values have been found as is believed will make it profitable to work the property.

LONE PINE GROUP, YAVAPAI COUNTY.

This group of gold-bearing claims is situated about 9 miles south of Prescott, in the Hassayampa mining district. There are eleven claims, named Robert Emmett, Parnell, White Hawk, Black Hawk, Lone Pine, Greyhound, Polar Star, Reindeer, Blue Bird, Red Bird, and Black Oak. In connection with these a mill site was located on the Hassayampa River. The veins on these claims are described as formed chiefly of quartz carrying free gold above the water line and auriferous sulphides below. The most prominent outcrop is upon the Blue Bird and the Red Bird claims. The principal development work has been upon the Greyhound, and consists of the main tunnel, 250 feet in length. This tunnel follows the vein out of the Greyhound into the Red Bird claim. At 30 feet from the mouth of the tunnel there is a crosscut 30 feet to the westward and 20 feet to the eastward. It is claimed that this crosscut shows vein matter for a distance of 50 feet. Another crosscut, 85 feet beyond the first, also shows vein matter 40 feet thick. The last 100 feet of the tunnel is in broken ground. On the Parnell claim there is an open

cut showing a 2½-foot vein. On the Black Hawk a tunnel follows the veins for 130 feet. Many of the open cuts and pits along the several veins indicate their extent and value.

Wood consisting of pine, oak, and juniper can be had from the neighboring mountains. Water for domestic purposes is obtained on the claims, while an abundance for milling purposes can be had from the Hassayampa, near by. (Condensed from the statement by O'Boyle).

COMMODORE GROUP.

Weaver district (Martinez), Yavapai County, comprising the claims known as the Anaconda, Leora, and Oversight gold-bearing lodes. Ore refractory, valued at \$35 to \$40 per ton. A shaft 15 feet deep has been sunk on the Anaconda and one of 117 feet and another of 135 feet on the other claims. Drifts, 70 feet.

JOHNSON MINE, STANTON.

This mine, opened upon the great quartz vein which appears to have been the feeder of the enormously rich placer deposits of Weaver and Rich Hill, was worked for many years by the hermit Johnson, whose bones now lie buried under an immense wall of the lode from which he was stopping ore. He kept two or more arrastras at work on selected high-grade, free-gold quartz. The vein lies quite flat or at a low inclination, so that one may get about on the foot wall without the aid of ladders. But this inclination, is variable. There are several tunnels upon the property. In some places large branches of massive galena are found in the vein. Coarse gold is not uncommon, but is found in pockets and bunches, while the surrounding quartz is nearly barren. A specimen of "spike gold," valued at \$80, was obtained by me some years before the death of Johnson by purchase from Stanton. Showing it afterwards to Johnson, he recognized it as one of the specimens he had taken from his vein. There seems little reason to doubt that this vein and the "Leviathan" of Stanton are one and the same, and that it extends over the summit of Rich Hill. The gold no doubt occurs in coarse masses in pockets, with the intervening portions of quartz quite barren.

At the time of the opening of the mine by Mr. T. A. Conlee the tunnel was reported to be 200 feet long. The vein measured 6 feet between walls and carried from 1½ to 3 feet of sulphureted pyritic ore and the balance of the vein free milling quartz, valued at from \$8 to \$10 per ton. The Johnson mine is now being extensively developed by experienced miners, and it bids fair to become one of the great gold mines of the Territory.

FREE GOLD GROUP, YUMA.

In the Chocolate Mountains of Yuma County, 6 miles easterly from the Colorado River and Nortons Landing, about 6 miles northerly, as the crow flies, from the Old Clip Landing, and 60 miles northerly from Yuma, is situate the Free Gold group of mining claims. The country formation is of porphyry, quartzite, and granite, through which the ledge has its way in a northeasterly and southwesterly direction, defined for 8,500 feet on this group. The group consists of the Renown, Quien Sabe, Little Mint, Cashier, Hidden Treasure, Missing Link, Celestina, Free Gold, Arastra, Siwash, Rio Vista, and Skookum claims, but the development is principally done on the Free Gold, located on a horseshoe-shaped basaltic porphyry mountain. Through the hills of this mountain, and two lesser spurs of porphyry, a fruitful green-granite belt cuts, on a northeast and southwest strike; about midway of this belt is situate the quartz vein of the Free Gold claim, and 240 feet above the base of the mountain is the main working shaft. From the collar of the shaft to the ore platform is an elevation of 140 feet, and a distance by skidway of 230 feet to where ore is delivered, the car being handled by whim hoist cable.

The development of this claim consists of 209 feet of shafting, 222 feet of drifting, and 75 feet of tunneling. The working shaft has a depth of 130 feet, with north drift at the bottom, 27 feet in ore. At the 75-foot level there is a north drift 125 feet in length, and 100 feet of the No. 1 ore chute on this drift is stoped to the surface. The average thickness of the pay streak is 16 inches, while the whole vein, all carrying more or less gold, is 2 feet in width. The south drift at the 75-foot level is 70 feet long, and ore chute No. 2 was struck 40 feet from the shaft. No stoping of account has been done here. In the north drift, the heading at 125 feet from the shaft is just entering ore chute No. 3. This chute is proven by shafts and cuts and by visible gold in outcrop for 150 feet in length. This is virgin territory. A tunnel 100 feet south from the working shaft is 75 feet long, and is all in

ore chute. No. 2 showing a thickness of from 8 to 20 inches of \$30 rock. Thus there are three well-defined ore chutes, with from 40 to 60 feet of semibarren ground, save occasional pockets of rich ore intervening. The vein is from 2 to 5 feet thick, with small walls, and gouge casing on both foot and hanging. The ledge dips from horizontal 80° to the east, and may be clearly defined, in place, for 1,000 feet. The average thickness on the surface is 1 foot.

Copper occurs rarely as a pyrites and cuprite; silver lead, infrequently, as galenite; and iron pyrites, at times in nuggets and kidneys, and disseminated in cubes and flakes through the quartz. These, with brown hematite, high in gold values, constitute the concentrating factor.

The ground stoped is fairly timbered, and is fitted with a man ladder and skidways. In the drifts is iron strap tracking and gunboats for buckets underground. Improvements on the surface include a blacksmith shop near the shaft, a Davis patent automatic horse-whim hoist, with 200 feet of five-eighths steel cable and 2 steel buckets of 300 pounds capacity. There is a sideway track to the ore platform on an incline of 35°, and a wagon road over wash and mesa a distance of 5 miles, connecting mine and mill, over which four good horses or mules will haul 3 tons both ways.

On a point of mesa, on the county wagon road, is erected a modern 5-stamp mill, with narrow mortar, 850 pound stamps, inside plates, 4 by 12 feet silver-plated copper amalgamating apron plate, 6-foot canvas belt springer concentrator. Blake rock crusher with self-feeder. A steam plant of sufficient capacity furnishes power. Wells 30 feet deep furnish an ample supply of water, and an additional flow can be secured by driving the wells deeper.

The ores of the Free Gold claim and group are essentially free milling, wire, shot, and flake gold, spooning freely from clean-grit, blue-white, friable quartz. The freest spoonings are from honeycomb quartz, and the highest values are held in a brown hematite that gives from 2 to 30 ounces of gold per ton. A low percentage of yellow-colored iron pyrites is found, which is rich in gold. The rock will plate, under a competent mill man, 60 per cent of its assay value, and an average mill rock of \$30 per ton can be mined. In conjunction with the cyanide process, 85 to 95 per cent of the assay values should be saved. The favorable iron matrix, holding the gold fine and free, renders this a premium cyaniding proposition; the lead contained in the ores is in too minute a quantity to be considered, and it has been practically demonstrated that when copper compounds exist in a state physically hard, the cyanide solution does not act on them, and there are no other refractory minerals in the ore.

The vein is a true fissure vein in every particular, and there is a clear improvement in the thickness of the pay streak and in the gold values—not in occasional swells, but steadily and peculiarly regular from the surface to the lowest levels.

VEINS ON THE SAN FRANCISCO RIVER.

A group of gold-bearing veins on the right bank of the river some distance above the placers gave promise of profitable working, especially as the water of the river was abundant for milling purposes and the conditions were favorable for cheap working.

In March, 1898, it was reported that the Evans-Vanhecke Gold Company was running a 20-stamp mill regularly on ores from the veins in the district, and that it was the intention to increase the plant by the addition of 30 more stamps.

ROCHESTER GROUP OF GOLD CLAIMS, CARIBI DISTRICT.

The following memorandum notes were made during an inspection in 1896, since when much work has been done on each of the claims:

Great Eastern.—Quartz ledge trends north 50° east, dips easterly 70° and 75°. A white quartz at croppings. Has the appearance of quartz which often carries coarse gold. Pit about 25 feet deep. Vein over all about 48 inches wide. Sixteen inches of quartz on the hanging wall and 12 inches on the foot. Walls soft and clay like; color, light gray. Some galena seen.

Grand Central.—About 1,000 feet higher than the camp on the west side of the mountain. Red and gray volcanic or plutonic rocks porphyritic. A "blind ledge" almost in the midst of a large amount of blue clay and decomposed porphyry. When oxidized the iron oxide becomes ochery yellow. This lode shows free gold. Course of vein is north 30° to 40° west, dip southeast at angle of 46° to 60°. A shaft was about 100 feet deep. The clay at the bottom quite damp. Thickness varies, at one place 4 feet. Advised cross cutting to the west. Some 30 to 40 tons out on bank.

Grand Mogul.—Several ledges and spurs, on a narrow ridge between two gulches or arroyos. Rock is red porphyry. Little or nothing done on the cropings. A tunnel started below them.

Little Buckhorn.—A bulging vein. Trend north 30° west, south 30° east. Dip east. From 18 to 24 inches wide.

Big Buckhorn.—On the top of a ridge. A quartz vein trending north 40° west. Dip is easterly 75° to 80°. Fine "ribbon" quartz. Walls have a soft gouge. There are some stains of copper. This vein can be cheaply mined.

AZURE KING GROUP.

The Azure King group of six mining claims in a solid block, and consisting of the Azure King, Azure Queen, Azure Prince, Azure Chief, Copper Glance, and Casheer, is situate 20 miles north from the town of Yuma, opposite the Picacho gold mining district of San Diego County, Cal., and three-fourths of a mile from the Colorado River and steamer landing. The country formation is of porphyry, slate, and quartzite, through which the ledge has its way in a north-westerly and southeasterly direction across the country rock and strata, strongly in place. The vein matter is of talcose schist and soft blue slate, with a gangue of white quartz between smooth gouge cased walls, with "slicken sides" markings to the greatest depth of workings, and holding a thickness of vein from 2 to 15 feet and a pay gangue from 20 inches to 10 feet thick. Development consists of numerous shafts along the line of vein from 20 to 80 feet deep, which, without crop, and where the lode cuts across the canyons, clearly defines the vein 7,500 feet in length. To the 30-foot level in five shafts the ore is in body and large patches. Below this level, as shown in two 80-foot shafts, the ore occurs in kidneys and bunches, the vein between smooth walls with a dip of 80° from horizontal to west.

The ore occurs as a chalcocite (copper glance), cuprite (red copper oxide), malachite and azurite (green and blue carbonates), and generously of chrysolla (a hydrous silicate of copper). No antimony or arsenic is found, thus assuring a premium quality of copper of great tenacity and ductility, suitable for the manufacture of electrical appliances and other high-grade metal fabrics.

There are numerous parallel lateral feeders and stringers of clean ore, dipping and tending toward the mother vein. These feeders are strongly mineralized and are characteristic of the veins through their entire length. The intervening country rock for a width of from 50 to 150 feet is stained with copper oxides and silicates from these and lesser interlacing veinlets of ore.

In addition to the regular northwest and southeast veins, there are two parallel north and south cross veins highly mineralized with cuprite and chalcocite. Cross vein No. 1 cleaves its way through the Copper Glance claim, outcropping in a saddle between the highest mountain peaks in the district, showing a 4-foot width of vein, thus furnishing superior tunnel sites to be run as an adit, with and on the vein, gaining 1 foot in depth to each 2 feet of drives, and a depth where the two veins intersect of about 250 feet from surface.

The assays of ore as found give: Crude hand assorted—No. 1, gold \$47.50, silver 20 ounces, copper 30 per cent; No. 2, gold \$22, silver 14 ounces, copper 18 per cent. The ore in place as it came from the mine, unassorted, gave return of gold \$6, silver 4 ounces, copper 10 per cent. If not treated on the ground by concentrating, the ore can be hand assorted to 25 per cent of copper. This was the method employed at an early day when these claims were first worked, and the ore shipped to Swansea, England, by way of river and Gulf of California. It is a straight siliceous ore.

There are two mill sites connected with the Azure King group, one on the bank of the Colorado, thus affording a navigable river outlet; the proximity of the group to the river and to Picacho, just across the river, which has a daily stage and United States mail from Yuma, also affording exceptional accessibility. (Yuma Sun, Vol. III, No. 38, December 23, 1898.)

GOLD PLACER DEPOSITS.

Papageria.—The wide extent of country lying to the west and south of the Tucson Mountains, especially the region south of the Southern Pacific Railroad to and even beyond the boundary line, is inhabited largely by the Papago Indians and is known as Papageria. It has long been known as a region of placer gold, and the Papagoes have taken out from their waterless placer deposits a large amount of gold by "dry washing." As early as 1875 Governor McCormick reported that

these Indians had for years brought more or less of gold dust to the Tucson merchants, and that in one month of that year one firm purchased over \$3,000 worth of gold from them.

Horseshoe Basin placers.—The gold-bearing gravel deposits of this name are upon the southeastern flank of a spur of the Quijotoa Mountains and have been known and worked for a century or much longer by the Indians. It is probable that these placers were one, at least, of the sources of gold brought in by the Papagoes and they may have been the main source. The following estimate of the amount of gold annually produced by the Indians is from a letter received from Mr. W. F. Day, January, 1899:

“The placer mine in the near vicinity of Quijotoa worked by the Papagoes in their crude way are producing annually between \$6,000 and \$7,000 worth of gold.”

The placers are extensive, and no doubt machinery will someday be applied to work the ground on a large scale, thus creating an important industry for Pima County.

TEMPLE BAR MINING COMPANY.

Location on the banks of the Colorado River, in Mohave County, about 100 miles above the Needles. A French company under the general management of Captain Delmar. In September, 1895, the late “Dan de Quille,” wrote of the Temple Bar enterprise as follows:

“*Mining on the Colorado.*—The altitude at the mouth of the Rio Virgin is only 800 feet above the sea level. The Colorado at the mouth of the Rio Virgin is approached by a low bottom land. It is on this part of the Colorado, on the Nevada side, that the Temple Bar Mining Company is operating in a novel way. They own a big bar on the river, the gravel in which yields from 60 cents to \$1.25 per cubic yard. (Another account gives the average as 20 cents a cubic yard.) To work this bar two big barges have been constructed, between which revolves a monster wheel, by means of which water is raised to the height of 250 feet, and forced through nozzles that play heavy streams upon the auriferous gravel. By this device it is expected that 3,000 yards of this gravel can be washed in a day. At this rate it will require many years to work out the bar.”

The company expected to begin washing on the 15th instant and are now probably in full blast. The Temple Bar Company have a fine location. Their claim is situated just below the mouth of the Grand Canyon, where the gold, rushed down through the great rocky gorges above, would find lodgment in the flat shore of the Nevada side of the river. Above the Grand Canyon is Marble Canyon, and about the first place where fine gold can settle is where this company are at work, which is about 10 miles above the mouth of the Rioville River, a small stream a short distance above the mouth of the Rio Virgin.

GREATERVILLE PLACERS.

The Greaterville Placers, in Pima County, about 40 miles from Tucson, are on the eastern slope of the Santa Rita Mountains, about 3 miles south of Rosemont. They are nearly opposite the high peak of the range known as “Old Baldy” and as Wrightsons Peak, which reaches an altitude of 10,000 feet. The placers are about 5,000 feet above tide in their higher portions, this being the height of the upper ridges of cemented débris flanking the central mountain mass. Several dry creeks or gulches here take their rise and slope gradually away into the broad valley beyond. The chief valleys or dry gulches, which mark the flow of ancient streams or brooks of considerable volume, and which even now are occasionally flooded by heavy rains, are known as Hughes Canyon, Fish Canyon, Sawmill Canyon, Gardner Canyon, Chispa Gulch, and Left Fork Canyon. The general descent is to the southeast. All these and the tributary gulches are more or less gold bearing. These placers have been worked for many years. They were described by Colonel Black in 1890. (Arizona, the Land of Sunshine and Silver, etc., J. A. Black, commissioner of immigration.) He states that the placer mining there had been found profitable for fifteen years, though conducted in a very crude way. The town of Greaterville had at that time about 150 inhabitants. Placer gold has been found almost everywhere. The gravels and sands of the beds of these dry gulches or dead streams are charged with placer gold in little pellets and grains and even in nuggets weighing ounces. Mr. Anderson, an old resident of Greaterville, has seen many which weighed from 3 to 4 ounces, and one nugget from Chispa Gulch sold for \$750. This gold is not confined alone to the beds of the gulches, but may be found higher up in the sides of the mesas and even in the cemented débris of the higher edge of the slope. The drainage must formerly

have been in great force and volume from the high mountain, as everywhere around the ranges of Arizona, to have formed such extensive marginal slopes, since cut into by more modern and constant floods. We here, too, have the phenomenal condition of canyons commencing on the eastern side of the main ridge of the mountains and extending westward through the higher and seemingly the harder and more resisting parts of the range, as, for example, the Box Canyon. This heads or commences at the upper edge of the gravelly slope of the eastern flank of the mountains and cuts directly through the whole range to the Santa Rita Valley on the west. For a great part of the distance it is between high, solid walls of granite and quartzite, and it hardly seems possible that the gorge is wholly one of erosion. Analogous conditions are found in the mountain ranges west of the El Grupo or San Joaquin rancho, in Sonora, where the entire range is cut through, the eastern valley draining into the western toward El Plomo.

The placers of Greaterville have the reputation of having contributed some millions of dollars in value in gold to the mineral production of Arizona. No reliable statistics have been kept. Formerly hundreds of placer miners or gold washers were at work where ten are found now. The first to arrive secured the richest deposits, and gradually the yield per man per day has diminished until now the placers are regarded as good for ordinary wages only, and, in fact, many of the Mexicans who are now washing do not average probably over 75 cents to \$1 a day. The absence of persistent flowing water is of course a great disadvantage in washing out dust, but its absence permits of cheaper digging and raising the pay from the bedrock.

As a rule, the deposits are comparatively shallow. Deep pits and shafts are not required. The method of working is mostly that practiced by the Mexicans. A very narrow grave-like pit is sunk to a bedrock and the "pay" is sufficient. Other smaller pits are dug at a little distance apart and the pay between them is excavated and hoisted by windlass to the surface. Water being scarce, for most of the year at least, is brought to the pit in canvas bags by donkeys, and the gravel is washed by the common placer miner's cradle, such as is used largely by Chinamen in California. As this is a slow and tedious method of handling the pay dirt, no large returns can be expected. It is not possible to form a reliable estimate of the general average value of the ground per cubic yard. Of course, much depends upon the selection and upon the position of the gravel. The usual measure of the gravel is the "ajori" or box with a capacity of ten buckets of dirt. This may yield at the present time from 50 cents to \$1, but possibly it was not strange to get nearly an ounce from the same quantity. Pits and cuts and piles of washed gravel all over the flats in most of the gulches attest the great amount of labor performed and the apparently complete exhaustion of the ground, yet there is a plan on foot to wash it on a large scale by water brought in from the higher mountain streams. The gravel, it is said, will be raised from the beds of the gulches by the modern powerful dredging and excavating machines, and will be dumped into elevated sluices which may be moved from side to side so as to give room for the discharge of tailings. Water will be impounded in storage reservoirs. From the extent of the placers only, estimated by old residents, these are now available. The limits are approximately 7 by 5 miles, or 35 square miles.

The fineness of this placer gold is said to be such as to make the gold worth \$17 per ounce, but usually it is taken in trade at the local stores at \$16 per ounce.

It is not possible to state with certainty where this gold originated and from what veins or deposits it has been derived. But a rapid inspection leads to the opinion that it has come from many veins of moderate size cutting through the bedrocks of conglomerate sandstone and granite, all of which are represented, as also shales and limestones, and here and there an eruptive dike of plutonic rock. These formations, as elsewhere shown, appear to be equivalents of the old Cambrian and Silurian formations of the middle part of Box Canyon, near Deerings Camp, and also of the red sandstones and shales of Old Hat district, on the northeast side of the Catalina Mountains, where they are traversed by the gold-bearing quartz vein known as the Silver Bell. These old fragmental rocks appear to be gold bearing to a high degree. Thin seams of amorphous hematite traversing the conglomerate at Deerings Camp contain gold in visible grains, as pointed out to me by Mr. Deering. A great number of such thin knife-blade seams would, under the enormous degradation and erosion of geologic ages, contribute largely to the placer deposits.

There is also a well-defined mineralized contact placer between the massive limestones and the quartzite and conglomerate series. This is gold and lead bearing. It appears as a well-mineralized lode containing quartz as a veinstone, with a heavy mineralization of iron pyrites and galenite. The croppings are very rusty and are highly charged with lead carbonate and fragments of undecomposed

galena, as more fully described elsewhere. Free gold may be found by panning these rusty ores, and it is not improbable, as claimed by Deering, that this extensive contact lode contributed a large part of the gold of the Greaterville placers. (Vide "Golden Gate group.")

LOST GULCH PLACERS.

Placer deposits of considerable extent and value have been worked for years in Los Gulch Globe district. These deposits appear to have been supplied by the disintegration and erosion of a multitude of small veins traversing the granitic rocks of the region. (Vide Lost Gulch mines and Sultan group.)

HUACHUCA MOUNTAINS.

Placer gold ground is found in the Huachuca Mountains. It is reported that placer miners are constantly at work near the Harper mine and making good wages.

PLACERITAS, HASSAYAMPA.

The placers along the Hassayampa above Walnut Grove, at Placeritas, have long been known and worked, and are regarded as good-wages mines.

WEAVER PLACERS.

The gold placer deposits of Weaver are celebrated for their richness and the coarseness or weight of the grains of gold. They are at the southern base of the mountains and west of the Hassayampa at the foot of the Rich Hill at Stanton. They have been worked for many years—thirty or more. The deposits of gravel are not deep and heavy. The gold appears to have been broken out from a not far distant vein. The soil is red with iron oxide and the gravel is chiefly quartz veinstone. The deposit on the top of Rich Hill was found in value from an area of less than 1 acre of ground, along an old river channel.

A score or so of men are now working on these placers from year to year, and it is supposed that they get from \$2,000 to \$4,000 in value per month.

The Rich Hill channel is noted for its coarse, heavy gold. Small scale gold does not occur there. It has not been transported far from its original matrix. The same observations apply to the placers of Weaver, which no doubt had their source in the same vein from which Rich Hill was supplied. It seems strange, however, to get such coarse gold on the top of a mountain. Tom Connell, who mined extensively on the top of the hill, assured me that he could not get even \$10 worth of fine scale gold, but he took it out in coarse masses and nuggets. One of the largest found was worth \$400, another one \$300, and another \$150 in round figures. Three lumps taken out by him were worth \$1,008. Nuggets to the aggregate value of some \$3,000 were taken out within a small area. Pedro Lucero, at Weaver, found one piece worth about \$450.

LYNX CREEK PLACERS.

These placer deposits are about 8 miles east and north of Prescott. They have been worked more or less since 1863, but irregularly and intermittently. A tract on these placers of about 300 acres has been bought by an English syndicate and equipped with a hydraulic plant, but the scarcity of water prevents constant working. Hundreds and thousands of dollars have been taken from these placers and millions remain. The gravel averages 25 cents per cubic yard, and there are thousands of acres.

GOLD ON THE SAN FRANCISCO RIVER.

Extensive placer deposits are found along the San Francisco River about 7 miles above Clifton. It was proposed some years ago to work these banks of gravel by the hydraulic process, and a large sum of money was expended in sending out sheet iron for a pipe line and a machine plant to bend and rivet the sheets into pipe. The want of adequate fall and space for the tailings caused the abandonment of the enterprise.

SMITH DISTRICT PLACERS.

Placer mines of the Santa Rita Mountains were described in 1875 as the Smith district placers, but their position was not stated. Being at that date but newly discovered and worked, the reports from these produced quite an excitement in Tucson. The grains of gold were coarse and heavy, some of the nuggets being

worth at least \$50, and one was found worth \$90.50. Heavy lumps of gold have been found on the northeastern slope of the Santa Catalinas, and were perhaps derived from the Southern Belle lode or from other veins in that region.

CANADA DEL ORO.

The placers of this great wash on the northeastern slope of the Catalina Mountains have long been known and worked with variable success.

CHEMEHUERIS PLACERS.

According to the commissioner of immigration of Graham County, the dry placers of the Chemehueris Mountains continue to add thousands of dollars annually to the wealth of the world.

M' CABEL.

Situated about 20 miles east of Prescott, opened to a depth of 500 feet and equipped with a 10-stamp mill and producing regularly, but the amount is not known.

The Little Jessie mine is about 2 miles distant and has also been a great producer.

CROWN POINT.

In Yavapai County near the Hassayampa below the site of the Walnut Grove dam. Opened to the depth of nearly 300 feet showing a ledge reported to be about 4 feet wide and with bodies of high-grade ore.

MAHONEY MINE.

A well-defined auriferous quartz vein 4 to 7 feet in width, nearly vertical, and prospecting well in free gold. Location about halfway down the Hassayampa Canyon on the left side. This ore is very red, the iron being in the condition of hematite.

BILL NYE AND WADSWORTH.

Two claims of these names have been located by Alex. McKay in the Quijotoa district on the northern side of the range. These claims are gold bearing and form a portion of a group located and worked for copper ore and noted in this report under the head of copper.

LOWDHAM GROUP.

The discovery of a gold-bearing vein by Mr. Alex. McKay on the south side of the Quijotoas is also reported. Three claims have been located on this lode—the the Lowdham, Robin Hood, and the Friar. Other claims are known as the Ben Hur and the Ben Lomond. The remarkable specimens of crystallized heavy spar (barite) generally known among the miners as “fossil oysters” are taken out of cavernous openings in some of the lodes of the Quijotoas. The Museum of the School of Mines at Tucson is indebted to Mr. McKay for several fine specimens. Placer deposits are found around these mountains, particularly below the Ben Lomond claim and at the other end of the range at Horse-Shoe Basin. (See under heading of placers.)

The Bonita and Gold Coin Group of gold claims are in the vicinity of these placers and the lodes on them may have been the source of the gold.

FRESNAL GOLD MINES.

The discovery of remarkably rich gold and silver ore on the western side of the Baboquivari range of mountains southwest of Tucson has been one of the most notable events of the year in mining circles of this Territory. The samples brought in for assay at the Arizona School of Mines show free gold and rich silver ore. The combination is very promising, and the samples frequently assay as high as \$1,000 to the ton, but this is upon hand-picked samples. Some of the hand-worked ore, as sacked for shipment, has, however, run as high as \$600 per ton.

The veins were discovered by Henry Wicks and J. D. Burrow, prospectors; associated with the Allison Brothers, of Tucson. The discovery is one of the results of the system of making reliable assays at the Arizona School of Mines for a

nominal sum as established by the legislature. Mr. Allison systematically sent in samples from croppings for assay, often getting nothing to encourage him, until the prospectors came across the croppings of this ledge. Mr. John Brockman, of the Pearce or Commonwealth mine, has purchased Mr. Burrow's interest in this property, and active mining operations will be commenced without delay. Considerable shipments of high-grade ore were made in 1898 and have been continued in 1899. The shaft has been sunk deeper and the lode in the bottom shows free gold and looks promising for the future.

Some of the earlier samples from the newly discovered ledge gave the following encouraging results:

	Silver.	Gold (value).
	<i>Ounces.</i>	
Two sacks.....	51	\$248.04
Eight sacks.....	95	186.03
Average sample.....	36.7	88.88
Large rich piece.....	247.5	1,498.59
Tunnel sample.....	2.5	6.88

This discovery has stimulated the active prospecting of the Baboquivari Mountains, and many other locations have been made and are now being prospected and developed.

MONTEREY MINE.

This property, also known as the Kuhn Kahn, so named from an old Papago chieftain, is situated in the Cababi mining district, about 80 miles west of Tucson and about half a mile west of the Huntington, on Desert Well. A Papago village is near this well and the mine. This location, of the usual length, 1,500 feet, and a width of 600 feet, was made upon a very well defined auriferous lode or vein cutting vertically through a chocolate-colored porphyry. This vein averages from a few inches to 18 and 20 and 36 inches in width. It crops out boldly along the surface for nearly 300 feet and has been prospected for that distance by a series of pits and open cuts and two shafts, from all of which gold-bearing quartz has been taken. The deepest shaft is 90 feet; a second shaft is 45 feet deep. The quartz shows ribbon structure. Selected portions of the ore were carted away and shipped to smelting works; the remainder was left on the dumps. A mill test was made upon about seven tons of this quartz at the Arizona School of Mines' 5-stamp battery mill. Two separate runs averaged \$11.22 in value saved on the plates. The tailings averaged \$8.78 per ton and are found to be adapted to cyaniding. The gold generally in this ore is extremely fine, and probably the whole ore could be cyanided directly with success. There is considerable lead carbonate present, indicative of the presence of galena at a lower level. The ore could be worked at the mine by pumping water to it from the Desert Well or by carting it to the well or to the Quijotoa wells, about 6 miles west of the mine.

ANDERSON GROUP.

At and near Greaterville are several claims in the midst of the placer ground traversed by lodes carrying gold and silver and lead with iron pyrites and sometimes blended in a quartz veinstone having the characteristic structure of true veins. These claims comprise the Treasure, the Beniger, West Point, Granite Mountain, Fulton, Silver Crown, U. B. and A., and the Arastre.

The Treasure has three openings on it, the deepest about 40 feet. The vein follows the contact between limestone, the foot wall and quartzite the hanging wall. Assays of the ore from this claim as selected for shipment gave, silver, 65 ounces; gold, value, \$5; lead, 48 per cent.

The Beniger.—Occurs in limestone. Seventy tons of ore out in the dump will assay, silver, 40 ounces; gold, value, \$3.

The West Point.—In porphyry and granite will yield ore carrying, silver, 113 ounces; gold, \$7 in value.

The Granite Mountain.—In porphyry and granite yields ore assaying, lead, 44 per cent; silver, 90 ounces.

Fulton.—In limestone and slate lead, 40 per cent; silver, 30 ounces; gold, value, \$3.

Silver Crown.—In limestone lead, 35 per cent; silver, 35 ounces; gold, value, \$2.
U. B. and A.—Silver, 300 ounces; gold, value, \$8.
Arastre.—A small vein in crystalline rocks will yield ore assaying \$27 gold.

General run of shipping ores, Anderson group.

Name of claim.	Lead.	Silver.	Gold.
	<i>Per cent.</i>	<i>Ounces.</i>	<i>Value.</i>
Treasure.....	48	65	\$5
Beniger.....	40		3
West Point.....		113	7
Granite Mountain.....	44	90	
Fulton.....	40	30	3
Silver Crown.....	35	35	2
U. B. and A.....		300	8
Arastre.....			27

These figures show approximately the values in the three metals of the ore culled for shipment. The use of proper crushing machinery and concentrators would give a larger product and higher values and at less cost.

WHITEFORD GOLD MANUFACTURING COMPANY.

The property consists of five claims, the Confidence, Last Chance, Gold Rock, Reliance, and Walker. These are located upon gold-bearing quartz lodes in which the gold is partly free and partly in combination with pyrites. The main lode is reported as averaging 3 feet in width. In December, 1898, the company was working two shafts and driving a tunnel upon the lode. Location on Mineral Creek 2 miles north of the Ray Mines. There is an abundant supply of water, but the timber is limited.

GOLD CONTACT LODE.

Under the name of Golden Gate series several claims have been located and worked above the Greaterville gold placers in Pima County, on the east side of the Santa Rita Mountains, about 45 miles from Tucson in a southwesterly direction. It is between Rosemont and Greaterville, a quarter of a mile to the west of the main road between these two places and at an elevation of about 5,000 feet, in the oak-tree region, salubrious and pleasant at all seasons. The lode follows the central plane between the old Silurian, or Devonian, limestone above and the sandstones and quartzites below. These foot-wall rocks, in their turn, rest upon a foundation of granite. The plane of contact occupied by this lode is approximately the same which is marked for miles in distance to the northward by deposits of auriferous and argentiferous copper ore. At the Backbone and the Eclipse, two copper-bearing claims west of the Rosemont, the limestone seems to be much nearer to the basal quartzite than it is farther to the south. The heavy beds of conglomerate and sandstones thin out, while the lower quartzite next to the granite retains its full thickness. It is between these two formations—the quartzite below and the limestone above—we find the beds of copper ore.

This lode has been prospected and worked to a slight extent, and the best ore sacked for shipment to El Paso and other smelters. It is an auriferous lead ore. There is also a notable portion of pyrites mingled with the galenite, and this may be the source of the gold. At and near the surface, and in fact as deep as the workings have been extended (not over 60 feet) the ore is very rusty and ferruginous, indicating a strong mineralization with iron pyrites which will no doubt make its appearance abundantly in depth or below the water level. The gangue or veinstone is quartz. The width of the lode ranges from a foot to 4 and 6 feet or more. The nature of the hanging wall suggests possible cavernous enlargements and large bodies at intervals. It is observed that there are branches or stringers extending upward and outward from the lode into the limestone. It is probable that the contact is also marked by the presence of a porphyritic or plutonic dyke, the foot-wall rock in places appearing like a rusty, decomposed, intrusive rock, rather than a sandstone or mechanically-formed rock.

The general direction or course of the contact is northwesterly and southeasterly, and the dip is to the eastward at an angle of from 45 to 60 degrees. The slope of the mountain at the south end is such as to cut the contact diagonally,

and thus permit the lode to be attacked by mining upon its end. A tunnel can be run in upon the course of the lode so as to obtain "backs" of from 100 to 300 feet in the distance of the length of two claims. The development by working consists of several incline pits of slight depth at intervals along the croppings, as shown in the following tabular exhibit of the assays of samples from the claims and pits named:

Name of claim.	When taken.	Silver.	Gold.	Value.
1. Conglomerate	Pit No. 1	Trace.	0.53	\$10.95
2. Golden Gate	40-foot incline, 6 feet	Trace.	.54	11.26
3. Golden Gate	No. 3 opening, 18 inches	Trace.	.28	5.79
4. Golden Gate No. 2	20-foot pit, 12 inches	8.71	.71	14.67
5. West Side	Top of shaft, 60 feet deep	Trace.	.82	16.95

Sample No. 2 was from the so-called talc, supposed to be of no value. The average in gold value of these assays is \$10 per ton. The ores show free gold in the pan or horn spoon by washing. All the samples contained lead in the form of galenite and the carbonate, some of them of high grade, but the percentage was not determined. The pulps of the above samples, being mixed together and then concentrated by washing out in a pan, gave 15 per cent of concentrates averaging 35½ per cent of lead, 9.14 ounces silver, and 1.89 ounces of gold, valued for gold alone at \$39.06 per ton. The clean tailings, without the slimes, amounted to 48 per cent, and the slimes, lost, by difference, 37 per cent. The tailings carried 1.27 ounces silver, 0.40 ounce of gold, valued at \$8.28 per ton. Another concentration test of lump ore from the 40-foot incline shaft on the Golden Gate gave 20 per cent of high-grade concentrates assaying: Lead, 30 per cent; silver, 4.20 ounces; gold, 2.91 ounces, value, \$60.10. The tailings gave: Lead, not determined; silver, 1.02 ounces; gold, 0.36 ounce, value, \$7.44. The tailings, being washed clean of slimes, are in a good condition to be treated by the cyanide process. The concentrates can be sacked and shipped to a smelter. The hauling to Tucson or Vail's Siding would cost \$3 per ton and the railroad freight about \$2.50. The locations are known as the Conglomerate, Golden Gate, Golden Gate No. 2, Golden Gate No. 3, and the West Side, besides other locations for water and mill sites. There is another group of claims upon veins traversing a massive conglomerate of granitic rock. These veins are small, but rich in free and combined gold, and are known as the Gold Fish group, comprising Gold Fish, Carbonate, Golden Fleece, and Golden Eagle.

THE SULTAN GROUP.

A series of gold-claim locations in the Globe mining district, Gila County, is known under this title. The group consists of the Badger, Cedar Tree, Cedar Hill, Peacock, Keystone, Homespun, Transit, Free Silver, and Little Man. The veins of auriferous quartz traverse granite rocks of similar nature to those in which the Lost Gulch veins occur. Diorite is also reported. The group consists of eleven claims, all contiguous. They are located 8 miles from Globe, in one of the most prolific districts in the Territory. There are no buildings and no machinery upon the claims, and none of the shafts has as yet reached a depth of over 140 feet. Both the hanging and foot walls are of a diorite formation. The veins have a northeast and southwest trend and vary from 2 to 5 feet in width between walks in the various openings. In most of the claims the ore is free milling above the 50-foot level; below that depth it is more or less complex, being a siliceous quartz, carrying iron pyrites and gold, which will concentrate about 10 to 15 tons into 1. There are no silver minerals or copper or lead above the 100-foot levels to interfere by fouling the quicksilver. The gold is finely disseminated through the quartz and is occasionally visible in the richer portions, and pans well at the grass roots.

The principal development is on the Badger claim. An incline shaft is 140 feet deep. The last 20 feet of depth is under water, which prevents examination, but the material taken out and now on the dump shows a value in gold of from \$6 to \$8 per ton. It is a heavy ore and would yield 1 ton of concentrates to 10 tons of ore. From the 120-foot level a drift is run southwest 30 feet, showing an average width of 5 feet of ore; also a drift along the trend northeast 27 feet, that shows about 2 feet of ore. Taking these drifts along the trend of the vein, as well as the ore in the shaft, from the lowest level to surface, including all openings, makes an average of 3 inches. A drift at the 65-foot level southwest 27 feet, also northeast 25 feet, shows a uniform body of ore, all of which is easily mined. The cost

of mining it should not exceed \$1.50 per ton; very little powder is necessary to extract the ore. The average value of the ore of this shaft and drifts by furnace assays and mill run is \$11.50 per ton, but it is more base than free milling. The product above the 120-foot level would concentrate 15 tons into 1, and there is upon the surface dump about 170 tons.

Badger Crosscut No. 2.—This opening is 300 feet southwest of the Badger shaft. It is an open-cut tunnel, showing the vein 115 feet below the croppings. A winze 25 feet deep connects with the workings of an old location shaft 40 feet deep. The workings show an average width of ore of 2½ feet. It is claimed that this ore will yield from \$12 to \$14 on the plate of a stamp mill.

Keystone Claim.—Located on the north side line of the Badger; has a tunnel 70 feet long. A winze sunk 20 feet from the mouth of the tunnel is 40 feet deep. Ore, containing some lead-ore minerals, assays from \$4 to \$5 per ton.

Cedar Tree Lode.—Tunnel, 110 feet; continuous body the whole length, both in roof and floor of ore, averaging 10 inches in its roof and 1 foot along its bed; 40 feet from mouth of tunnel a winze is sunk 40 feet; ore continuous, gradually widening, at lowest point uniform width of 3 feet; assay value \$15, concentrating 15 to 1. Some of the surface ore is very high grade and free milling. This is considered the best mine of the Sultan group.

Cedar Hill No. 1.—Opened by tunnel 180 feet; about 150 feet from tunnel and directly over it a shaft was sunk 40 feet from surface, showing 6 inches of high-grade ore. Water can be easily secured for a mile on this group of mines and without heavy expense, and wood can be had for the cost of cutting, there being an abundance on the locations. The ore bodies in the various openings on the mines of this group show remarkable strength and continuity. With proper facilities they can be easily mined.

KASSER GOLD MINING COMPANY.

Several locations upon Lost Gulch, in the Globe mining district, have been worked under this title, and from one of the veins traversing granite rocks a large amount of high-grade gold quartz has been milled at the company's mill near by. The gold is associated with galenite and iron pyrites, and the decomposition of these ores has produced some fine specimens of wulfenite and of vanadinite. The tailings average about \$3 per ton. The property is near the Black Warrior copper mines and is not far from the Sultan group. There are deposits of placer gold below all these veins in the gulch or arroyo and they have been extensively worked. The rocks of the lower portion of Lost Gulch are finely laminated mica slates or schists.

ORO BLANCO GOLD MINING DISTRICT.

Oro Blanco district receives its name from the fact that most of its placer gold is so largely alloyed with silver that the yellow color of the metal is lost and the gold is nearly white. A large part of the product is not over 0.400 fine. The district is situated in the southwestern portion of Pima County and is bounded southerly by the border line of Sonora, Mexico, into which State the gold-producing formations extend. It is more than 10 miles square, and consequently the district has an area of more than 100 square miles. All of this territory is gold bearing. It has long been known for its white-gold placers and has been considerably prospected, but there has not been any serious or extensive development work. It is said that Mr. W. C. Kempton, mining engineer, who visited the district, remarked that, considering the extent and highly mineralized surface, it has been less developed by workings below the surface than any other mining section in the country. The district is accessible from Tucson by a triweekly stage. The roads are generally good. The rock formations are generally granite and porphyry, with argillaceous slates. These formations seem to be everywhere gold bearing. In almost every ravine or gulch gold can be found by panning, and even on the hillsides and on the surface generally, especially where the soil is reddened by decomposed pyrite, gold can be obtained by dry washing. Most of the placer mining is carried on by Mexicans in a crude and desultory way, often with a small and wholly inadequate water supply, and in certain places by dry-washing machines worked by hand. The returns are small, but the miners manage to get their living, especially when they can get water. Not only gold, but silver, lead, copper, and iron ores are found in different portions. Gold is, however, the most generally diffused metal, but follows chiefly a broad belt or line through the district. The chief gold mines are found along this belt. The chief mines or claims are known as the Oro, Nil Desperandum, Sorrel Top, Tres Amigos, Holden, Gold Bug, McClenahan, Esperanza, Rob Roy, Golden Eagle, with many other locations and prospects, on several of which work is now being prosecuted.

free gold, it is expected, will be readily taken out on plates. One of the walls is a soft porphyry.

Ben Butler.—Opened by a shaft 84 feet deep on a vein averaging $3\frac{1}{2}$ feet. The ore has given a value of \$8.58 per ton by assay.

Midnight.—Opened by a shaft 22 feet deep on a 3-foot ledge, which is in places 12 feet thick and yields by assay from \$8 to \$12 per ton.

Morning Star.—Shaft 36 feet deep. Ledge reaches a width of over 8 feet. Assays have shown \$15 in value per ton.

Little Willie.—Shaft 72 feet deep on a ledge about $3\frac{1}{2}$ feet wide. Average by assay \$10.

Aspen.—Shaft 33 feet deep. Ledge 3 feet wide, averages by assay \$10 value per ton.

Evening Star.—Traversed by a 4-foot ledge, which averages in value from \$9 to \$15 per ton by assay.

Wedge and Triangle.—These two claims are also located to cover good veins.

A large sample made up of samples from all these claims averaged \$6 per ton in value. Water can be obtained from wells $2\frac{1}{2}$ miles distant, and will have to be pumped to a mill. The ore is comparatively free milling.

Gold Rock.—Among the several mining enterprises attracting attention at Yuma in 1898-1899, the Gold Rock merits mention. It was closed down with an indebtedness of upward of \$200,000, but it has been revived and the debt has nearly been paid off. There are three claims, known as the Queen, the Crown, and the Cross, about 30 miles west of Yuma.

Moreno (now Guadaloupe).—After lying idle and neglected for several years, work was resumed upon this property in 1898, and the ore was being worked in the Ingersoll mill at Tysons Well.

FREE GOLD DISTRICT, COLORADO RIVER.

To the gold-bearing region along and near to the Colorado River, in Yuma County, north of Silver District and of the old Clip mine, it is proposed to give the name "Free-Gold District" from the fact that an abundance of free gold is found there on and near the surface. This district is from 2 to 3 miles wide and 5 miles long. One end is about 4 miles from the Colorado River. The old Yuma road passes near it. It is east of the old Celestine arrastres. The rocks, according to Mr. Sparks, are granitic, porphyritic, and volcanic. These rocks are traversed by quartz veins. There is no development yet beyond a depth of 150 feet. One claim, the Golden Chimes, has a vein, according to R. W. Sparks, who has prospected there, from 4 to 8 feet wide, with some 50 tons out on the dump, which is expected to average from \$35 to \$40 per ton.

OTHER MINES AND PROSPECTS NEAR YUMA.

The discovery by Gleason and the important developments following greatly stimulated prospecting in the mountains north and south of Yuma and eastwardly from the Colorado. The field is a rich and promising one. The great drawback is the absence of water, or its extreme scarcity. The existence of very fine gold-bearing rock up and down the Colorado River has long been known, and early excited the attention of prospectors. Much search has been made for the lead supposed to exist called the "Lost Squaw Mine," from which it is said large nuggets of gold were brought in by an Indian squaw, who refused to disclose the locality and who suddenly disappeared without leaving any clew to the place where she obtained the gold.

COMMONWEALTH MINING COMPANY.

Pearce mine.—During the year 1896 this newly developed mine became a large producer. It is another example of the great amount of mineral wealth lying dormant in Arizona, awaiting the prospector and the aid of capital. The croppings have been known for years, but being in one of the "lost mountains" of volcanic rock in the Sulphur Spring Valley, they were despised and neglected, although some hand samples were taken, and without any satisfactory results. This is also an example of the fact that samples may be taken from some parts of even a rich lode and not yield anything by assay. Many assays and tests are required to properly ascertain the nature of a mineral lode. The mine is about 17 miles east of South Cochise Station on the Southern Pacific Railroad. It was bonded in 1895 and was worked until May, 1896, the ore taken out remaining on the dump. It was then purchased by the bondholders at about \$275,000 and shipments of the ore began. The shaft is now about 400 feet deep, and makes a most

satisfactory showing of the vein to that depth. Drifts have been run each way from the shaft, and the ore is raised to the surface by steam hoists.

The ore in 1896 was shipped in bulk from Cochise station to Pueblo at the rate of from 4 to 10 carloads per day. The freight rate to Pueblo is \$11.75 per ton. It is stated that the ore so shipped carries from 1 to 2 ounces in gold and from 50 to 75 ounces in silver. A great part of the ore, however, is of much higher grade, and in the comparatively short time during which the mine has been worked it has yielded large fortunes to its owners. Jenish mills were at first used; subsequently a ten-stamp mill. In June of the current year it was announced that a larger engine and thirty stamps were to be added to the mill and that the working shaft would be enlarged to three compartments.

A large part of the production is now milled upon the ground, and only the higher grades of ore are sent to the smelters.

LYNX CREEK MINES.

There is great activity in gold mining around the head of Lynx Creek, in Yavapai County, and a large tonnage of ore is being treated and shipped daily. No part of Arizona is so strongly mineralized within an equal area as is the neighborhood of upper Lynx Creek. This locality, within a radius of a few miles, has more than twenty rich veins and paying properties, which development is proving to be permanent.

WEAVER DISTRICT.

In the neighborhood of Rich Hill and Stanton, Yavapai County, and between these localities and the Hassayampa River, there are many valuable gold prospects, and a great deal of development work is being carried on. All of the veins run high in gold from the grass roots, and it is confidently expected that a large number of permanently producing gold mines will soon be in operation in this district. The neighborhood has been famous for its rich placer mines for many years.

COPPER.

PRODUCTION OF COPPER IN ARIZONA.

The fame of Arizona as a copper producer extends throughout the world. The ores of this most important metal in their varied forms are extensively distributed throughout the Territory. The chief and best-known centers of production are Bisbee, in the southern portion of Cochise County; Jerome, in Yavapai County; Morenci and Clifton, in Graham; and Globe, in Pinal County. Large quantities have also been produced in Pima County, near Tucson, and in the Santa Ritas, near Rosemont. In the early days of the Territory, even before the construction of the railways, quantities of copper were produced at the Longfellow mines and sent out by ox teams overland. In these early days, also, the mines of the Ajo Mountains produced and shipped large amounts of native copper, and the scarcely less rich and valuable red oxide, to San Francisco by way of Yuma and the Gulf.

It would be a great and almost impossible task to enumerate, and much more difficult to describe, all the localities of copper ores in Arizona. Many of great promise are yet lying idle, waiting for the hand of capital to develop them. Many are yet to be discovered, for the work of the prospector in Arizona is not yet completed.

The year 1898 was a busy and profitable one generally for our chief copper producers. The production was not only well sustained, but it exceeded the records of former years. Great advancements and improvements in the art of reducing the ores were made, by which not only the cost of treatment was reduced, but by which ores of a lower percentage were profitably treated, while at the same time a superior product can be turned out, costing less for transportation. The well-known Williams Brothers, at Bisbee, and the managers at Jerome and at Clifton have, in their respective fields, been in the vanguard of progress, and have not allowed the reputation of Arizona for alert, progressive intelligence to suffer nor to be diminished.

The rapid rise in the price of copper has stimulated the investment of capital in the many neglected copper-mine prospects of the Territory. Many of them which had fallen into neglect have been reopened and developed into producing properties. Prospecting has also been stimulated and new veins and deposits of copper ore have been located and sold under working bonds. The older and largely producing properties have been pressed to greater activity and increased output, so that the copper production of Arizona for the year 1898-99 is the

largest in its history, being 110,823,864 pounds against 81,019,222 pounds for the year 1897 as shown by the annexed table:

Production of copper in Arizona.

Pounds.		Pounds.	
1883	23,874,965	1891	39,873,279
1884	26,734,345	1892	38,436,079
1885	22,706,366	1893	43,902,824
1886	15,657,035	1894	44,531,108
1887	17,720,462	1895	48,329,403
1888	31,797,300	1896	73,745,321
1889	31,586,185	1897	81,019,922
1890	34,796,689	1898	110,823,864

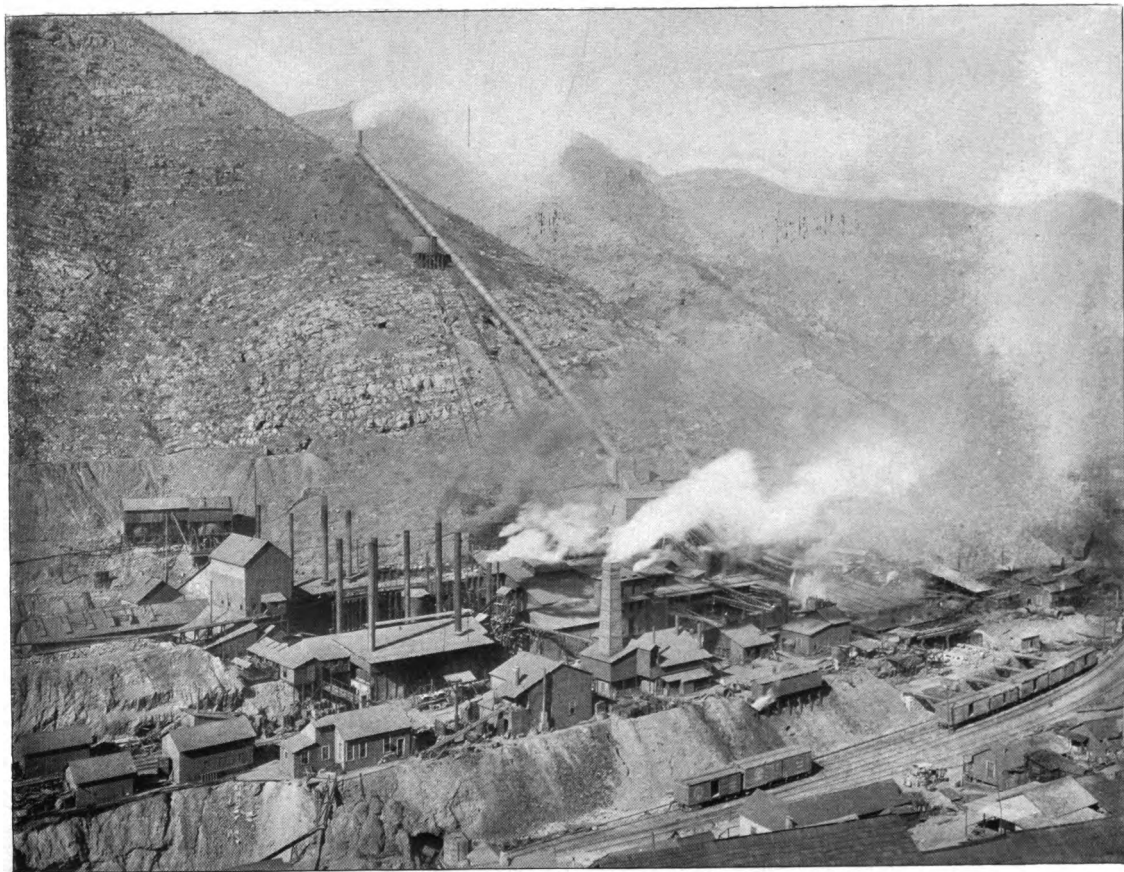
The production for the first six months of 1898, or from January to June, inclusive, was 49,503,294 pounds, and for the first six months of 1899 it amounted to 63,847,198 pounds. The Engineering and Mining Journal says: "Arizona, which was last year the third State in the amount of its production, showed a gain of 19,820,942 pounds, or 24 per cent, the greater part of which came from its two great mines, the United Verde and the Copper Queen, although some of the smaller producers, such as the Arizona Copper Company at Graham, showed large advances."

The total copper production of the United States for the first six months of the year, ending June 30, 1898, amounted to 269,580,880 pounds of fine copper, and for the entire year to 535,900,232 pounds of fine copper, including 7,015,375 pounds in copper sulphates, an increase over the year 1897 of 6.8 per cent.

While there is a considerable export from Bisbee of copper in the form of rich copper matte through Nogales into Sonora, Mexico, there is also a large importation of the metal through the same channel. In the month of March, 1898, the importations at Nogales were the largest in the history of the custom-house, amounting to 7,685,874 pounds, valued at \$551,984. The official figures for the year 1898 are not satisfactory.

THE UNITED VERDE COPPER MINES.

The United Verde copper mines, situated at Jerome, 28 miles from Prescott, in Yavapai County, and owned by Senator W. A. Clark, of Montana, have a world-wide reputation. Their production in both copper and gold has been phenomenal. While it is not the policy of the company to furnish detailed information for publication, enough is known to justify the statement that the yield in copper bullion of these mines per month is approximately 3,000,000 pounds. Some months the yield exceeds this amount. The bullion contains considerable gold and some silver. The ore bodies in the mines are of great extent and value, and can not be exhausted in a lifetime. The mines and reduction works of the United Verde Copper Company are at present employing about 1,000 men. The principal shaft is about 600 feet deep. From different levels tunnels have been driven, and the underground workings are extensive. The engine capacity of the plant amounts to 2,000 horsepower, which is utilized in hoisting ore, operating air drills, copper converters, machine shops, and a 40-ton crane. A vast amount of new ironwork has been put in, consisting of structural works for buildings covering the entire plant, engine and boiler rooms, converters, blast furnaces, machine shops and foundry. The plant in some respects is the most complete in the country, and the converters in use there are said to be the largest in the world. A reverberatory furnace is used in smelting the finer ores, especially those rich in silver. A greater part of the ore when taken from the mines is first roasted in heaps, extending along the slope of the mountain in three long rows, whereby it is desulphurized. It then goes to the blast furnaces and finally to the converters. The copper bullion which is thus produced is about 99 per cent pure copper. The mines, smelting plant, and town of Jerome are situated on the east slope of the Black Hills range, pretty well up toward the crest, at an altitude of about 5,600 feet above the sea level, and at least 1,800 feet above the Rio Verde Valley, which spreads out in grand panorama to the east and south. The town contains about 4,000 people. A considerable amount of prospecting is going on in the adjacent territory, and mining is active in that vicinity. The equipment of these mines is thorough and complete in every way, and the property is conceded to be one of the greatest and most valuable in the known world.



BISBEE—WORKS OF COPPER QUEEN COMPANY.

BISBEE.

The production of high-grade 99 per cent black copper at Bisbee has been during 1898 the largest in its history. It is said to average two carloads a day. Besides shipping ingots of black copper, there is a considerable output of a rich copper matte, which is sent to Mexico to supply another company with a desirable form of flux. It contains about 45 per cent of copper, and is sent at the rate of about a carload a day to Agua Caliente, Sonora, Mexico, by way of Nogales.

In 1896 the company was running four blast furnaces and smelting about 400 tons daily in each twenty-four hours. The product was copper matte, which was bessemerized, or treated by the pneumatic method in three stands of trough converters, giving a product of ingot copper averaging 99.3 per cent of fine copper. The production for the fiscal year ending June 30, 1896, was 10,492,500 tons, or 20,984,510 pounds, of bessemer pig copper, averaging 99.2 per cent fine copper. The introduction of the pneumatic process, with its special American modifications, in Montana and in Arizona, at Bisbee and Jerome, has revolutionized the art of copper smelting, and has made our text-books on the subject chiefly valuable as histories of the metallurgy of copper. The production for 1899 has been maintained at a high figure, and the town of Bisbee has been exceptionally prosperous.

Bisbee is fortunate in more than one respect. It is situated near the head of a canyon, on almost the extreme south edge of Cochise County, about 6 miles from the Mexican line. It is owned by the Copper Queen Company, and is generally understood to be one of the many copper camps controlled by Phelps, Dodge & Co., of New York. It is reached by its own railroad, which connects with the Southern Pacific at Benson, about 35 or 40 miles northwest. It is said that there are 1,000 men on the pay roll of the company. The wages paid are \$3 above and \$3.50 below ground, and fortunate indeed is the man whose name is on the roll of the favored thousand. The output of the camp is said to be three carloads of refined copper per day. The town is scattered up and down the canyon for at least a mile; but the town proper is centered immediately east and south of the big smelting plant. The business of the town is carried on largely in the canyon, where the stores, saloons, restaurants, and lodging houses are principally located. On the steep face of the mountain south of the canyon is to be found the principal residence portion. The main canyon is intersected by another a short distance below and almost immediately opposite the smelters, and is known as Brewery Gulch. As this gulch afforded a limited quantity of building space, it has been made use of, and here the small merchandising of the community is carried on. On the whole it may be summed up that the mines and reduction works of the company occupy the north side of the canyon, the residences the south side, and the business houses the canyon proper.

At the head and front of the Copper Queen Company stand two men whose names are household words in southern Arizona, Messrs. Ben and Lewis Williams. The former is superintendent, and under his direction the Copper Queen Company's plant and mines at Bisbee have passed into history as one of the most successful copper-producing works in the country. Independent of the great value of the mines, there are not less than \$1,000,000 or \$1,500,000 involved in the great plant itself and incident thereto. Mr. Lewis Williams, or as he is better known among the little army of employees, "Don Lewis," is second in command, and in the absence of Mr. Ben Williams is superintendent in charge; but at all times the smelting plant is under his immediate supervision. Than these gentlemen there are not two more popular employers of labor in the whole country. Their fair and courteous treatment of the men and the kindly interest in the welfare of their employees have endeared them to all.

THE CLIFTON COPPER DISTRICT.

The mines of this district have so frequently been referred to that it is unnecessary to repeat much that has already been said about them. Few people, however, are aware of the immense amount of development work done in this field during the last few years. The principal companies engaged in business are the Arizona Copper Company, Limited, of Clifton, and the Detroit Copper Mining Company of Morenci. The former company draws its ore supplies from various groups of mines, situated from 5,000 to 7,000 feet above sea level. The most important of them—the Longfellow group—which is situated in the heart of the Morenci field, side by side with the mines of the Detroit Mining Company, has been a producer since 1872. Up till a few years ago practically all of the ores were taken from the contacts between magnesian limestone and the porphyry. These ores were oxidized

and self-fluxing, and a single smelter was all that was necessary to produce copper bullion 98 per cent fine. The mineralized limestone belt extended fully a mile in length. The ore bodies, however, were largely superficial in their occurrence, and were never found in quantity at a greater depth than 300 feet below the surface, the average depth of pay ore being 150 feet. The ores, in the main, had been formed by the replacement of limestone by solutions of copper. It was not to be expected that this field would last forever. As early as 1891 the mines situated in the limestone field began to give evidence of exhaustion. Extensive exploration by the diamond drill was only successful in exposing and throwing more light on the mineral formation. Exploration for new ore bodies in this direction being unsuccessful, attention was turned to the extensive porphyry belt against which the limestone and lime shales abut.

On the surface of the porphyry belt there were practically no indications of copper. There was, therefore, nothing definite to follow from the surface. Under the circumstances it was deemed advisable to puncture the Humboldt Mountain with a tunnel which would cut under the apex of the mountain at a depth of fully 400 feet. This work, conducted with judgment, was successful in exposing enormous bodies of low-grade sulphide ores, which, however, were so low in grade that for a time it was doubtful if they could be treated with profit. An enormous amount of capital had been sunk in the development of the ore bodies and further large outlays had to be made on concentrating plants and on other plants necessary for the treatment of these ores. The problem was attacked with vigor and skill, complete success attending every effort. These results practically amounted to the transformation of one of the oldest copper companies in the Territory into one of the youngest, for it laid open to it a virgin field which has already proved to be much more extensive and much more enduring in its character than the original limestone belt on which the company formerly depended. In addition to the Longfellow group, the company has also groups of mines known as Queen, Coronado, and Metcalf groups. Of these, the latter, so far, has been the most important. It has produced largely of a low-grade oxidized ore found on the surface of the Metcalf Hill. This ore, while extremely low in grade, occurs in great quantity. For its successful treatment concentration and leaching have both been found necessary.

The Coronado group, on account of its distance from the works at Clifton, and also on account of the difficult and expensive transportation, has heretofore been given but little attention. It is, however, a property of great extent and of great possibilities.

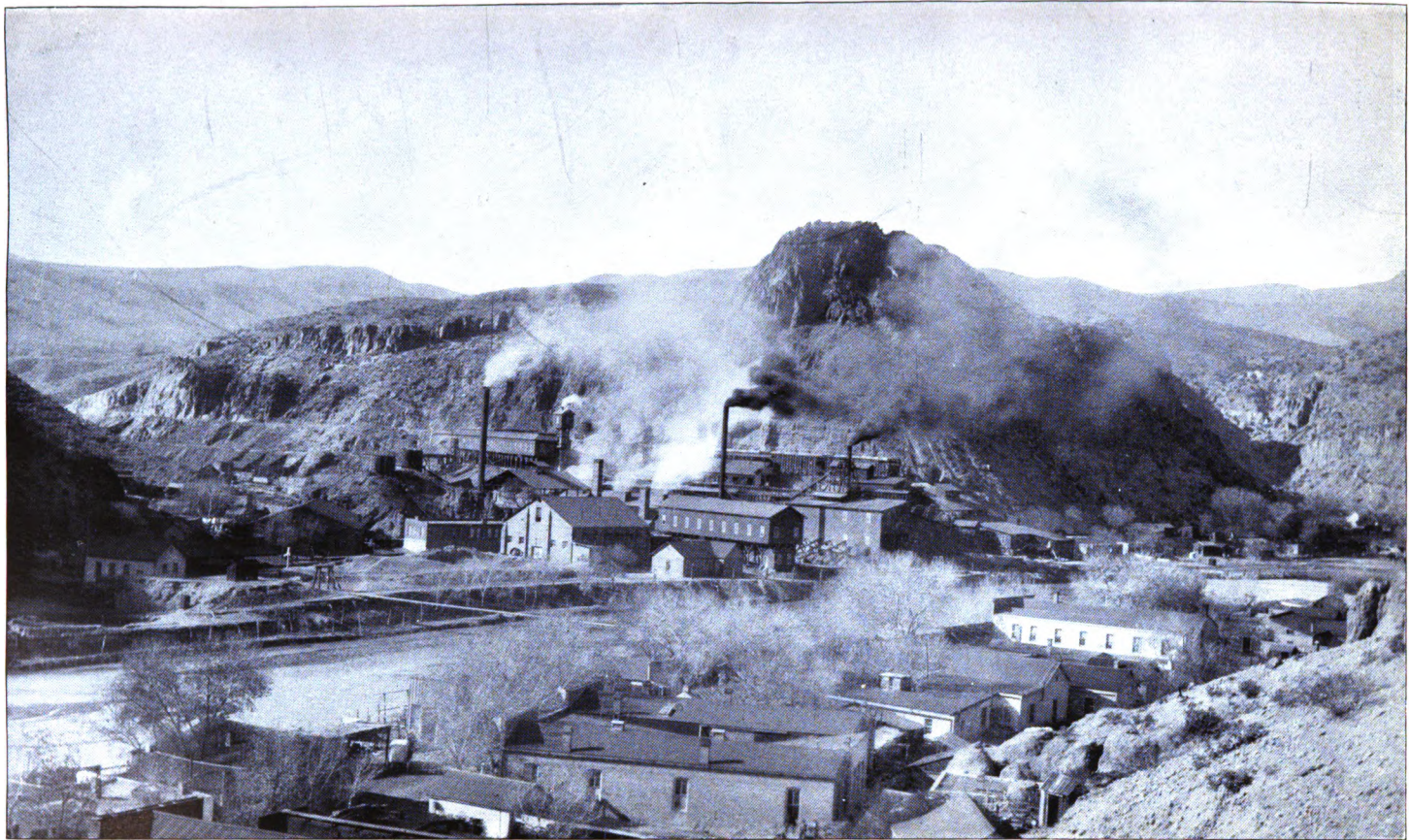
The metallurgical plant is one of the largest in the Territory, and consists of smelting furnaces with a capacity of 500 tons per day, concentrating plants with a capacity of 750 tons per day, a leaching plant with a capacity of 150 tons per day, a two-converter Bessemer plant, operated entirely by gas-engine power; a sulphuric acid plant and a bluestone plant. In addition to the Bessemer plant three of its concentrating plants are operated by gas-engine power. The gas engines employed have a rated capacity of 750 horsepower, and have been found to be extremely economical in fuel. The company is now producing copper at the rate of 10,000 tons per annum. It employs about 1,500 men on its mines, railways, and works.

In connection with the works there is an insurance society in successful operation. This society is officered and managed by the employees of the company, and the monthly charge for this insurance society amounts to only 50 cents, and for every dollar subscribed by the employees the company contributes 25 cents. This extremely low charge has been found to be more than equal to meet all claims made upon the society through accidents, and also through the hospital, which is also maintained by the society. The camp of Clifton is one of the healthiest in the Territory, and a more prosperous or more contented body of workmen can not be found anywhere.

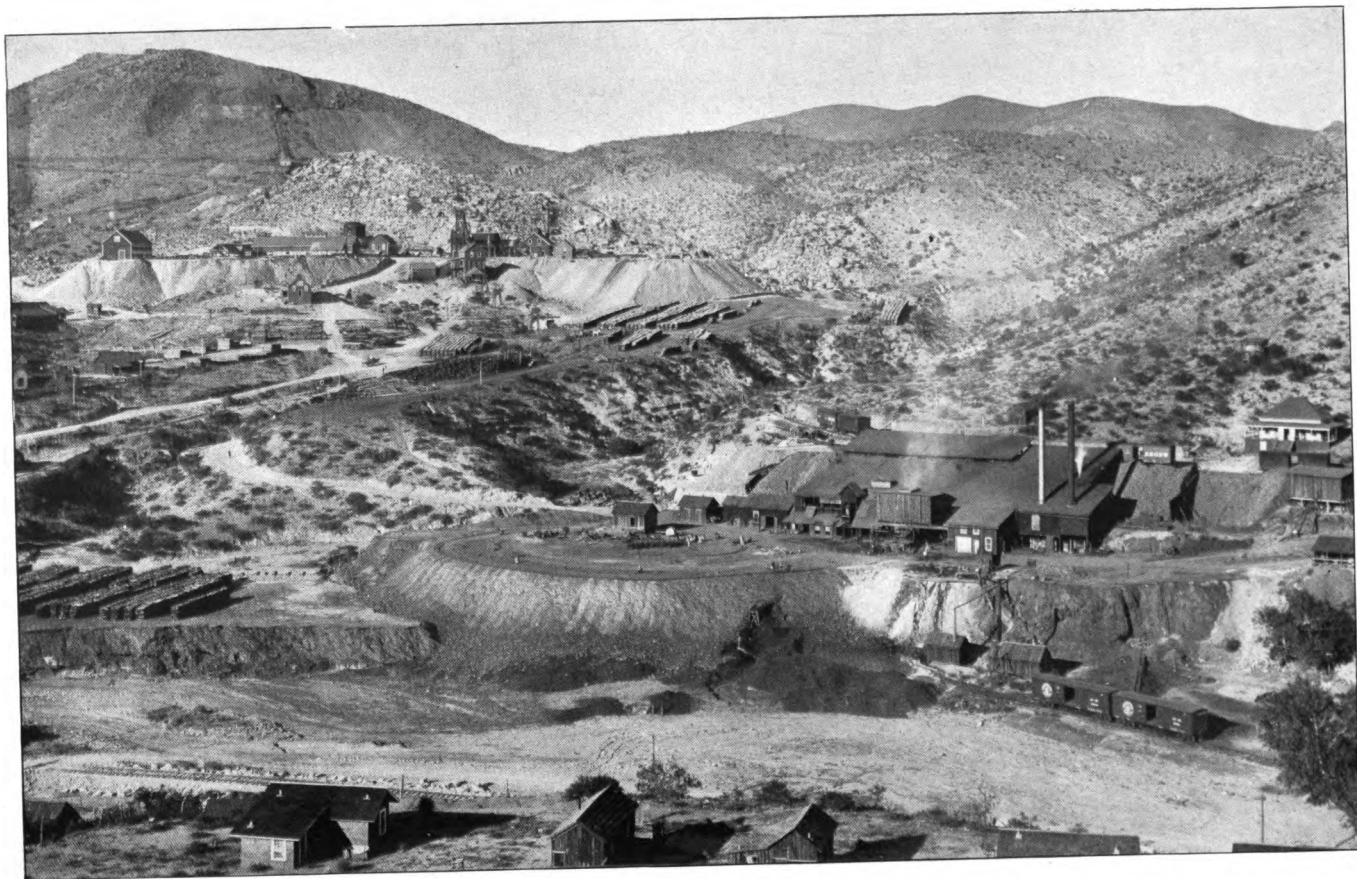
In addition to the society the employees have also a magnificent reading room, equipped with baths and built so as to be suited for meetings, entertainments, and dances.

Situated at an elevation of 3,500 feet above sea level, Clifton enjoys a climate which is a happy medium between the extreme heat of the southern parts of the Territory and the more invigorating climate of the North.

The Detroit Copper Company at Morenci, the property of Phelps, Dodge & Co., produces 7,500 tons of copper per annum and employs 1,000 men. This company is about to build a narrow-gauge (3-foot) railroad from Morenci to Guthrie, a distance of 18 miles. The company is also erecting a 100-ton concentrating plant, and is making many improvements, all of a substantial order.



CLIFTON PLANT OF ARIZONA COPPER COMPANY, LIMITED.



COPPER REDUCTION WORKS, GLOBE.

GLOBE COPPER DISTRICT.

Globe district is situated on the northwestern slope of the Pinal Mountains, about 28 miles from the famous Silver King Mine. In the period from 1876 to 1883 this district attracted much attention by reason of the many discoveries of rich silver veins. At present mining activity is confined chiefly to copper. The completion of the Gila Valley, Globe and Northern Railway, a branch of the Southern Pacific, now gives access to the region and has greatly stimulated its development. The first location on what is now considered the main copper-bearing belt was made in 1875 by the locators of the Silver King Mine, and it was named the "Globe." This location is now held and worked by the Old Dominion Copper Company, which also has two other locations on the same vein—the "Southwest Globe" and the "Globe Ledge." The vein is described as following a contact, having for a foot wall diorite and for the hanging wall limestone containing fossils of the carboniferous period. On the west side of the outcrop there is a capping of a volcanic rock, referred to as trachyte, which conceals outcrops in that direction. That good ore occurs there was shown by Dr. Trippe by a drift west from the shaft, and openings were afterwards made through the bed of trachyte and have been extended downward on ore for over 300 feet. This deposit was regarded by Dr. Wendt as a fissure vein, and he notes that in approaching the ore body through the long adit tunnel running lengthwise of the claims the conditions are similar to those observed in the Longfellow mines at Clifton and the Queen and Prince mines at Bisbee, especially as regards the decomposition and kaolinization of the rock.

The ores are mostly oxidized, but large bodies of sulphides have been found on the second and third levels, with oxidized ores below them. They carry a large amount of silica and frequently require heavy additions of lime and iron to the charges.

The Old Dominion Company put up two 100-ton smelting furnaces. The production of black copper from November 1, 1895, to August 1, 1896, was reported as 6,940,000 pounds.

THE UNITED GLOBE MINES.

The mines have the "Hoosier Ground," consisting of some eighteen locations on the main lode, including the Hoosier, Centralia, Gladiator, Transit, Nevada. The Buffalo group includes the Buffalo, Cleveland, and Mark Twain. In these mines we find practically the same conditions as in those of the Old Dominion claims. The vein, however, changes its trend somewhat, lesser in its angle of dip, and is not so wide. The limestone also becomes more magnesian. Sulphide ore in bodies has not yet been found, and the ore is a little more siliceous than those described. Samples taken from the veins for a week gave the following for the average composition for the principal substances :

	Per cent.
Copper	14.6
Iron	19.3
Silica	29.4
Lime	13.1
Magnesia	4.2

The present output of the group, derived from two water jackets, is on an average 3,000 pounds of black copper daily and of excellent quality, assaying usually as follows :

	Per cent.
Copper	97.60
Silver .....	.52
Gold	Trace.
Iron	1.01
Sulphur	Trace.

Since the report for 1898 there has been a change of ownership and a reorganization of the company, under the same control and largely the same ownership as the mine at Bisbee. According to an extended description of the camp in the "Silver Belt," the United Globe mines were organized as a company for the mining and smelting of copper in 1892.

The property of the company comprises some thirty mining claims on the Globe copper belt, north of the town of Globe; a smelting plant and other surface works, and a sawmill on Pinal Mountain. None of the claims, except the Buffalo and the Hoosier, perhaps, were anything more than favorable prospects when purchased by the company, and the smelter was a crude affair of one small water-jacket furnace.

In August, 1895, the work of remodeling and enlarging the plant began and has progressed steadily since. In this work of improvement the superintendent has had many obstacles to contend against, chief of which was difficulty in getting the necessary lumber and the slow transportation of machinery and other supplies. Happily, these annoyances are now about at an end, and the visitor to the United Globe will see one of the most complete and substantial plants for the handling and smelting of copper ores in Arizona.

The smelter has been practically rebuilt, and the smelter building and tramway terminal cover an area of 189 feet square. The buildings are spacious, thorough in construction and planned for convenience and facility in handling the ores, coke, copper, etc. The principal furnace is a 126 by 38 inch elliptical water jacket of the Douglas patent, built by the Samuel L. Moore & Sons Company, of Elizabeth, N. J. The new feature (the invention of Prof. James Douglas) is the leading of the blast, through the water compartment before entering the furnace, causing the heating of the blast, with a corresponding cooling of the water and a more even temperature around the crucible. The theoretical capacity of the new furnace is 125 tons per day, but the actual capacity, smelting the oxide ores of the district, will likely be from 150 to 175 tons. A 36-inch jacket of the ordinary pattern will also be employed. The most important addition to the plant is the tramway of the improved Bleichert pattern, built by the Trenton Iron Works, New Jersey. The line runs from the Buffalo ore bins to the smelter, a distance of 3,000 feet. Ore from the Hoosier shaft will be hauled 1,500 feet in cars, drawn by mules, to the Buffalo ore bins and there transferred to the cable tramway.

At the mines the principal development work is directed toward the openings of the Hoosier claim and adjacent territory between it and the Dime, in Copper Canyon. For this purpose there has lately been erected a small hoisting plant on the Hoosier shaft, together with the main blacksmith and carpenter shops, a storehouse, and office for the mine foreman. Underground work has just been initiated to crosscut from the main foot wall into the limestone, where it is supposed that the main ore bodies will be encountered.

An important strike of rich ore in a considerable body was reported in this mine in April, 1897. The several mines were then supplying more ore than could be smelted in the 30-inch jacket then in operation.

The work in other portions of the Hoosier territory for several months past has consisted of making thoroughfares and openings for necessary ventilation, and generally to connect the principal claims of the Hoosier group with the main outlet at the Hoosier shaft. Little or no work has been done for several months in the Buffalo mine.

The old road to the big Johnnie claim has been repaired and a new portion constructed leading to the Buffalo ore bins, and over which it is proposed to utilize the traction engine which some years since did duty for the Copper Queen Company in hauling ore from the White Tail Deer mine to Bisbee.

The Big Johnnie, Birdsnest, and Buckeye claims will furnish some ore to the smelting works, and their products will be hauled by this engine.

The outlying claims are connected by telephone with the mine foreman's office and the smelter.

A dynamo will shortly be added to the smelting plant for lighting it and the company's buildings near the works.

In January, 1897, at the United Globe, work on the upper terminal of the cable tramway was completed. At the smelter the ore and rock bins under the crushers are being constructed and many lesser details looked after. The stacks have been erected over the furnace, the floor laid in the engine and blower room, and the smelter practically completed and ready to begin the production of copper, and it is expected that one 36-inch jacket will be blown in about February 1 or soon thereafter. Progress is reported in mine work. The Hoosier shaft is down about 280 feet and sinking proceeds uninterruptedly.

The commissioner of Gila County reported in 1898 that the Globe mines had produced 70,000,000 pounds of ingot copper, and that the owners of the Copper Queen at Bisbee have, in Globe district, about thirty-five contiguous claims.

PINTO CREEK MINES.

He also reports a promising mineral country on Pinto Creek, north of Webster Gulch, which is known to be rich in gold, copper, and lead. It is 16 miles west from Globe. Several companies have been organized to work some of the claims; amongst these are the Pinto Creek Mining and Smelting Company, the Kasser Gold Company, and the Black Warrior, in Webster Gulch. The Continental mines are 14 miles west from Globe.

BLACK WARRIOR COPPER COMPANY.

The company has fourteen full claims situated about $6\frac{1}{2}$ miles westerly from Globe, Ariz., being more particularly described as being on Webster Gulch, 1 mile above the junction of Webster and Lost gulches.

During the summer of 1898 the Black Warrior Copper Company was working, under bond, the Diamond H. group of claims, consisting of twelve, situated at the head of Lost Gulch, one-half mile above the Kasser Gold Mining and Milling Company's stamp mill. Work on the Diamond H. group has developed in the 135-foot shaft a body of sulphide of copper and sulphide of iron ore carrying 20 per cent copper. The district is short on sulphide ores, and the Diamond H. group, under the management of the Black Warrior Company, promises to supply the smelters with sulphide ore. The ore found so far will concentrate about 8 tons into of concentrates, and as the work progresses the sulphides are getting stronger and the mine promises soon to turn out sorting sulphide ore. The vein is a contact, the lime and permanent contact vein, with porphyry as a foot wall and the lime as a hanging wall. This contact runs straight from Lost Gulch on the Diamond H. mines to Pinal Creek.

The Black Warrior Company's copper properties proper have produced from their Webster Gulch claims 2,000 tons of ore, and shipped the same to the United Globe smelter, at a profit of \$10 to \$15 per ton on ores running from 10 to 22 per cent.

Montgomery.—The Montgomery claim, the one on which the most development work has been done, has a 300-foot shaft, 250 feet of which is in 10 per cent copper ore; a 350-foot tunnel, 240 feet in 10 per cent ore, and a body of copper ore has been opened for several hundred feet, running from 10 to 20 per cent, from which shipments of 700 tons have been made.

Dadeville.—The Dadeville claim, abutting on the east end of the Montgomery, has two 100-foot shafts connected by a drift or vein. In the east shaft on Dadeville there is opened up a 6-foot body of ore oxide of copper, running 24 per cent copper. Work is now being done getting ready to block out the ore preparatory to reduction. The ore is taken out for \$1.50 per ton, as the mine is practically a large quarry; one open cut is 20 feet wide and 20 feet high, 150 feet long, all in ore, sides, top, and bottom. To further extract ore, all that is necessary is to go down the hill a few feet and start another bench, quarrying the ore out and, after sorting, dumping into cars and haul it by a horse on a 30-inch track and cars to the ore chute at east end of Dadeville claim.

The company is now working on a 200-foot tunnel, to tap the bottom of the three main shafts, thereby doing away with hoisting of the ores. All ores will be taken out through this tunnel and dumped into ore chutes ready for loading and shipping to Globe. The haul to Globe is an easy grade downhill. One team of four animals can haul easily 4 tons of ore per day.

The Black Warrior Company will make careful study as to what kind of a plant is necessary for the treatment of the ores, and until such time as it sees fit to build a plant will take advantage of the smelting rates at Globe. (From data furnished early in 1899.)

Since the above was reported the company has erected a smelting and leaching plant and all the buildings necessary to a well-equipped mining camp with perfect appointments, and it is expected that the product in copper will be large before the close of the year 1899. The plant includes a tramway 6,000 feet long, which carries the ore to the reduction works. These works include an acid-leaching plant which has a daily capacity of 300 tons.

Continental Copper.—This copper property, situated 11 miles west of Globe and formerly owned and controlled by N. L. Amster, was purchased by the Old Dominion Company in July, 1899.

COST OF COPPER AT GLOBE.

The following figures, obtained from the late Dr. Alexander Trippel, regarding the cost of producing copper at Globe, are interesting. For many years the average of the copper ores of Globe was from 14 to 15 per cent of copper, and at that percentage the metal cost 5 cents a pound to produce. This sum included all the expenses, including the management, administration, etc. For a period of about one year the best ore averaged from 17 to 19 per cent monthly. Coke cost \$52 per ton at the smelter, and the 98½ per cent black copper cost 4.3 cents per pound. It is to be noted that the conditions since that time have essentially changed. It was then not accessible by rail, but now coke can be delivered at Globe for much less than by teams.

TWIN BUTTES, MARTINIQUE.

This group of copper-bearing claims includes: Senator Morgan, Gladstone, Copper Monument, Copper King, Copper Queen, Copper Glance, Copper Bullion, Copper Prince, Senator Tillman, Copper Hill, and James G. Blaine—eleven claims in all and located in three groups. These claims are in the Pima mining district, on the west side of the Santa Cruz Valley, about 25 miles southward from Tucson, and are easily accessible. The development consists of superficial openings and pits, from which a considerable amount of copper ore has been taken and shipped to the smelter, as shown by the subjoined list. These ores occur at and near the contact of plutonic injected rocks or dikes, with limestone beds of the Lower Carboniferous age.

Number of pounds and percentage of ore shipped to smelter from the Twin Buttes mines (Ellis, Wish, and Baxter, owners).

Pounds.	Per cent copper.
28,665.....	21
21,185.....	23.70
21,610.....	16.30
23,450.....	18.70
211,975.....	27.50
50,050.....	20.70
16,170.....	21.70
11,065 ¹	10
48,610.....	19
57,310.....	15.30
41,955.....	14
11,410 ¹	10
81,470.....	18.50
17,735.....	19
642,660.....	-----

¹ Second-class ore.

Averaging over 18 per cent copper.

During the spring of 1899 Mr. H. Ruckman, of Tucson, secured a bond on this property and disposed of it to Col. J. P. Martin, of Xenia, Ohio, who is now developing the mines, and has named the group the Martinique. The property was reported upon by the late Dr. F. M. Endlich some years since, and recently for Colonel Martin.

AZURITE COPPER AND GOLD MINING COMPANY.

The mines of this company are in the Sierritas Mountains, in the foothills 18 miles south of Tucson in Pima County, and are accessible by a fine natural road. A carriage can be driven to the mines. The company has acquired eight claims, known as the Mineral Hill group, also other claims known as the Shedd group, and has been for several months of 1899 engaged in the work of development and smelting the ores extracted from the deposits. These ores consist of the yellow sulphide of copper in depth and of the products of its oxidation at and near to the surface. These secondary ores are in large quantities and consist of green and blue copper carbonates, red oxides of copper, and the variously colored mixtures of these minerals with red oxide of iron. All occur in limestone at and near to the contact of the limestone with granitic and plutonic rock. This limestone is much altered by the contact. It is changed from blue to white. It is probably of the age of the Carboniferous. The ores are much spread through the limestone and the exact thickness and extent of the ore bodies is not yet sufficiently shown by the comparatively superficial working, consisting of many pits and open cuts and quarry-like openings. The aggregate depths of the shafts is stated at about 400 feet; length of drifts on the 100-foot level, 575 feet; on the 200-foot level, 250 feet; crosscuts on the 100-foot level, 200 feet; on the 200-foot level, 250 feet. There are two winzes of about 50 feet each. But these openings are being constantly extended and the figures do not represent the extent of the workings in June, 1899. Water has been found on the 310-foot level.

According to the statement made by the company, the mines had, prior to the purchase, been leased on a royalty on the ore extracted. Since the year 1875 over 4,000 tons of ore have been mined and shipped away to different smelters. The returns, as far as obtainable as to quantity and quality, are as follows, and

are taken from the certificates of the three smelting companies which purchased ore on their own sampling and assaying :

Year.	Quantity.	Shipped to—	Assay.
	<i>Pounds.</i>		<i>Per cent.</i>
1895	1,250,000	El Paso	22
1895	2,000,000	Tucson	12
1896	670,000	do	12.6
1896	761,350	Copper Queen	11.4
1897	52,370	Tucson	19.3
1897	242,767	Copper Queen	10.7
Total	4,976,487		14.6

¹ Average.

To work these mines, to secure United States patents, and smelt the ores a company was organized at Tucson, Ariz., December 18, 1897, under the laws of the Territory, with 2,500,000 shares of a par value of \$1 each. Several shipments of black copper and of high-grade matte have been made. One shipment on the 25th of June, 1899, consisted of 42,900 pounds of copper bullion and matte, completing a record of over 200,000 pounds of copper bullion and matte during the last run of the 30-ton smelter at the mine.

OLIVE CAMP.

For the last ten years the Olive Camp, in the Pima mining district, located southerly 18 miles from Tucson, has been a steady producer in a greater or less degree. When silver was at a fair value many thousands of dollars were taken out in high-grade ores and shipped to the various reduction works of the country, and, as silver depreciated in value, none but the higher grades of ore were shipped, and the output naturally decreased.

More recently attention has been turned to the development and shipment of high-grade copper ores which abound in that district, as well as some lead ores, so that the district continues as a substantial producer. Recently some very promising developments have been made and copper ore shipments continue, but none but high-grade ores are shipped on account of freight rates and high smelter charges. But time will obviate this, as reduction works must soon be established in the district as the large amount of low-grade ore accumulating on the dumps will make an investment most profitable.

SAN XAVIER MINE.

This is one of the oldest and most extensively worked mines in the vicinity of Tucson. It has a history of several years and has yielded large amounts of ore from extensive bodies of a low-grade character, but easily accessible and convenient for working and shipping. It is in the foothills of the Sierritas Mountains about 20 miles south of the city, and is reached by a splendid natural road of even grade, leading to the mine about a thousand feet higher than the San Xavier Mission. It is not far from the Azurite claims, and is in the line of the extensive mineralization of the formations by contact metamorphism.

The group of claims was patented and held by parties in Boston, but after some years of idleness the property was acquired, in 1897, by Gen. L. H. Manning, who has reopened the mines and revived the working and shipping the ores to the smelting works at El Paso.

The ores as developed in depth below the horizon of oxidation are a mixture of zinc blende, galena, and copper sulphide.

The San Xavier mine was worked originally by "chloriders" some twenty years ago as a silver and lead proposition, no attention whatever being paid to the copper contained, either in the ores which they extracted and sorted, nor to other portions of the claims which show quite large percentages in copper. The property was left idle for some ten years, the mine filled up with water, and what is known as the water shaft, which is 300 feet in depth, contains very large bodies of sulphides carrying from 15 to 25 ounces of silver, 3 to 10 per cent copper, and from 15 to 40 per cent lead. All of this body of sulphides in the water shaft will also show from 20 to 25 per cent zinc. After ascertaining the values from actual shipments and finding that the zinc was not desirable by the smelters, about 50 tons of the

ore was concentrated with a view of separating the zinc from the copper, lead, and silver. These experiments were made on a Wilfley table and the result was very satisfactory.

Some of the mixed ore was also worked upon the jigs at the Arizona School of Mines and a very fair separation of the galena was effected, while at the same time there was a concentration of the other minerals by the separation of quartz and earthy matters. In general, however, the ore is concentrated by nature and does not justify effort to effect a separation of its constituents.

The sulphide bodies have been well developed, and these ores can be worked by any ordinary methods of working sulphides or by separating the zinc which is the only objectionable feature of the ore, and then ship to the smelters, or they can be shipped as mined. All of the sulphides appear to be higher in value in copper, lead, and silver than the carbonates. It is difficult to give any reliable estimates upon the number of tons of sulphides which are actually developed. There are such vast quantities, and the openings are so irregular, that any estimate which might be made would not be reliable. Mr. Manning, in 1897, felt perfectly sure that at least 50,000 tons of material could be secured between the water shaft upon which there was one hoist, and the union shaft upon which there was also a hoist, the distance between the two being 275 feet. The minimum value of these sulphides is not less than \$15 per ton. Thus, taking the low estimate on these ore bodies of 50,000 tons, we have a gross value of \$750,000. In October, 1897, Mr. Manning estimated that there were exposed practically from 25,000 to 35,000 tons of the oxidized ores to a depth of 60 feet. In one place the vein or deposit was fully 50 feet in width, and several shafts had been sunk into this body to the depth of 60 feet.

The returns upon shipments of considerable quantities to the smelter show a considerable difference in the composition of the ore at different places. The ore body appears to be made up of lenticular masses lapping one over another as in segregated masses. Considerable masses of nearly clean galena are found, and again the copper sulphides appear in greater volume.

The average of the ores thus far shipped has been from 1½ to 5 per cent copper, from 2 to 15 ounces in silver, and from 10 to 30 per cent lead. The other constituents in the ore are on an average about 35 per cent silica, 12 per cent iron, and 5 per cent lime.

In October, 1897, the smelter paid for all the metallic contents of the ore. For the silver 95 per cent of the New York quotation was allowed, and for the lead 55 cents per unit, and for the dry copper 80 cents per unit. Of course, since the great advance in the value of all the metals these figures would be exceeded. In other words, the ores of the San Xavier are worth much more in 1899 than they were in 1897.

The following figures show the costs and charges upon this ore in October, 1897. It then cost \$1.93 per ton to haul the ore from the mines to the railroad. The railroad rate was \$2.50 per ton, and the smelter charges, based upon the lead and silver percentages, was from \$4.50 to \$6 per ton; the average smelter charge during the month of October was \$5.50 per ton. The fixed charges were as follows:

Smelter charges	\$5.50
Railroad freight	2.50
Hauling	1.93
Total fixed charges	9.93

The following figures show the extent of the extraction and shipment, the expenses and the returns upon the San Xavier in the month of October, 1897:

Thirty-four cars shipped contained 752 tons:

Total gross value of ore	\$10,237.00
Total expense	8,218.00
Net profit	2,019.00
Net profit per ton	2.68

The daily average, therefore, for the month was 25 tons. The shipments for the future, it was claimed, would average in value somewhat better than those given, because some 400 tons were shipped during the month from old dumps which some years ago had been hand sorted for the silver contents, thus running some of the cars down to as low as \$12.50 total valuation.

At the end of the month of June, 1899, Mr. R. W. Forbes, the superintendent, was in Tucson and stated that the mine was yielding satisfactorily and that it was the intention to ship 1,000 tons of ore a month. About 50 men were employed.

TABLE MOUNTAIN COPPER.

It is understood that there was a considerable development of copper ore at Table Mountain, beyond the San Pedro, during the year 1898. No report or description of this property has been received for 1899, but operations appear to have ceased. The coke which was ordered and delivered at Willcox was seized and sold, and it is supposed that the mine did not justify further development or the erection of the proposed smelting plant.

About 6 miles to the eastward of Mammoth, and over the pass at Table Mountain, is the property of the Table Mountain Copper Company. The company now has 50 or 60 tents pitched, and these constitute the present living and business apartments. Lumber and material are being hauled into the camp, and more comfortable and commodious quarters will soon be erected for the accommodation of the company and its employees. About 75 men are now employed in the camp. The company has expended several thousand dollars in making a first-class wagon road from their camp to a main road leading to the Southern Pacific Railroad at Willcox, and over this road all the supplies and machinery will be transported to this camp. This property is being developed by means of an open cut, and resembles a large quarry rather than the usual mine. The face of the cut has a vertical thickness of about 50 feet, and the surrounding croppings extend about 3,000 feet laterally.

SAGINAW.

Extensive developments and improvements were made during the year 1898. The installation of large pumps for raising water were made on the borders of the Santa Cruz, and water was supplied to the camp from this source. A costly mill and a smelter were erected at the mines, but the ores were too lean and base to pay a profit, and the plant was closed down and has been in the hands of the sheriff.

MOHAVE COUNTY COPPER.

Important indications or "prospects" of copper-bearing ledges are reported from Mineral Park, Mohave County. The ores appear to be the yellow sulphide and copper glance in veins traversing crystalline rocks.

COPPER ORES ALONG THE COLORADO.

The rich copper conglomerates of the vicinity of La Paz attracted great attention about the year 1865. Very rich masses of nearly pure citreous copper were taken out, but the quantity does not appear to be sufficiently large to justify working. In the vicinity of Castle Dome there are rich copper ores in small quantity which carry free gold. These appear to be more in the nature of veins than of deposits like those of La Paz and Planet. Of the copper mines of the Harcuvar Mountains no information has been obtained.

COPPER MINES OF THE AJO.

These historic mines in Maricopa County, which, in the early days of the occupation of Arizona by the whites, sent out wagonloads of native copper and red oxide, and which have largely added to the fame of the Territory as a copper producer, have been worked with more vigor in 1899. For an interesting notice of the earliest workings on these mines reference is made to the Sketch of the History of Mining in Arizona. The mines have been worked in a small way for years past, but in 1899 Col C. C. Bean has been actively engaged in reopening and in working one or more of the principal mines, and has made shipments of a high-grade ore to smelters. He finds chalcopyrite and bornite in depth and is sanguine of a successful result. Other parties in the district are mining and concentrating ore and shipping out the product by the Southern Pacific Railroad from Gila Bend station.

COPPER GLANCE.

This noted claim in the Huachuca Mountains is about 15 miles from Fairbanks by wagon to foot of the mountains and thence 11 miles by trail over the summit of the mountains to the mine. It was opened and worked for some time. Shipments of high-grade copper glance ore were made from a chute or chimney about 50 feet in length. There is a continuous vein from the summit of the range to a

depth of about 500 feet. Considerable development work has been done. The lower tunnel, about 500 feet below the summit, is 606 feet long, following the vein, which shows for the entire distance. About 2,000 feet of drifting and tunneling has been done, but does not show any increase in the size of the vein or any important reserves of ore.

HILLSIDE COPPER MINES.

A region south of the Hillside silver and gold mines, upon the Santa Maria, Yavapai County, is remarkable for the abundance of siliceous copper ore in small seams traversing the rocks. Chrysolla and some black oxide abound, to the exclusion of the usual carbonated and ferruginous ores.

AMAZON GROUP, YAVAPAI COUNTY.

The copper claims known as the Amazon Group are upon Castle Creek, in the southern portion of Yavapai County. They are known as the property of Bob Groom. It is reported that portions of the large ferruginous outcrops assay well in gold.

SAN CARLOS COPPER CLAIM.

Claims of this name were located in August, 1870. They are about $7\frac{1}{2}$ miles south of the Cottonwoods, toward the Gila River. Copper ore occurs here in vein-like layers associated with quartz in granite. These layers are irregular in extent and form and are not continuous, but crop at intervals and irregularly. The seams vary from 2 inches to $2\frac{1}{2}$ inches at the broadest places of the undecayed ore. This ore is largely silicate and carbonate derived from the decomposition of vitreous copper sulphide. The incline shaft, in December, 1881, was about 30 feet deep, at an angle of 40 degrees.

RAY COPPER MINES.

These claims are in the eastern end of Pinal County, on Mineral Creek, a tributary of the Gila River, and about 6 miles from Riverside. There are several claims in this group on and about Ray Hill. The Ray claim in 1883 had been opened to a depth of 80 feet vertically, or 130 feet on the incline, below the tunnel level. The tunnel extends in a north and south direction 190 feet. The copper ore is contained in a bed of felsite, which is considerably decomposed and softened. The ore is different from the usual oxidized compounds which enrich rocks of the same class in the Clifton district and elsewhere in central Arizona, but the arrangement of the ore masses in the bedding of the rocks is apparently similar. The richest portions appear to lie in lenticular bunches trending in a northwest and southeast direction and separated by barren ground. Concentration will probably be necessary to secure profitable results. It is claimed that a sample of the copper-bearing stuff averaging only 3.7 per cent can be concentrated so as to give a product of ore averaging 25 per cent. The presence of both gold and silver is claimed for this ore. There has been extensive underground working aggregating over 1,000 feet of levels and tunnels, but as the mine has been shut down for several years it is not probable that many of these openings are accessible. The property has been extensively prospected during the year 1899 by means of the diamond drill to a depth of 800 feet. The results are not publicly reported, but it is believed that they were satisfactory and that they will lead to active development by an English company.

THE KENNEDY-BRYAN GROUP.

This group consists of nine full mining claims and three mill sites so located at Riverside, Pinal County, upon the left or south bank of the Gila River as to cover numerous outcrops and indications of copper-bearing deposits. The property was visited and examined by me in February, 1899. The names of these claims are: Agnes, Hunters No. 1, Hunters No. 2, Bryan No. 1, Bryan No. 2, Bryan No. 3, Bryan No. 4, Bryan No. 5, and St. Karl. These are each 1,200 by 600 feet. The mill sites are known as W. J. Bryan No. 1 mill site, the Hunters mill site, and the Agnes mill site. They are so located as to give good places on the bank of the river for furnace or other work. All these claims have been surveyed by A. J. Colton, United States deputy mineral surveyor, Florence, and their relative positions are shown upon a map made by him. This group is at Riverside, 32 miles east of Florence, and about 41 miles from Picacho, the nearest station on the

Southern Pacific Railroad. It is believed that the parties now reopening the Ray mine, which is near this group, will soon open up a good roadway from Riverside to Picacho.

ROCK FORMATIONS.

The foundation rocks of the group are granite with a few croppings of quartzite and of limestone, the whole being cut or traversed by thick depths of plutonic rock, which may be called greenstone or diorite. There are two chief intrusions of this nature trending in an approximately east and west direction.

Copper ores are developed at and near to the contact of their greenstone dikes with the granite. These ores show as seams and veins from a few inches to a foot or so in thickness. At places there are two or three such seams parallel to each other separated by softened or decayed rock, all highly colored by oxide of iron.

The general mineralization of the region is shown by the prevalence of the red oxide of iron by which the rocks are stained and impregnated on each side of the veins of copper ore; and these are heavy croppings of iron oxide in the form of hematite associated with quartz in crystals indicative of a regularly formed lode or vein of large size.

The outcroppings of copper ore is so frequent and widespread that it is difficult to describe. It shows a general mineralization, but there are two or three main lines of cropping upon which work of a comparatively limited and superficial character has been done.

The outcropping ores as usual are the results of the oxidation and change of the normal sulphide ores in depth. These oxidized ores are the carbonates and oxides of copper with some silicate, all intermingled with oxide of iron and with the siliceous portions of the rock.

As a rule these surface ores are basic rather than acid; that is, the iron oxide prevails as the gangue rather than silica. And where the gangue is siliceous it is much impregnated with iron. As a rule also these surface ores are high grade and give good returns by assay.

The ores in depth (as shown by two shafts) are sulphides of the ordinary yellow copper ore (chalcopyrite), mingled with ordinary iron pyrites, and in a gangue consisting largely of calcite, some iron carbon, and of quartz.

The presence of some high-grade vitreous copper or copper glance has been noted in or near some of the outcrops of the veins in association with the oxidized ore. This, I regard as one of the results of oxidation and concentration; as a secondary product rather than a normal one, such as will be found in depth.

The presence of both gold and silver in notable quantities is claimed for these ores, but the assays so far as made fail to support this claim; gold being present in only very small quantities in the pyritic ore and silver to the extent of from 1 to 3 ounces per ton. (See the tabular statement of assays.) There are, however, portions of the heavy croppings charged with iron which look like gold-bearing rock. These require exhaustive and careful testing to determine whether they are sufficiently charged with the precious metal to pay to work. Chimneys or chutes of pay ore may possibly be found upon these lodes.

The principal development is upon the claims Bryan No. 1, Bryan No. 2, and Bryan No. 3. Special descriptions of each claim follow.

Bryan No. 1.—This is the most northerly of the series of four claims covering the chief outcrop of ore. Upon this claim there is a well-defined outcrop of copper ore following the south side contact of the greenstone with the granite. This outcrop assumes the form of a regular vein, standing in a vertical plane in full view at the top of the deepest shaft on the group at the side of a gulch. The croppings consist of oxide of iron and iron-stained rock. The copper-bearing part at the surface is from 12 inches to 24 inches wide or thick, but it widens below, and is claimed to be 5 feet wide or more. This is an old shaft sunk by the old Ray Company years ago, and was well timbered, but the planking at the sides has decayed and it is not safe to go down into it, hence it could not be examined in depth. It is vertical, 300 feet deep with two drifts, one to the eastward for about 100 feet—some say 140 feet—and one to the west. A specimen hand sample of the average ore at the cropping is ferruginous and siliceous streaked with layers of silicate and carbonate of copper, and yielded 12.6 per cent of copper by assay. (Sample H of table.) The ore below the 60 or 100 foot level is believed to be in the condition of sulphide, the form of ore which could not be easily worked at the time the shaft was sunk. The continuity of this lode for a considerable distance westward across the gulch and up the hill is shown by several outcrops in line on which there are two or more open cuts. One shows a silicate ore over a breadth of about 24 inches including the green staining with red oxide of iron, of which there is a considerable breadth. The best ore measures about 12 inches. A second open

cut shows iron croppings and copper stains pitching southwardly. Most of the copper seams dip to the south.

Bryan No. 2.—This claim parallel to and adjoining No. 1 on the south side is perhaps the most important of the group. It has numerous openings proving the continuity of the veins of copper from nearly one end to the other.

At one of the central openings a crosscut on the surface some 30 feet or more in length shows three distinct seams or layers of good copper ore each from 6 inches to 18 and 24 inches in breadth, including the copper-stained rock, but ferruginous soft rock lies between and on each side of these seams over a breadth of 12 feet or more, leading to the conclusion that the mineralized ground below has at least that breadth and probably a greater breadth. These copper-ore veins or strata are parallel and dip to the north. Samples F, I, K, and L came from these veins, showing, respectively, 21.5 per cent, 16 per cent 20.2 per cent; and 15.9 per cent giving an average of 18.40 per cent. These are the upper, carbonated oxidized ores. The nature of the ores below is shown by a shaft sunk 100 feet deep upon the same line of strata or veins a short distance up the hill. At the bottom of this shaft the ore is mostly in the condition of sulphides. It is a mixture of copper pyrites with iron pyrites, the iron being more abundant than the copper. A general average sample taken across the work of this shaft 4 feet at the bottom (sample A) yielded by assay at the rate of: Copper, 11 per cent; silver 1.23 ounces, and gold 0.04 per ton of ore. The average of other side of the shaft, also about 4 feet wide, showed in the aggregate about 2 feet of sulphide ore, a layer next to the hanging wall being mostly iron pyrites. This yielded by assay (sample B): Copper, 8.1; silver, 2.61 ounces, and gold a trace. These results from the 100 foot shaft are the best index and evidence we have of the nature and average assay value of the normal sulphide ores of these claims. They average for this shaft 9½ per cent.

Bryan, No. 3.—Upon this claim there are open cuts and two shafts, but not now safe to descend. At one of these shafts a pit of sulphide ore, from which the best quality has been shipped to the smelter, shows the mixture of yellow copper ore, iron pyrites, and calcareous spar and quartz. An average sample of this ore, excluding the surfaces, gave the result of 10½ per cent by assay. At the extreme eastern end of No. 3, upon the hillside facing the Gila River, there is a large outcrop of brown siliceous ore filled with streaks and films of copper silicate. There is a large cropping extending some 30 feet, from which 10 to 15 tons have been thrown down from a face of ore 4 feet wide or thick. An average sample taken of this ore (sample D) yielded by assay 6.4 per cent. There is an excess of silica, though considerable oxide of iron is present. This brown ore is somewhat like that called mahogany ore at Clifton, and, like that ore, is accompanied by small, beautifully formed crystals of diopside or "emerald copper."

ROSEMONT DISTRICT, PIMA COUNTY.

Rosemont, a noted copper-mining center, is situated on the eastern side of the Santa Rita range of mountains lying to the southeast of Tucson and about 40 miles distant. It is in the oak tree belt and about 4,000 feet above tide. Some of the numerous claims and locations were formerly worked temporarily by Mr. L. J. Rose, of California, and finally, in June, 1896, passed into the possession of the Lewisohn Brothers, copper brokers, of New York City. Since that time exploratory work has been carried forward on two or three of the chief claims, notably the Chicago and the other claims on the western side of the range and near the Frijole Camp. The sale included all the possessions in the district of the former Rosemont Mining and Smelting Company.

The geology of this region is very interesting, both from the scientific and purely practical point of view. It affords excellent examples of contact deposits and of replacement of limestone by ores of copper. Rocks crop out in great variety, and nearly all have traces of copper showing here and there, besides the main deposits or lodes. A very general metallization by copper is thus shown. The contacts between the chief formations are the main repositories of copper ore. There are several such contacts in the cross section of the Santa Rita Mountains, for in passing from west to east we find limestone and granite with copper deposits, as at and near Frijole Camp, then quartzite with copper impregnations, then limestone with copper at the contact, then a dike of porphyry succeeded by limestone, red quartzite, or sandstone, and finally conglomerates and slates.

The ancient quartzites form the summit of the range and these quartzites rest upon coarse porphyritic granite. The quartzite is believed to be Cambrian in age, the overlying limestone Silurian, and the conglomerates and shales Carboniferous.

A porphyry dike cutting through the limestones is marked on the western con-

tact by strong cupriferous metallization, and the limestone in turn, where it rests against the quartzite, has heavy bodies of soft ferruginous, gossan-like material, giving promise of large bodies of copper ore below. The quartzite croppings in their turn give abundant evidence of impregnation of copper by large superficial coatings of green carbonate of copper. It would appear that the great reef of quartzite extending for miles—and some 200 feet in thickness—had furnished a considerable part of the copper ore deposited in the limestone below and along the planes of contact of the two formations, the insoluble quartzite forming the foot wall and the soluble limestone the hanging wall. Under such conditions we have good reason to expect that the cupriferous solutions have dissolved the limestone, forming branches, and cavern-like deposits of ore replacing the limestone.

There are two known planes of contact where copper cores have been found under such conditions. They are locally known as the first and second contacts or the eastern and western. One is at the junction of the porphyry dike with the limestone, and the other is at the contact between the limestone and the reef of quartzite.

Narragansett claim.—This claim was located in 1879 and has the usual size, 1,500 by 600 feet, and covers the croppings of copper ore and of iron ore marking the eastern contact of the limestone with the porphyry dike. It has been prospected and worked sufficiently to show that there is a continuous body of copper and iron ore. The ledge is generally about 4 feet in thickness, consisting of ferruginous copper ore, from which shipping ore is culled by hand. It is a good smelting ore. There are some portions in which silica occurs in the ledge with the iron, but the copper is usually in the form of the rich sulphide known as copper glance or as the carbonate. The vein is opened by crosscut tunnels and by open cuts. The steep hillside invites this mode of attack. There are four such tunnels leading through the porphyry to the vein, which is then followed down by incline shafts, the deepest of which is only 60 feet below the level of the tunnel. The inclination or dip of the ore of these inclines is about 52 degrees, getting steeper as depth is gained. The dip of the vein in the upper portion is southerly and westerly toward the quartzite, but the normal dip of the formations, including the quartzite, is eastwardly. It appears probable that this dip of the upper portion of the vein and the inclosing rocks is due to the crushing down and bending over of the formations by their weight on the very steep hillside. The sections remind one of the sections of the upper part of the Comstock lode, which were so bent over near the surface as to give a westerly dip to the lode at the Ophir and the Gould and Curry claims, opening out the upper portions like a fan and dipping westwardly, while the true dip of the wall was eastwardly. A crosscut westwardly from the bottom of the deepest shaft has recently cut a considerable body of ore in the limestone under the porphyry dike. A considerable quantity of shipping ore has been taken out of this claim. As the returns from the smelter will give a better idea of the percentage value of the ore in copper than can be had from hand samples, the following have been copied from such returns:

Shipments from the Narragansett, 1896.

Weight.	Copper.	Weight.	Copper.	Weight.	Copper.	Weight.	Copper.
<i>Pounds.</i>	<i>Per cent.</i>	<i>Pounds.</i>	<i>Per cent.</i>	<i>Pounds.</i>	<i>Per cent.</i>	<i>Pounds.</i>	<i>Per cent.</i>
35,990	23.75	10,200	22.10	35,185	21.20	77,840	16.87
35,183	23.70	19,395	25.70	32,803	24.41	37,100	24.50
29,510	20.50	67,100	22.20	47,978	21.79	618	16.11

The sample from lot 77,840 pounds assayed 22.20 per cent by the cyanidic wet assay at the Arizona School of Mines (No. 1274), but was settled for by dry fire assay at 16.87 per cent by the smelter. The same assay (No. 1274) showed the presence of one-fourth of an ounce of gold per ton of ore. This is not sufficient gold per ton to be allowed for by the smelter, but it accumulates in the copper and is saved if the black copper is refined by the electrolytic process, and is therefore an element of profit to the smelter, making the ores more desirable for sale and causing them to command a higher price or preference over ores that are not gold bearing. It is also an important element of profit to parties who own both mines and a smelter, for there are methods of obtaining most of the gold in portions of the black copper, thus increasing the contents of gold up to the quantity essential to the economic separation of it from the black copper.

Backbone and Eclipse claims.—Directly above the Narragansett mine and lying along the summit or backbone of the range and covering the plane of contact

between the limestone and the quartzite, there are two claims, 1,200 by 600 feet, one patented, known as the Backbone and the Eclipse. These claims cover what is known in the camp as the "second contact," or the contact place between the basal quartzite and the beds of limestone. All along this plane of contact there are strong evidences of the extensive mineralization of the strata by copper ore. The outcrops are soft and highly colored with oxide of iron for a width or breadth of from 15 to 20 feet, including a body of yellow-colored, shaly, slate-like material, apparently discolored by the decomposition of the ore. This coloration and softening of the rock is especially noticeable upon the Eclipse claim, which abuts upon and forms the continuation of the northern end of Backbone claim. There are several openings on the Eclipse showing ore of good quality. There are cross cut openings at surface revealing the decomposition of the rocks near the contact, and deeper cuts, pits, and shafts showing that ore occurs of good quality. One of the shafts, about 100 feet deep, has at the bottom a crosscut drift, showing, according to Mr. Thomas Deering, vein matter with ore mixed through it for a distance or breadth across the formation of 37 feet. Of this distance 4 feet next to the foot wall is compact sulphide ore, a good ore for smelting. A sample from this 4 feet of ore sent by Mr. Deering to the Arizona School of Mines, Tucson, yielded 24 per cent copper.

Smelting works.—At Rosemont, about half a mile east of the summit, a first-class copper-smelting plant has been erected with a capacity of 60 tons of ore a day. This furnace has been standing idle for several years, but in June, 1899, it was put into operation upon the sulphide ore—first heap roasted—brought over from the Helvetia district on the western side of the range. When in blast these works give an excellent and convenient market for the ores of the district from outside claims. While the smelter at Tucson was running, some of the ores produced by the Narragansett, the Backbone, and the Eclipse claims were sent there and sold, but since the closing down of this Tucson smelter, ores have been shipped to El Paso for reduction. It is possible that a nearer market might be found at the furnaces of the Copper Queen at Bisbee. Hauling from Rosemont to the railway at Vail's Siding costs about \$3 to \$3.50 per ton for ores. There is an abundance of oak timber on the hills and slopes about the mines; large pine timber can be had in the higher ridges of the range to the southward where there are extensive forests. During the rainy season there is a superabundance of running water, but in the dry part of the year there is a supply from springs only. There is a fine spring and a mill site in connection with the patented Eclipse claim. The chief mine of the Lewisohn Company, from which the large supply of copper sulphide has been drawn, is on the western slope of the mountains and adjoins the Helvetia group.

HELVETIA COPPER CAMP.

The claims known as the Helvetia group, to which my attention was directed, are situated on the west side, and are entirely distinct from the Rosemont property. These claims are located under the general mining law, in the Helvetia mining district, No. 1 being on the western side of the divide of the Santa Rita Mountains, in Pima County, 31 miles southeast of the city of Tucson, Ariz., and at a general elevation of from 4,300 to 5,000 feet above tide.

The rock formations are granite at the base, overlain by limestone and quartzites, with porphyry dikes at intervals. The limestones and quartzites are much uplifted by the granite and by dikes and have been impregnated with ore of copper, especially at and near to the planes of contact. This alteration of the rocks and the impregnation with copper ore, being the result of the intrusion of Plutonic rocks from below, gives good reason to expect the ore bodies to exist in depth.

The ores at the surface and near to it are, as a rule, much rusted, and chemically changed from their original state, as sulphides to oxides and carbonates. They are in the nature and form of "contact deposits" originating at and near the plane of contact of granite or porphyry, with the limestones and quartzites. (Abstract of a report by W. P. Blake, 1898).

Of the exact form of this contact of the granite and limestone there is, at present, but limited knowledge, there not having been extensive underground explorations. The work of sinking at the Mohawk and drifting toward the limestone contact appears from general report to show that the contact plane is more nearly horizontal than vertical. The oxidized ores of the district generally are basic and free smelting, with an abundance of lime and iron for fluxing, and without an excess of silica. The croppings are ferruginous and mixed with green and blue carbonates of copper, and occasionally with high-grade red oxide

of copper. In depth, or at and near the water level, from 100 to 200 feet below the croppings, the ores change to the sulphides; to the yellow copper ore—chalcocopyrite—which when pure carries 34 per cent of copper, a percentage, however, not attainable in practice. Such sulphide ores are now treated at the great copper mines of Arizona with regularity and success. They are the standard ores at the Copper Queen, the United Verde, and other leading properties.

For the most advantageous treatment of the standard sulphide ores it is important to have some of the surface or oxidized and carbonate ores to mix with the charges. The abundance of such surface ores and the large amount of iron croppings become of extreme importance and smelting value to any furnace that may be started in the district. Even iron ore that contains only 2 to 3 per cent of copper then becomes available, and the copper is saved in the operation, as also the small amount of gold generally present in the iron ore.

The district has been shipping copper ore for years, but these ores have been taken from the most superficial openings and pits here and there in a multitude of places, and without the aid of capital. The work has been done by poor prospectors who have been maintained by the proceeds of shipments of ores taken from the croppings. Within a year or so, however, the district has had the advantage of some developments by capital. There has been acquired a number of claims which are now being opened and surveyed for patenting. These claims lie on both the east and west sides of the mountains.

MOHAWK.

The chief exploration by the Rosemont Company on the west side is upon the location known as the Mohawk, where a shaft has been sunk to a depth of 165 feet, from which crosscuts and drifts have been extended, giving access to large bodies of yellow copper ore. At this single claim upward of 2,000 tons of 12-per cent ore are now piled on the surface preparatory to the erection of a smelter at an early date, or transportation over the ridge to the furnace at Rosemont.

This development is very important to the district by giving practical proof of the nature of the ore and ore bodies below the surface, fully sustaining and verifying the theoretical deductions from the surface showing at that claim and at other claims in the district.

This underground development shows also that the main bodies of the sulphide ores extend in the direction of the Old Dick claim. The 80-foot level of the Mohawk extends eastward to within 60 feet of the end line, where, according to information and belief, the sulphide ore body is 11 feet wide. The average thickness of the ore body is stated to be about 4 feet. But the nature of such deposits is to occur in bunches or lenticular beds, and these are often of great magnitude compared with the linear extent or the surface croppings.

The following is a list of the claims, each 1,500 by 600 feet, of which a specific description follows:

HELVETIA COPPER GROUP.

Old Dick, Leader, Copper World, Exchange No. 1, Exchange No. 2, Copper Fuel, Owasco, Brunswick, Heavy Weight, Backbone, American, Flying Dutchman, Heavyweight Mill Site, Elgin, Telephone, Boston, Chance, Black Hawk, West End, Silver Spur, Wedge, Tally Ho, Triangle, Turner, Bean, Water Witch, Water Wish.

Old Dick.—This claim adjoins and abuts upon the end of the Mohawk claim on the west. The Mohawk, now producing large amounts of copper ore, is the extension of the Old Dick, and had far less showing of copper ore at the surface. The Old Dick shows copper ore in a series of pits and cuts from one end to the other, from each of which the prospectors have shipped ore of a high grade. The deepest opening is a shaft 110 feet deep, showing sulphide ore in the bottom of the shaft and oxidized ores above the surface. Beginning at the west end of the claim, where it abuts on the Mohawk, we find one discovery shaft, or pit No. 1, 30 feet deep, with an irregular open cut at the surface, in which, as well as the sides of the pit, copper ore is now standing over a breadth of some 10 to 15 feet. There are two bodies of ore separated by a few feet of copper-stained rock. One mass of ore extends vertically downward to a short drift at the bottom, showing ore. From these slight openings many tons of select ore were shipped away to the old Columbia smelter, and averaged about 14 per cent of copper; some of it ran higher. The walls are limestone. The ore bodies are fine examples of the effect of the decomposition of a body of sulphide ore in the midst of limestone, the soluble limestone being crowded away by the copper solution and replaced by

the copper carbonate and iron oxide, the iron occupying the central portion of the mass and the copper ore inclosing it next to the limestone walls. This oxidized carbonated ore will be replaced below by yellow copper sulphide ore, like that now piled on the surface at the adjoining claim, the Mohawk, averaging 12 per cent of copper.

A considerable number of tons of good ore could be immediately extracted from this opening, certainly not less than 10 tons, from the showing in the sides, and probably much more, without any dead work.

Pit No. 2: Proceeding eastwardly along the claim, similar conditions as respects ore are found in pit No. 2, a short distance from pit No. 1. There is a good showing of copper carbonates and iron over a breadth of 10 feet or more. The limestone is quite white. There are practically some 5 tons of oxidized ore in sight and about 2 tons of second-grade ore on the dump, which would yield 10 per cent, the first quality having been shipped away.

Pit No. 3: In Limestone. Over 3 feet of ore exposed. Oxide of iron in the center. At one place the breadth appears 12 feet. Shallow opening, and the ore is not well exposed. The strike or trend is seemingly east and west, and the dip to the south. The ore at each end of the cut is very promising, and a considerable number of tons could be taken out at once.

The second-grade ore left on the dump is estimated at 15 tons of 10 per cent average.

Pit or cut No. 4: Soft, green carbonate ores crop out here for 4 feet or more in thickness. About half a ton on the bank in a pile, and more on the hill above. Not fully opened up.

Pit or cut No. 5: The sides of this opening are freely stained with copper and iron, and there are from 8 to 10 tons of ore on the dump, estimated to average 5 per cent copper.

Cut and shaft No. 6: This opening is near the center of the claim and is the most extensive on the ground. An open crosscut leads through quartzite and limestone to the top of a shaft 110 feet deep. Ore stains show over a breadth of from 5 to 6 feet at the top, and continue down the shaft, where good sulphide ore comes in. The ground in the open cut shows copper green stains for 15 or 20 feet beyond the top of the shaft. At about 80 feet from the surface a short incline crosscut of 14 feet in ore leads to a crosscut of 41 feet in ledge matter. There is a considerable amount of efflorescence of bluestone (copper sulphate) on the sides of these deep openings.

Cut and pit No. 7: Another pit in ore has been opened some 15 feet east of the cut and shaft No. 6. This pit is about 10 feet deep. From the top of this pit an open cut from 8 to 10 feet wide and 40 feet long extends along the croppings easterly to another opening.

Cut No. 8: This is a large open cut about 25 by 30 feet across and 15 feet deep at the back, from which some 250 tons of ore were taken years ago to the old Columbia smelter.

Cuts 9 and 10: Passing eastwardly some 200 feet from No. 8, there are several small cuts showing ore, of which no special note was made, to open cut No. 9 some 70 feet in length, following ore, and still showing fine croppings of good shipping ore, blue and green carbonates, and some red oxide of copper. At the head of a short incline pit the ore for 11 feet in width averages 14 per cent in copper.

Pit No. 10 is 30 feet deep, and shows sulphide ore in the bottom.

Cut No. 11: This opening is near the eastern end of the claim, and is an incline 32 feet in depth, from which good ore is taken.

Leader claim.—This lies to the eastward of the Old Dick and of the Hughes Cabin, at an elevation of 4,850 feet above tide, or 300 feet higher than the Cabin. It is opened by a tunnel 100 feet long with two short drifts. There is a large body of rusty ore lying nearly flat, covering the roof and sides of the tunnel. It is not fully opened up. There is probably a body of ore underneath. It is cavernous ground, and the mines broke through into a small cave. Hughes shipped 40 tons of selected ore from this claim. The iron ore is excellent for smelting purposes. The deposit is formed near the contact with underlying granite. A large outcrop of carcenous quartz along the lower margin of the ore ground is impregnated with galenite, and is silver bearing. There are several other open cuts and pits on this property along the plane of contact with the granite, showing good ore which carries both copper and silver.

World.—Opened by an irregularly shaped open cut 75 feet long. There is here a large amount of soft ferruginous, earthy ore, good for fluxing, besides a good quality of copper ore, distributed. It has yielded well. There is a large waste dump which contains considerable ore. It averages about 4 per cent copper.

Pit No. 2 (Leader): In quartzite 30 feet. Some cuprite found here. Here is also a large dump, like that at the main opening. If it would not pay to smelt it, it might be concentrated.

Pit No. 3: This follows the contact between the quartzite and the lime, and shows about 5 feet of ore.

Pit No. 4: Considerable iron gossan and green carbonate ore mixed together; a good ore for smelting. The ore shows on all sides of the pit, and its extent is not determined.

Exchange No. 1.—There is an interesting development of beautiful azurite and malachite on this claim, extending for over 100 feet on the surface, and opened below by a tunnel of the same length. The ore body is in limestone, and varies in width from 18 to 24 inches of high grade ore, without the usual accompanying gossan. It is followed by the tunnel, and ore is standing in the bottom and roof; but part of the ore above has been stoped out from the surface downward. I, however, estimated that 100 tons might be easily taken from this part of the claim. The open cut is said to have yielded \$30,000 worth of ore. The residues of heaps of ores on the surface will probably amount in the aggregate to 20 tons as good as sample No. 5 while the tonnage of the waste dump is much greater. Sample No. 6 yields over 12 per cent.

Brunswick.—A small open cut on this claim, about 10 by 15, and 6 feet deep, shows a mass of ore in the bottom about a foot in width. About 500 pounds of ore out on dump. At a second opening the face of cut, about 5 feet wide, is colored by iron and copper ore. An average sample taken across this face (Sample No. 7) yielded—per cent of copper, by assay. There are about 10 tons of ore out on the dump, but the best quality has been taken away. A second cropping or streak of ore is found about 20 feet to eastward of the first.

Heavyweight.—Upon this claim, at an elevation of 2,000 feet above tide, the plane of contact of limestone formation with underlying quartzite is marked by a belt of copper ore opened upon by a succession of cuts and irregular pits, from which good shipping ore has been taken. The ores of this contact are harder and more siliceous than the ores on the other claims, and have more garnet in them. This garnet is a product of the contact with granite, or the dykes of porphyry which also traverse this mountain. Probably 20 to 25 tons of 10 per cent ore can be gathered up at the various dumps and heaps left after sorting out the ore of best quality, a considerable amount of which has been shipped away.

Backbone.—At this claim it is evident that an included mass of low grade porphyritic ore has decomposed, leaving a mass of ferruginous gossan of nearly pure limonite in the midst of the lime rock. By following this gossan, or leached iron ore downwards on a slope for some 30 feet a considerable quantity of blue and green carbonate copper ore has been taken out and shipped away. Some ore yet remains at the bottom and is spread through a thickness of from 18 inches to 2 feet or the iron ore in alternate layers or seams or thin plates, forming an excellent mixture for smelting.

American.—This claim lies parallel with the Old Dick, on the north, and adjoins it. It also is near the hoisting works of the Mohawk. In a 20-foot pit there is a large cropping of soft iron ore from 4 to 6 feet wide, bordered with carbonate copper ore along the contact with the limestone. About 1 ton of ore is piled on the dump.

Elgin.—This claim adjoins the Mohawk mine of the Rosemont Copper Company on the west. It has several exposures of ore. Pit No. 1, in Limestone, near to the discovery and center of the claim, shows green carbonate ore. About 1 ton out on the dump. Pit 10 feet deep. A second opening in the side of arroya, at the bank, about 10 feet deep, reaches sulphide ore in fine grains, disseminated a low grade ore, but not necessarily as good as may be found at a lower level. Sample taken here yielded only 1.2 per cent. Another sample, a part of the hand specimen, gave 25.2 per cent. Assay No. 10, Pit No. 3 above, on the hill, is 12 to 14 feet deep and has good ore exposed. Pit No. 4 beyond, on the north slope of the hill, also shows good ore. Sample No. 11 from this place yielded 24.2 per cent. This was a hand sample of sulphide ore. All of these pits or openings are in a nearly north and south line. No. 4 shows an outcrop of quartz in an irregular vein. Copper stains and ore are here distributed over a broad surface, and much work is required to show the exact form and extent of the deposit.

Telephone.—This claim adjoins the Elgin, and is only slightly opened by several 10-foot pits. At No. 1, in the side of the hill, there is a much copper-stained rock, with iron gossan, and kidneys of yellow copper ore. At No. 2 Pit, about 15 feet wide and 20 feet long, the croppings show good ore, consisting chiefly of copper carbonates and iron oxide. About 1 ton of ore is on the bank. A hand sample, No. 12, yielded 22.1 per cent.

Wood and water claims.—The four claims named the Turner, Bean, Triangle, and Water Witch are for timber (cord wood) chiefly, although on the Bean there is a spring of water. There is a considerable amount of oak timber growing on these claims which cover the best portion of the northern face of the higher ridge of the Santa Ritas. Cord wood can be had at \$2.50 to \$3 delivered. Mining timber, from the main ridges, about 10 miles south, can be delivered at the mines for 10 cents a running foot, with the bark off, and measuring 8 to 10 inches in diameter.

Labor.—Underground miners receive \$3 per day of ten hours. Surface men from \$1.25 to \$1.50. Chiefly Mexicans.

Distance from railroad.—The nearest railway station is 14 miles distant, at Vails Siding. The camp is 31 miles from Tucson. At present the trading being with Tucson, the ores shipped are taken to Tucson, at a cost of \$3.50 per ton for hauling. The freight from Tucson to the Silver City smelter (where some of the ores are now sent) is \$3.25 and to El Paso about the same cost. Reports from the property under date of July, 1899, state that development is proceeding rapidly, and that a smelting furnace will soon be in operation producing copper, also that a railroad will be built from the Helvetia mines to Tucson.

COPPER SMELTING AT TUCSON.

The copper furnaces of the Tucson Mining and Smelting Company renewed operations in 1896, and were supplied for the most of the time from the mines of the region about Tucson, chiefly from the Helvetia district, from Olive Camp, and the Sierritas. The copper ores received from July 1, 1895, to June 30, 1896, amounted to 2,200,000 pounds. The copper bullion shipped during the same period weighed 265,751 pounds, and the copper matte, 228,548 pounds. In April, 1897, a successful run was made upon 180 tons of ore, containing gold and silver as well as copper. This lot of ore consisted of the output of many different prospects or claims. One consignment of about 25 tons of high grade ore came from Sonoro, Mexico.

During the winter of 1897 and 1898 the smelter closed down and has not since been in operation.

COPPER IN THE DRAGOONS.

There are many copper-mine locations in Dragoon Mountains, east of Tombstone. Some of these deposits, formed apparently as the result of metamorphism of limestone strata by intrusive dikes of plutonic rock, contain quantities of a green garnet, which, being heavy and mingled with ore, is apt to deceive many regarding the richness of the ore. The garnet also is objectionable in the furnaces of the smelters, as it makes a thick, pasty slag and impedes the smelting.

A furnace has recently been erected by the Golden State Company, and was blown in the summer of 1898. This furnace is reported as having a capacity of 30 tons of ore a day. Coke is hauled from Cochise Station, on the Southern Pacific Railway. Some difficulty was experienced with the garnetiferous ore, but no further report has been received.

Another property farther south in the same district is the Black Diamond, which gets its name from an immense outcrop of lustrous black iron ore. It crops out along the contact of a dike of porphyry with beds of limestone, and is composed of specular iron, magnetic iron, and quartz intimately mingled, so as to form a very hard mass. Through this mass there are strings or patches of fine copper ore, irregularly distributed and not as much segregated and separated from the mass as is desirable. The ore, when pure, consists of bornite, the variegated copper sulphide known also as erubescite. It is a beautiful ore and a desirable one, as it also carries silver. By the decomposition of the stringers and bunches of this copper ore a considerable amount of copper green staining results.

The development of this deposit consists of open cuts, tunnels, and a shaft about 60 feet deep, with a drift and crosscut at the bottom, most of which is in iron ore too lean in copper to pay for extractions; some good ore has been selected from the various openings and has been shipped to smelters and gave good returns.

The Black Diamond is near to the summit of the Dragoons, nearly west of the Commonwealth mine, at Pearce, about 6 miles distant. The altitude is about 6,000 feet. There is a large development of stratified limestones, sandstones, and quartzite, forming the crust of the range at that point, and extending northward to and beyond the "South Pass."

Later reports from the Black Diamond show that development has progressed actively during the spring and summer of 1899, and that large bodies of ore have been encountered.

Middlemarch.—This claim in the Dragoon Mountains, Cochise County, produced about 20 tons of black copper in 1898 and a very little matte. The ore is highly siliceous, with much of the mineral garnet in it, and closely associated with the ore, making it difficult to smelt. The average content of copper is about 5 per cent. The furnace, a round one, of 50 tons capacity, was made at the Denver Iron Works. It was run irregularly. There was considerable difficulty at first in getting the proper smelting mixtures. The black copper produced ran about 98½ per cent copper, and the small amount of matte assayed about 75 per cent. As the more highly pyritic ore was reached below the surface, the quantity of matte was increased.

Golden Gate claim.—Messrs. Fitz and Barrett erected a small smelting plant upon this claim in the Dragoon Mountains, making use of the old furnace from the Donnelly claim in the Chiricahuas. A small amount of copper was produced, but in September, 1898, the work was closed down.

COPPEROPOLIS GROUP.

Dr. A. H. Noon, of Nogales, described a group of three claims known as the Right Bower, Copperopolis, and Left Bower, near the Jalisco Mountains, in the Oro Blanco district, Santa Cruz County. They are 60 miles from Tucson. They are in the condition of prospects, but have been superficially developed by open cuts and pits, and some ore has been shipped and high-grade ores can be selected. Assays show the general presence of silver and a trace of gold and copper from 9 to 48 per cent. The property invites development.

SILVER BELL DISTRICT.

The old Silver Bell district mines, which for a decade or more have been neglected, have again been brought into prominence by the erection of a smelter and the active production of copper. It is also reported that most of the properties have been purchased and will be worked under one management, but no particulars have been received. The district lies in Pima County, in the Silver Bell Mountains, about 40 miles west of Tucson, and 20 from Red Rock Station, on the Southern Pacific Railroad, from which supplies and coke are hauled and the black copper is shipped. The rocks are porphyry and limestone. Many of the deposits of copper ore are found along the planes of contact of these formations. There are several groups of claims; one of the oldest locations of the camp is the Old Boot mine, from which a considerable amount of ore was taken in former years. It is now known as the

Mammoth.—The smelter now running (1899) is in connection with this claim, and is 1½ miles distant, in the foothills of the Santa Rosa Valley. It is a 30-ton water-jacket plant.

The mine is opened by a shaft and tunnel. The shaft, in May, 1899, was 150 feet in depth, and a crosscut of 50 feet exposed a body of copper sulphides, with some galena and blende.

SILVER BELL GROUP.

This consists of 14 claims. The chief work of development has been upon the Imperial, Southern Beauty, Page, and the Prospector. According to Mr. Judson, of the Denver Mining Reporter, who visited the district in May, 1899,

“A 200-foot tunnel has been driven in on the Imperial, opening up several pockets of lead carbonates. The Southern Beauty is opened by a shaft 160 feet in depth. The vein is on the contact between lime and porphyry, but the shaft did not open up the main bodies of ore unquestionably existing on this contact. The Page has a long tunnel, which opened up some small ore deposits. The Prospector has been opened by a shaft 50 feet in depth and a crosscut tunnel 220 feet through the porphyry. There has been about 4,000 tons of lead carbonates shipped from these properties several years since and some copper. Very little work has been done for several years, but we understand that active development will soon be commenced on this group.”

RED ROCK.

This group comprises several claims, which have been opened by shafts, open cuts, and tunnels. The deposits are near an outcrop of the granite.

CREPNA GROUP.

There are two claims—the Young America and the Young America Extension. They are in the foothills, in the valley southeast of the Silver Hill mine. The Young America is opened by a shaft 60 feet deep with a drift west 40 feet and south 20 feet and east 100 feet, with a winze of 75 feet.

SIXTY PER CENT GROUP.

About 1,500 feet northeast of the Young America. Two shafts 70 feet deep.

COPPER PRINCE GROUP.

There are ten claims in this group: The Stone Cabin, Equity, Danube, Copper Prince, Princess, Azurite, Copper Carbonate, Lead Carbonate, El Plomo, Nightingale, Georgia, Mountain Dew, and Iron mine. The chief work has been upon the Copper Prince, where there are several open cuts, tunnels, and shafts.

DOXOLOGY AND TRUE BLUE.

These two claims lie north of and parallel to the Copper Prince. The ores on these properties appear to be galenite and lead carbonate and not copper ores.

ABBEY WATERMAN.

There are five claims in this group—the Paddy Woods, Homestake, Carbonate, and two others. The ores are chiefly of lead, claimed to average for the selected ore 40 per cent lead, 40 ounces silver, and gold to value of \$5 per ton. May turn into copper in depth.

MARS GROUP.

Consists of five claims about $2\frac{1}{2}$ miles northeast of the Young American and of comparatively recent location. Some 40 tons of rich copper ore have been shipped.

OLD BOOT MINE.

This property, in the Silver Bell district, Pima County, near Red Rock, about 50 miles west of Tucson, has produced considerable copper. The ore has been smelted at the Nielson smelter. They are mixtures of the oxidized and carbonated ores, with some sulphides. They carry from 42 to 47 per cent of silica and from 16 to 20 per cent of iron. The ores of the large dumps carry smelting over 9 per cent of copper. There is not an appreciable amount of gold, but there are about two ounces of silver, giving about 20 ounces in the copper bullion. The smelter has a capacity of 30 tons. The copper bullion assayed about 98.8 and the matter 78.90 per cent. This mine is now being worked profitably and bids fair to become one of the large copper producers of the Territory. A smelter is in operation on the mine.

RED ROCK COPPER COMPANY.

The Red Rock Copper Company property consists of several mining claims in the Silver Bell mining district, in the county of Pima, Territory of Arizona, called the Uphill mine, the Burtis mine, the Peacock mine, the Daisy mine, the Wilson mine, the Bay State mine, the Mount Hope mine, the Western Slope mine, and the Wellington mine.

ATLAS MINING COMPANY.

Ores presented to the mineral collection of the Arizona School of Mines by Col. J. W. Locke, from the Metropolitan mine of the Atlas Mining Company, are fine masses of high-grade yellow sulphuret of copper. This copper is in the Silver Bell mining district, and is supposed to be near the claims of the Red Rock Company.

REMARKABLE COPPER CONGLOMERATE.

A few miles north of the Lost Gulch Gold mines, across the hills, there is a very remarkable superficial deposit of copper penetrating a rough conglomerate

breccia, apparently a tufaceous deposit capping the older rocks in horizontal layers. The fragments, cemented together by carbonate and silicate of copper, are of various sizes and colors—brown, green, yellow, red, and black predominating. The more sandy portions filling the spaces between the larger pebbles seem nearly saturated with copper carbonate, and many of the softer pebbles are unveiled with a coating of copper ore. In other portions pebbles seem to have been dissolved out, leaving a hollow mass of high-grade copper ore. The deposit is apparently the result of the overflow of cuprious solutions from some neighboring decomposing bunches of sulphide ore.

GOLDEN RULE.

This property, now worked under the name of the Golden Queen, Consolidated, was known in the year 1884-85 as the Golden Rule. It is situated in Cochise County, at the northern end of the portion of the Dragoon Mountains, south of the Southern Pacific Railroad, from which the camp is not more than half a mile distant. It is about 6 miles east of Dragoon station, and the nearest point or stopping place on the railroad is Manizoro siding. The elevation is about 4,700 feet. The vein is well and strongly defined, consisting of white quartz well mineralized with iron and lead sulphurets. It traverses the limestone parallel with the bedding and is near the basal contact with a strong dike of quartz porphyry, which appears to have disrupted and uplifted the sedimentary formations, and to have produced considerable alteration or metamorphism. The strata immediately underlying the vein are more siliceous and sandy than those above. In fact the footwall country may be said to be sandstone and shale and the hanging-wall blue limestone. The thickness of the vein ranges from a few inches to 24 and 36. The trend is nearly east and west, and the dip is northward at an angle of 35°. It can be followed for the length of the claim and is opened at many places, from which paying ore has been stoped out down to the first level about 250 feet.

Free gold can be found in the quartz on the dump. The best ores have been shipped away. The want of water for milling purposes has prevented milling the ore at the mine. Efforts to obtain water by drilling down into the lower slopes of the Sulphur Spring Valley about half a mile east of the mine have not been successful. A 5-inch bore hole has failed to reach water at a depth of 224 feet. It seems probable that water can be had at a greater depth in the mine by keeping near to the contact with the dike of porphyry.

COPPER AT DRIPPING SPRINGS.

Copper mines at this locality, near Skinnerville, 25 miles south of Globe, have attracted considerable attention, especially the Copper King and Rattler claims.

COPPER CLAIMS NEAR FLORENCE.

According to the Tribune there are promising copper-bearing claims about 10 miles east of Florence and 3 miles south from the Gila River, near the Florence and Globe road. About twenty years ago John D. Walker located and worked a mine in this district, sinking a shaft to the depth of 30 feet, from which he shipped 5 tons of ore that realized, it is said, the sum of \$2,000 in silver and copper. With depth the silver became less and the copper more, and as he was looking for a silver mine, which he found in the Vekol about that time, this mine was abandoned and remained so until a short time ago, when W. R. Stone and A. T. Colton, not being afraid to do some work on an abandoned claim, located and worked the same, finding the ore extensive and continuous, and have opened up by shafts and crosscuts large bodies of high-grade ore on the mines known as the Georgian and Marian, from which they have shipped a large amount of ore. William M. Griffith and others have done more than 100 feet of work in shafts and drifts on the Half Moon mine, from which has been taken a large lump of ore that will assay without assorting at least 20 per cent in copper. One sample across the width of the shaft gave an assay of \$9.35 in gold. The Accumulation mine, on which has only been done the location work in a shaft 10 feet deep, shows copper glance assaying 70 per cent copper. This mine is owned by Dr. J. M. Hurley and W. R. Stone. The Madam Denny mine shows a ledge at least 10 feet wide of copper ore, and that taken from the shaft on development work will average 15 per cent in copper. This mine is owned by Mrs. Kate M. Stone.

COPPER ORE NEAR CASA GRANDE.

Some very interesting samples of siliceous copper ore and carbonate of copper have been sent in from time to time from the districts about Casa Grande, but there is little or no reliable information regarding the nature or extent of the deposits.

BLUE EAGLE.

Located in Harshaw district, Santa Cruz County, by James Hale, Harshaw. The vein, according to Mr. Hale, is from 2½ to 5 feet wide, and carries ores of copper and silver averaging from 20 to 31 per cent of copper and 12 ounces of silver. This vein is opened by a tunnel 180 feet long, a shaft 30 feet deep, and a winze 33 feet. It is situated about 2½ miles north of the World's Fair mine and 3 miles from the Sonora Railway.

There are no reduction works. The ore is hand sorted and is shipped to the smelter at El Paso.

FARRELL GROUP.

This group of mines consists of the Morning Glory, Red Top, and Sunset mines. These are located in the Harshaw mining district, in the new county of Santa Cruz. The ores consist chiefly of the yellow copper pyrites—chalcopyrites—and yield 17 per cent of copper by dry assay and 15.4 ounces of silver. The openings are one shaft 82 feet deep, and one of 50 feet and 150 feet of drifts. The vein is reported as 5 feet wide between walls; to have the characteristics of a fissure vein, and to have yielded free milling silver ore to a depth of 50 feet.

WISCONSIN AND ARIZONA MINING COMPANY.

According to official documents this company is a Wisconsin incorporation holding mining ground in the Tyndall mining district, in Pima County, as follows: The Helvetia mine, begins at the initial monument in the center of mine, from which United States mineral monument on Helvetia Hill in said Tyndall mining district bears south 68° 51' east 1,991 feet distant, extending thence in length 750 feet easterly and 750 feet westerly along the course of the Helvetia lode, and 300 feet in width on each side of the center of said lode; the corners and centers of end lines marked with posts in mounds of stones, being the mine conveyed to the company by United States patent recorded in the office of the recorder of said Pima County, in book 18, Deed of Mines, at page 611.

COBREZA.

Located in the Cabafi mining district, Pima County, 6 miles from the Fresno Well and about 60 miles from Tucson. The ores consist of gray copper, ranging from 15 per cent upward, and they carry about 25 ounces of silver. In the early sixties ores were shipped from this claim to Swansea, England. Shipments are now made to Silver City by way of Tucson. There is not any mill for reducing the ore on the property. It is hand-sorted for shipment. The development consists of open cuts and pits not to exceed a depth of 45 feet. The vein in places is 8 feet wide between walls, and the ore-bearing part is said to average 3 feet. The claims are patented.

QUIJOTOA COPPER.

In addition to silver and gold bearing lodes, for which the Quijotoas are chiefly noted, copper deposits have been opened recently by Alex. McKay and his associates. This district is in Pima County and about 85 miles west of Tucson. There is a group of six or seven claims located for copper and the Bill Nye and Wadsworth for gold. The copper-bearing claims are known as the Waldon, Iron Cap, Brittle Silver, Magnet, Copper Cliff, Glasgow, and Triangle. A considerable quantity of ore was extracted and carted over to the Saginaw smelter, but had to be hand-sorted after delivery, so as to get ore of a grade suitable for smelting. It was designed, however, chiefly as a flux for other ores. It contained a large percentage of iron ore, and is supposed to cover a deposit of higher grade copper in the lode at a greater depth.

THE BRADFORD MINE.

In Tyndall district. A patented claim opened by a shaft 200 feet deep with short drifts and crosscuts. Operations have been resumed and the shaft on the

Bradford has been cleaned out and retimbered, and preparations are making for the extraction of copper ore. Assays at the Arizona School of Mines show that the ores will average 14 to 15 per cent copper and over 3 ounces of silver to the ton. This property is near the railroad, and about 10 miles below Crittendon, the nearest post-office and supply point.

COPPER DISTRICT AND CLAIMS ALONG THE COLORADO RIVER.

In the decade from 1860 to 1870 the copper mine prospects along the east bank of the Great Colorado excited much attention. There indications of valuable copper deposits may be said to occur at intervals from Castle Dome to Bill Williams Fork and beyond into Mohave County northwards. The following memoranda are condensed from notes relative to the principal claims of Williams Fork district and the La Paz district.

Planet claim.—Located on Williams Fork about 12 miles from the Colorado River. The ore occurs in limestone and is associated with specular iron ore. A shaft 40 feet deep and an incline 50 feet with two tunnels of 50 feet each constituted the development. The shipments of ore amounted to some 400 tons of high grade claimed to have contained from 40 to 45 per cent of copper. Large quantities of second-class and low-grade ores were left upon the dumps.

Eliza lode.—Great Central Company. This claim is also upon Bill Williams Fork and about the same distance from the Colorado River as the Planet Claim. The development consisted of a shaft 50 feet deep and a tunnel 80 feet deep. Shipments had amounted to about 50 tons of 15½ to 25 per cent ore. One hundred tons or more had been raised to the bank but had not been sorted. The first-class ore carried from 30 to 40 ounces of silver to the ton and some gold. A furnace for making copper regular or matte was in course of erection and had an expected capacity of 10 tons a day.

Mineral Hill.—One and a half miles from Bill Williams Fork and 10 miles from the Colorado.

Apache Chief.—This claim in the La Paz district south of Bill Williams Fork had shipped about 100 tons of ore to San Francisco from a shaft about 20 feet deep. The ore contains considerable oxide of iron.

Blue ledge.—Seven miles from the Colorado River. Incline shaft 80 feet deep. About 20 tons of 15 per cent ore out. Ledge about 2 feet wide.

Weaver mine.—Shaft 80 feet deep. Abandoned.

American Pioneer.—About 10 tons of low-grade rock was shipped. Abandoned.

Colorado.—Shaft 40-50 feet deep. About 5 tons shipped and about 100 tons of ore only not sorted.

Cozette.—An incorporated company. Opened by an incline shaft. Work stopped.

Other claims were known as the Greenhorn, Lula, and the Green Mountain. From the Hibernia about 20 tons of ore had been sent to San Francisco at a cost of \$33 per ton. From the Benefactor about 20 miles up Williams Fork about 20 tons have been shipped.

HAAS GROUP.

Situated on the Colorado River about 100 miles above the Needles following the river. They are 80 miles below the placer mining locations of the Temple Bar Mining Company. The copper ores occur in granite. The country is rough and hilly. The nearest railway station is Kingman, thence 19 miles by stage to Mineral Park. From Mineral Park 12 miles in saddle to claims. Steamboats on the Colorado can land at the bank. Wood is obtained from the drift-wood on the river by means of a boom.

GRAND REEF.

In Graham County, about 50 miles from Willcox, extensive cropping showing ores of copper and of lead, cuprite, and galena occur at the surface. It was purchased some years ago by Mr. John W. Mackay, and is being thoroughly developed by working before any attempt is made to utilize the ore. A shaft has been sunk to the depth of 500 feet, and drifts have been extended from it at each 100 feet of depth. The ore extracted in this opening up of the mine is piled on the surface. A permanent and comfortable camp has been established, with the confident expectation of a profitable and permanent enterprise.

THE PIETY GROUP OF COPPER VEINS.

The following data concerning the Piety group of copper claims are compiled and condensed from an unpublished short descriptive report on the property by Prof. George W. Maynard, of New York. This group is situated on the south side of the Gila River, Ripsey mining district, Pinal County, Ariz. The property is reached via the Southern Pacific Railroad to Casa Grande, and thence by stage over good roads to Florence, the county seat and the center of a flourishing agricultural district, 23 miles from the railroad, and then an additional 38 miles to Riverside, on the Gila River. The district is relatively accessible as compared with many other copper-producing districts in Arizona in their early development. The property consists of six full claims, 1,500 feet in length by 600 feet in width, a total of 123 acres. In addition there is a mill site of 15 acres, with an extent of about 2,250 feet of river front and an average width extending back of the river of about 300 feet. The total surface is, therefore, 138 acres. In the immediate district the only important development work has been on the Ray Mine, which, it is said, will soon be worked in a large way. A modern smelting plant has already been erected. The claims included in the property are known as:

	Feet.
Piety No. 1 and Piety No. 3, on the same vein	3,000
Piety No. 2 and the Gila, on the same vein	3,000
The Gerald	1,500
The None Such	1,500
Total	9,000

Piety No. 1 and its extension and Piety No. 3 are parallel to Piety No. 2 and its extension, the Gila. The surface showing consists of bold outcrops, which as a rule stand well above the surrounding country, so that the veins are readily traced. The general course of the veins is northeast and southwest.

Piety No. 1.—Development: About 250 feet from the west end of the location there is a prospect hole 12 feet in depth, but as it is not on the vein, which lies to the north, there is no ore. A drift 110 feet east of the prospect hole has been carried in 6 feet from the face of the mountain, and at the end a shaft has been sunk 21 feet. As this drift is entirely in the outcrop it did not show other than the characteristic copper stains of carbonate of copper. A sample, however, was taken for the entire length, which showed by assay: Copper, 16 per cent; gold, trace; silver, two-tenths of an ounce. This assay is only of value because demonstrating the existence of copper in the outcrop. The shaft leaves the vein about 15 feet below the collar. The vein is 12 to 24 inches thick, and disappears in the foot wall where it is widest.

Deep shaft.—Depth, 57 feet. A drift has been extended north 27 feet at a point 46 feet below the surface: width of drift, 3 feet 6 inches. The vein in the back of the drift measures 2 feet and has the usual green and blue carbonates scattered through it, but of too low grade for working. The drift was sampled for the entire length, excluding two or three inches of a rich streak which is persistent for the entire length of the drift in the back adjoining the front wall. Assay value: Copper, 2.23 per cent; gold, trace; silver, 0.47 ounce. On the south side of the shaft a drift has been started which is already in 4 feet. The vein is better defined at this point than elsewhere and has a width of 2 feet 10 inches of workable ore made up of the blue and green carbonates of copper, with a little red oxide of copper scattered through the mass, the gangue mass being an iron-stained quartz. The entire exposure was sampled. Result: Copper, 9.26 per cent; gold, 0.03 ounce, 60 cents per ton; silver, 9.90 ounces, \$5.74 per ton.

The vein cut in the upper shaft should also be followed.

Piety No. 2 is a parallel vein to Piety No. 1 and strongly marked by its strong outcrop. A shaft 13 feet 6 inches in depth has been sunk 50 feet west of the center of the location. The shaft is 8 feet in length north and south, and from the bottom a drift has been run 8 feet northwest. The only show of ore is 4 inches of a low-grade carbonate which cuts into the hanging wall. This is a favorable point for exploration.

Piety No. 3 is the east extension of No. 1 and is readily traced by the outcrop. Near the center of the location there is a 10-foot hole from which considerable carbonate has been taken. A continuous vein from the surface 10 to 12 inches in thickness is exposed at this opening, and is one of the best showings on the property. Standing at the center of the location on No. 3 and looking north one sees four distinct and boldly defined outcrops, including No. 3. The outcrops are practically parallel, and in general terms the dip is 10 to 12 degrees south.

The Gila.—This is the last extension of Piety No. 2. About 150 feet from the west end of the claim a hole has been sunk 10 feet, exposing a well-defined vein of carbonates for the entire depth.

The Gerald vein has not been as extensively prospected, but wherever holes have been dug fairly good copper indications have been found.

The None Such.—This vein as far as prospected shows exposures of red hematite iron ore, which will be an admirable flux in the smelting. An excellent quality of limestone is also found within easy reach of the property. All of the requirements for smelting, excepting fuel, are found in the neighborhood. The owners of the property erected a small experimental shaft furnace, and smelted a few hundred pounds of ore which had been gathered from the different veins. The insufficiency of blast made it impossible to put through any considerable amount of ore. The product obtained, however, was fairly good metallic copper. Borings were taken from this product, and were found to contain by assay: Gold, 0.53 ounce per ton; silver, 13.50 ounces.

SIERRITAS OR WESTINGHOUSE CAMP.

Several locations about 22 miles south of Tucson on the north slope of the Sierritas were partially opened several years ago by the Westinghouse Company, or some of the chief stockholders, who, under the advice of Dr. Peters, acquired the property and expended probably close upon \$100,000 for development and improvements. The work was soon after discontinued and practically abandoned. The buildings and machinery, store, etc., were purchased by the El Grupo Mining Company and taken to Sonora, Mexico. The remnants of piles of ore left on the surface are "low grade," "rebellious," or highly pyritic and siliceous mixtures of copper, lead, zinc, and iron sulphides, with considerable silica and perhaps some arsenic. Appearances indicate their occurrence in considerable quantities in masses intercalated in the bedding of the strata. The records of over 100 assays left in the books at the mine show the general presence of copper ranging generally in percentage from 2 per cent to 20 per cent. Some of the assays yield as high as 40 per cent, but these were from kidney-shaped bunches of exceptionally good ore. The average of 93 copper determinations is 9.54 per cent, and of 28 determinations of zinc, 15.64 per cent.

CASTLE CREEK COPPER-MINING DISTRICT.

One of the most promising mining districts in the Territory is the Castle Creek copper-mining district, situated in the southern part of Yavapai County. This district embraces a large area, and lies east of the Hassayampa River and within easy access to the Santa Fe, Prescott and Phoenix Railroad. The Castle Creek and its numerous tributaries traverse the entire district and furnish a plentiful supply of water for all domestic and mining purposes. The principal mountain ranges embraced in this district are: The Silver Bradshaws, the Buckhorn Range, and the eastern slope of the Red Picacho Range. The formation of this district from a mineralogical standpoint is varied, and furnishes a highly interesting study for the student of nature and her forces. A part of the district is highly metamorphic, notably the northern and western half, while the southern and eastern parts are exclusively eruptive. The country rocks may be classified as follows: Felsite, andesite, diorite, and granite, with schistose and rhyolite dikes in the northern half, and trachyte, with extensive deposits of conglomerate, tufa, and lava for the southern half. The region has been subjected to severe dynamic forces. The schists and other disturbances have resulted in numerous fissures, fractures, and faults, forming planes along which the mineral waters found easy passage, resulting in the formation of more or less extensive mineral deposits and veins carrying copper, gold, and silver. The zone of greatest activity in the deposition of mineral is apparently along the borders of the eruptive rocks, where they break into or contact with the metamorphic rocks. This zone covers a width of from a half a mile to more than 2 miles; in length, a distance of more than 15 miles. The district is comparatively new from a mining standpoint, although some mining for gold and silver has been prosecuted for several years. It is of recent date that attention has been attracted to the large deposits of copper found in this district. Five large groups of mines are now being actively worked in the Castle Creek copper-mining district, embracing the Copperopolis group as of first importance in activity of developments. This group consists of 28 claims and 9 mill sites. Three mines are located in the southeastern part of the district about 2 miles from the town of Briggs, and development work is being vigorously pushed, some 500 feet of work being already completed. The work so far shows a large

vein of copper-bearing ore. The vein averages in width from 20 to 100 feet along its strike, and runs for 2 miles on the Copperopolis property. The vein is a typical iron-copper vein, carrying but in places or bands of copper ore in the iron caps. The vein stuff shows a uniform value in gold of \$8 to the ton. The proposed development is to work through the capping or gossan to the water level and open the mine at the sulphide base.

The Jones group of mines are situated on the Copperopolis vein, and extend for 7,500 feet on the west extension of the vein. These mines are being worked by a separate company, and are at a depth of 250 feet, producing some fine copper and gold ore.

The Swallow group, located on a tributary of the Castle Creek, have been in the past worked for gold, and have produced gold in paying quantities. They are now being worked for copper, it having been determined that the mines are copper mines as well as gold, the gold of the vein being so far obtained by milling the gossan of a copper mine. It is proposed to install machinery at an early day for working the copper ores.

A third group of copper and gold mines is the Whipsaw group, located at the head of the Whipsaw Gulch. These mines have recently been partially opened and show very rich values. It is said by competent experts that there are now exposed 5,000 tons of copper ore that will average 15 per cent copper and \$10 gold to the ton. A complete smelting plant is now being built to the Colorado Iron Works for this group of mines.

In the Buckhorn Range some very fine prospects are being worked for copper. It is now practically assured that the Castle Creek mining district will soon occupy a prominent place among the various copper-producing districts of Arizona.

THE COPPER DEPOSITS OF COPPER BASIN, ARIZONA, AND THEIR ORIGIN.

[From the transactions of the American Institute of Mining Engineers, New York meeting, February, 1889.]

Copper Basin, in Yavapai County, Ariz., about 10 miles southwest of Prescott, is well named. It is a depressed area and a region of cupriferous impregnation, the principal development covering an area of about 40 acres. The geologic conditions are simple. The foundation rock is a coarse-grained granite and gneiss, in which soda feldspar predominates. There are also dikes of porphyritic rock and a large quartz vein containing pyrites.

Superimposed on this crystalline foundation we find heavy beds of mechanically formed rocks, conglomerates, breccias, and sandstones in horizontal layers cropping along the bed of a creek, and apparently the remnants of a much more extended formation, now denuded and largely carried away by gradual atmospheric erosion.

The heavy beds of conglomerate are in many places much broken and tilted up, even standing on edge in large blocks, as if they had been lifted by some great convulsion; but the cause is much more simple, being merely the removal by gradual disintegration of the softened and decayed granitic rock below.

The materials of these sedimentary beds are chiefly fragments of granite, gneiss, and plutonic rocks loosely mingled. They are the chief repositories of the copper ore, which forms the cementing substance. This copper ore is the blue and green carbonate azurite and malachite, and the ore is so generally spread through the mass of the beds that the blue and green croppings can be seen at a great distance, particularly after or during a shower of rain, when the colors are extremely brilliant and beautiful.

The copper carbonate is not only a matrix and a cementing material for the fragments of rock, but it invests and covers these fragments so that only malachite and azurite are visible. The beds are from 3 to 10 feet or more in thickness, and although seemingly solid carbonate of copper, rarely contain over 12 or 15 per cent of that metal. Some portions of the conglomerates are much more highly charged with copper than others, and in places the beds are almost without copper. If a lump of the coarse sandstone charged with the copper ore is digested in acid the carbonate of copper is rapidly dissolved out and the mass falls asunder in loose grains of sand.

In the bed of the little dry wash there are many boulders, from a few inches in diameter to one or two feet, which are completely covered with a crust of azurite. If there are cracks and cavities in the boulders the copper carbonate will be found inside or below the surface, but is mostly upon the surface as a thin covering.

These copper depositions are clearly the result of the gradual percolation of copper solutions passing through the porous sand rock, and the copper carbonate is a

deposit of incrustation, not of replacement, for so far as the sandstones and the conglomerates have influenced the deposition, the action appears to be mechanical rather than chemical. The surface, rather than the chemical composition of the strata, appears to have determined the deposition. Nor does it appear that the copper carbonate has replaced any calcareous or siliceous cement. The absence of a cementing material seems to have favored the infiltration and distribution of the cupriferos solution, which may have been gradually concentrated by evaporation, on the surface of the coarse grains of rock. Assuming what is very probable, that the copper was carried in as a dilute sulphate, it would be thrown down as carbonate on meeting carbonate waters or meeting water or moisture in the rocks more or less charged with carbonate of soda. Sulphate of soda would be formed and flow away to be perhaps concentrated by evaporation at some distant point and form beds of thenardite, a mineral which is abundant in Arizona. These deposits of copper carbonate, covering, as has been observed, about 40 acres, contain in the aggregate a very large amount of copper. The question of the source of such extensive depositions of copper at once arises.

The granite below the cupriferos beds and throughout the copper area is very much decomposed and softened, so that it may be cut with a pick or shovel. Considerable areas of granite surface are exposed, and are not covered by sandstone. There are numerous veinlets and thin seams of red oxide of copper, accompanied with malachite, and malachite also occurs disseminated in small nodular or concretionary masses, not much larger than kernels of corn, in the soft ferruginous clay resulting from the decay of the granite. These little button-like disks of malachite are so abundant that they could be washed out with profit if water could be carried upon the ground.

There are also considerable quantities of red oxide of copper in thin sheets, with malachite on each side. These are chiefly broken out from numerous small veinlets traversing the granite. The red oxide is in the middle and the malachite on each side next to the granite walls, the small infiltrated sheets of ore being seldom more than an inch in thickness and commonly not over half an inch thick. In some places fragments of such veinlets are very numerous, having been weathered out by the washing away of the softened granite, but no extensive nor heavy deposits have been found to justify sinking or mining upon. Several drifts and tunnels have, however, been run into the face of the granite hill following some of the veinlets of the copper ore, but the results have not been satisfactory.

Some of the small veins consist partially of quartz, this being the veinstone impregnated with malachite. These appear to have originated since the softening of the granite, and are probably the result of its partial decomposition.

In one of the principal tunnels, which has passed through the decayed portion of the granite and penetrated the unchanged interior portions, sulphurets of iron and copper are found in small bunches and seams irregularly distributed. The quantity is not large—not enough to justify mining—yet in the aggregate the amount of cupriferos sulphide is probably sufficient to be the source of the oxidized superficial ores. Further evidence of the very general impregnation of the granite with copper sulphides was found in the shaft sunk near the bed of the creek to obtain water. Yellow copper ore is found there in small but solid masses in the midst of the hard gray unchanged granite.

I do not attempt an explanation of the source nor origin of the chalcopyrite in the granite. Any satisfactory explanation would have a wide application. There is no evident relation of the sulphides to the porphyry dikes, nor, so far as is observed, is there any pyrites in these plutonic rocks. This is, however, a matter for investigation.

All the observed phenomena point to the disseminated yellow copper ore as the source of the superficial copper deposits and as the principal factor in the alteration of the granite. It would appear that the soluble sulphates of iron and copper formed by the oxidation of the copper pyrites and carried by endosmotic percolation through the substance of the rock have acted upon the feldspar, promoting their decomposition with the separation of silica and the alkalies, the deposition of the copper as oxide and carbonate, the formation of alums and probably also of sulphate of soda, which, flowing away, may have concentrated beyond. The formation of the extensive deposits of copper carbonates may also have been brought about by carbonated surface waters more or less impregnated, as is not uncommon in those dry regions, with carbonate of soda. That soluble silica is one of the products we know, from the fact that in a little trickling stream of water flowing from a spring in the decayed granite there was an abundant separation of gelatinous silica colored green by copper. In this abundance of silica separated from the granite we find an explanation of the origin of many of the little veins of quartz-carrying copper ore and another fact in evidence of the origin of quartz veins generally.

Thus the granite becomes softened in place and "rotted" as deeply as surface waters and air can penetrate, the sulphides disappear, silica and the alkalis are removed, and a ferruginous claylike mass is left with disseminated accretions of copper carbonate and the formation of quartz veins.

An extended chemical investigation is necessary to determine all the conditions which exist before the exact order of interchange of elements can be stated with confidence. These Copper Basin deposits of copper ore in sandstone and conglomerate are very different from those found in the Triassic shales of New Jersey and of Germany and of other countries where the ore is disseminated in grains or patches and in the mass of the rock. In the Copper Basin deposits the ore is spread continuously through the mass and invests the grains of rock, forming a coating. The ore does not in any case appear to have been deposited by reason of the presence of any organic remains, as, for example, the stems of plants such as are found in the sandstone of northern Texas or in Russia. Murchison has described cupiferous grits, sandstones, and shale developed at the Zavods of Yugofski and Matovilika, where the ores of copper, chiefly the green carbonate, are disseminated, and are in the form of cupiferous concretions, generally the carbonized stems of plants. (Russia and Europe in the Urals, p. 144.) Not only Murchison but Maynard has described the deposition of copper on organic remains in the copper sandstone of the Urals. (Trans., IX, 33.) These Arizona beds differ from the cupiferous Permian strata not only in the form of the copper deposition but in their much more modern and local nature.

The copper deposits of northern Texas are familiar examples of the deposition of copper ore on the remains of plants.

Wendt has mentioned the copper of Copper Basin as "carbonate ore which must be of secondary origin" (Trans., XV, 74), but otherwise it has not been noticed in our transactions. He considers the red oxide of the Santa Rita copper mines of New Mexico as derived from the native copper by alteration. (Copper Ores of the Southwest, Trans., XV, 27.)

The explanation of the origin of the Copper Basin herein given will apply particularly to the conglomerate deposits accompanied by extensive kaolinization of the crystalline rocks.

This Copper Basin ore is not a "smelting ore." The bulk of its substance is not sufficiently fusible. Its origin by infiltration suggests the nature of the process by which the copper should be taken out. It is an ore especially well adapted to leaching. The absence of soluble minerals other than the copper carbonate is a great advantage, while the open granular condition of the rock permits the ready action of a solvent and of subsequent lixiviation.

The conditions at once suggest the following process, which is given in outline merely: (1) The solution of the copper carbonate by dilute sulphuric acid. (2) The extraction of the copper by electrolysis. The conditions favoring this method are numerous, but the greatest is the abundance in the region of auriferous pyrites of the "rebellious sulphurets" for which the gold miners are seeking the cheapest and best method of working. The distance over which these sulphurets must now be transported entails a heavy expenditure. The establishment of sulphuric-acid works at Copper Basin would make a home market for the sulphurets, and while the sulphur is utilized for making acid the oxidized residues holding the gold could be chlorinated. Thus the sulphide ores, on the one hand, and the clean carbonates of copper, on the other, although difficult to utilize separately, would by combination give us the precious metals and the copper in a marketable form at a comparatively low cost, and the problem of working both is solved. The spent residue of iron oxide might also be utilized (provided there was rail transportation) at lead-smelting works. There are several economies by such process which will suggest themselves. No greater supply of water is required. The acid need not be concentrated; "chamber acid" would be strong enough. It is possible, also, that no great quantity of acid would be needed, for when the bath is once formed it is probable that the copper ore itself may be made the anode and yield its copper to the solution direct. Pine wood for fuel is abundant on the adjoining mountains, and dynamos can be run very cheaply.

Our fellow-member, Prof. G. W. Maynard, some years ago put up a plant in Siberia for the treatment of copper-carbonate conglomerate ore by lixiviation with sulphuric acid, and has promised to contribute to the transactions of the institute an account of the plan and its results in practice.

THE MARICOPA COPPER MINES COMPANY.

The mines of this company are situated in Maricopa County, 32 miles southwest of Wickenburg and 16 miles in the same direction from the Old Vulture gold

mine. The property has always been known as the Osborne copper mines. William Osborne located them twenty years ago and has held them ever since up to the time the present company bonded them. Very little work has been done until the present active development. A vertical shaft has been sunk 126 feet deep, and is to be extended to a depth of 500 or 600 feet, or until sulphide base is reached. The main dike of this group courses through the country very prominently and ranges in height from a few feet to 75 feet, and a width from 150 feet to 200 feet. Along all this dike are seams of fine carbonate copper ore, and is in a series of a few inches to 7 feet wide. The value is from 14 to 35 per cent copper, with values in silver and gold. Open cuts have been made all along the course of the dike, exposing fine deposits of azurite and malachite carbonate ores. The present shaft is all in this class of ore. The main dike is a formation of porphyritic lime strongly charged with a red oxide of iron. On the west of the dike, running at right angles, is a dioritic slate; on the east, a metamorphic limestone. The original locations consisted of 15 claims. The company now own about 40.

COPPER MOUNTAINS, YAVAPAI COUNTY.

This property, opened several years ago by the Stoddard Copper Company, which has lain idle for a long time, is to be reopened and worked. A recent discovery of a large mass of sulphide ore is reported. A great deal of development has been done in 1898-99, and the showing made is said to be very good.

ARGENTIFEROUS LEAD AND SILVER MINES.

Under this caption are included the claims and mines producing galena ores or lead carbonates—ores of lead and ores of lead containing silver—as well as the mines producing silver ores proper. Considering the fact that some of the most important mines produce gold as well as silver, the two metals being united in the ore, it is difficult to decide under which caption to place the descriptions. This is especially the case with such properties as the Commonwealth and the new discovery at Fresno, where free gold accompanies silver ore, as in the Comstock lode in Nevada. There can not be any question about the Silver King of Arizona, one of the very few mines which yields silver without gold.

Galena—the sulphide of lead or galenite of the mineralogists and the most common and abundant ore of lead—is well known in Arizona, where it is abundantly distributed, and is generally accompanied by both silver and gold. The chief localities where it occurs in commercial quantity are the Castle Dome district, Silver district, Eureka district, in Yuma County, at several localities in Mohave County, and in Yavapai County.

In Pinal County lead ores carrying silver occur in many places, especially in the old Montezuma mine, between Phoenix and the Hassayampa, and in the Mineral Hill district. At times large bunches of lead ore are found in the Mammoth mine, Pinal County.

In Pima County lead ores occur in quantity at Crittenden, at the Washington camp, at the Vekol, in the Quijotas, the Silver Bill district, the Abbe Waterman mine, and other places. Ores have been shipped also from Greaterville and from the old Yuma mine near Tucson.

In Cochise County there are several localities, notably the Dunn mine, in the Chiricahuas, and at the several claims near Cochises Head.

GALENA AND GOLD.

It is worthy of note that galenite as an associate of native gold is more common and abundant in the auriferous quartz veins of Arizona than in the gold-bearing veins of California. At the Vulture mine, for example, galena is a common associate of the gold, together with iron pyrites; so, also, at the Mammoth Gold mine, at the Oro Bello and the Oro Fino claims, and at many other of the pyritic gold mines in the Bradshaw Mountains, amongst which Ryland mine may be mentioned, and the mines along Slate Creek and the Upper Hassayampa.

LEAD AND MOLYBDENUM.

The very frequent occurrence of these two elements in close association in the lead-bearing veins of Arizona is a familiar fact to the miners and prospectors. It may be said that the molybdate of lead, the species wulfenite, is always found in notable quantities wherever galenite has undergone chemical change, with the formation of oxides and carbonates. Some prospectors have called it yellow lead

ore. It occurs generally in bunches of thin tabular yellow crystals. The intimate association and the general occurrence of wulfenite with the lead ores justifies the opinion that there is an intimate intercrystallization of the sulphide of lead and the sulphide of molybdenum, though molybdate sulphide is generally supposed to be hexagonal in crystallization.

AURIFEROUS CARBONATES.

At many of the lead mines of the Territory, notably some in Mineral Hill district, there are large superficial accumulations of nearly clean lead carbonates which yield notable amounts of gold. Such ores are very desirable for smelting mixtures. (See Crown Point Group *infra*).

CASTLE DOME DISTRICT.

The veins of the Castle Dome district may be said to have been rediscovered in 1863, for it was evident that they had been anciently worked, as already stated in the historical introduction. The metal had been taken out from many of the veins by the ancient miners down to a depth of from 6 to 15 feet and in continuous lines or trenches, in some places for 50 to 100 feet or more. These old workings were found to be safe guides to good metal-bearing ground a short distance deeper. Well-worn trails leading off from these pits to the banks of the Gila River, some 18 miles distant, and the ruins there of some rude smelting furnaces indicate that the ores were carried to the Gila, probably on the backs of Indians, and that they were smelted there, whether by the Aztecs or the early arriving Spanish explorer is not known. Since 1863 these mines have been worked almost continuously, and are now yielding silver-lead ore of most excellent quality, which is shipped to San Francisco. The claims were worked by prospectors without capital until October, 1870. Up to January 1, 1892, there had not been an investment of over \$300 in building or permanent improvements. The climate is such that men can work the year round without more protection than is afforded by brush, huts, or tents.

On the 1st day of January, 1872, Mr. George Tyny reported the following-named claims as producing in 1871:

	Tons.
Buckeye	250
Hora Temple	400
Castle Dome	} 600
Castle Dome Extension	
Don Santiago	30

The veins crop out on a rolling plain or mesa at the base of the Castle Dome Range, a very rugged and picturesque group of mountains trending northwest and southeast, rising near the center to the remarkable dome-shaped summit with precipitous sides, looking like a huge round castle or building with a dome. It is a noted landmark, being visible from a great distance in all directions. It was originally called "Capitol Dome" by the officers at Yuma in 1853, from the fancied resemblance to the Dome of the Capitol at Washington. This mountain range, being but sparingly watered, has never been convenient to prospect and very little is yet known of its structure or mineral value. The mines are usually reached from Yuma by driving first to the Castle Dome Landing, on the river, and thence to the mine from 16 to 18 miles east and inland from the river. The claims are numerous. Some have been patented and worked to a depth of 300 feet or more. The veins are remarkably regular and well formed. The ore is galena, carrying about 30 ounces of silver to each ton. The veins trend in a general northwest and southeast course, and are nearly vertical. The outcrops are indicated by outlying masses and weather-worn crystals of fluorspar, which is the chief veinstone. Calcite and gypsum are also found, and in some of the veins there is a veinstone of quartz dispersed in sheets or "combs" along the walls or in distinct sheets in the center. Manganese spar and barite are also associated in layers. The thickness or power of these veins is usually from 2 to 3 feet, sometimes from 8 to 12 feet, wide. There are veins also only a few inches in width. In general the veins are well filled with ore. This ore occurs in sheets or bunches scattered through the veinstone and commonly known among the miners as ball metal. In one mine in the district a mass of nearly solid ore 8 feet thick was found.

At or near the water level, where the galenite has decomposed, both carbonate and sulphate of lead are found associated with a pale-green fluorite and an abundance of crystallized yellow wulfenite, another occurrence giving evidence of the presence of molybdenum in galenite.

The rocks of the district are compact fine-grained mica and clay slates standing nearly on edge and traversed by numerous dikes or intrusive masses of a chocolate-colored porphyry.

In 1879 a company was formed to work these veins and smelt the ore at Melrose, opposite San Francisco. This company acquired title to 31 claims in Castle Dome and to 3 claims in Silver district. Among these claims the principal ones worked were the Railroad, the Hopkins, Flora Temple, and William Penn. Large shipments were made to the works at Melrose, averaging generally 60 to 70 per cent of lead and 20 to 30 ounces silver per ton. An average for the first six months of the year 1879 was (on 438½ tons), lead 69 per cent and silver 26.47 ounces per ton. Notwithstanding the favorable value of these ores and the facilities of mining and transportation, the enterprise was a failure. This was caused chiefly by the lack of adequate capital, necessitating borrowing to keep the smelting works going and to carry a large amount of ore and bullion in the course of smelting and refining. The lead produced from the Castle Dome ores is very soft and is especially well suited to corroding for the production of white lead.

SILVER DISTRICT.

This district abuts upon the Colorado River and is about 20 miles above Castle Dome landing. It is remarkable for the great size of the veins, especially of the Silver Glance, which has enormous quartz croppings covering a breadth of 100 feet and carries galenite and chloride of silver in seams through its mass. It has not been much explored. Masses of "float" galena weighing several pounds were found by me just below the outcrop.

The Red Cloud claim yielded a large amount of lead ore for shipment, and is well known among mineral collectors for the fine large crystals of red wulfenite found in the ores.

The Hamburg, the Princess, and the Ironside are other important claims. Ore from the Hamburg mined by the Castle Dome Company yielded from 40 to 80 per cent of lead and from 150 to 306 ounces silver per ton. Beautiful crystallizations of red wulfenite and of vanadinite are obtained at these mines.

PLANCHES DE LA PLATA.

There has been and there still is a difference of opinion as to the exact location of the source of the celebrated large masses of native silver taken from the earth near to the present international boundary line, but on the Mexican or Sonora side, nearly south of Tucson. The celebrity of the locality as the source of enormous masses of pure native silver, larger than could be loaded upon mules, dates from before the middle of the eighteenth century, for a royal decree dated in 1741 not only mentions the weight of some of these masses, but reserves the region for the exclusive use of the Crown. According to Ward, he had in his possession a copy of the decree of Philip the Fifth, dated Aranjuez, May 28, 1741, the object of which was to terminate a prosecution instituted by the royal fiscal agent against the discoverers of Arizona for having defrauded the treasury of the duties payable upon the masses of pure silver found there. The decree states the weights of the walls, sheets, and other pieces of silver discovered (bolas, planchas y otras piezas de plata) to have amounted to 165 arrobas 8 pounds, in all 4,033 pounds, and mentions particularly one mass of pure silver weighing 108 arrobas (2,700 pounds) and another of 11 arrobas, upon which duties had been actually paid by a Don Domingo Azmendi, and which, as a great natural curiosity (como cosa especial), the King states ought to have been sent to Madrid. The decree ends by declaring the district of Arizona to be royal property, as a "criadero de plata" (a place where by some natural process silver was created), and by directing it to be worked upon the royal account. This put a stop to the enterprise of individuals, the district was deserted, an attempt to send a colony there failed, and in a few years the very name of Arizona was forgotten (Ward's Mexico, 1st ed., vol. 11, pp. 136-138).

The following is taken from an interesting description of the Planchas district from the pen of F. B. L., dated at Nogales, June 15, 1891, and published in the Citizen. This writer places the Planchas locality at about 20 miles southwest of Nogales:

"This is one of the oldest as well as one of the most famous mineral regions of Mexico, and is unique in history as having furnished the largest nugget of native silver ever discovered in the world, its weight being 2,700 pounds. This discovery was made in 1736, causing tremendous excitement and a great 'rush' to the new diggings. Such masses of pure silver as were unearthed in the Planchas Canyon

was the wonder of that day, and have never been equaled since. Numerous specimens of native silver weighing from 200 to 400 pounds were picked up here in those early days, and there is only conjecture as to the quantity of this metal which has been added to the stock of the world from the Planchas district; but there is good foundation for the presumption that it would aggregate many millions of dollars. The old shafts and workings of more than a century ago and of more recent dates to be seen in this locality afford abundant proof of the extensive operations carried on by the early Mexicans. Even as late as about 1870, according to Francisco Maraquin, chief of the Planchas de Plata customs, whom I met here, a piece of native silver weighing 40 pounds was found in the Planchas Canyon and sold to Monte Verte, administrator of Hermosillo mint, Sonora, and still later the better known discovery of the silver hatchet in 1886 by a Mexican cowboy, which was sold to Charles Altschul, of Nogales, for \$111, serve to confirm the traditions handed down to us concerning the marvelous discoveries of early times, and furthermore would tend to justify the prediction of an immense ledge of this treasure somewhere in the district as well as warrant the large expenditure now being made by the Plata Reina de Sabora M. & M. Co., under the superintendence of Col. Richard A. Pomeroy, in the projection of tunnels far beneath the old workings. All indications go to show that the early workings with these mines was on the surface. When the ore showed indications of 'pinching out' work was suspended and again resumed in a new place. This method gave rise to belief that the ore attained no depth, that the deposits were merely surface. It is to be regretted that others besides the Mexican gambusinos have pursued a similar policy. Colonel Pomeroy has broken 1,500 feet of ground since December, 1890, and has demonstrated that each of the six claims owned by the company is a lode, and that the most favorable results may be attained by deep mining.

"The ores of these mines consist principally of black silver. The company is now, very wisely, doing no milling, but pursuing a systematic method of development, and will soon be in a position to ship quantities of ore, and will have abundance to treat on the ground. A brief description of these mines might prove of interest to readers of the Citizen.

"In the Ladera mine the method of working was entirely surface and much waste rock had to be removed to obtain the ore. The new tunnel being driven will cut 100 feet below the old workings, where it is expected to strike the ledge. As these ore shoots are encountered they may be followed, leaving the pillars of nonmineral-bearing rock standing. The rock in the breast of the tunnel indicates close proximity to ore, all running something in silver. It is estimated there are 10,000 tons of mineralized rock on the dump worth \$11 per ton. First-class ore of this mine averages from 40 to 100 ounces.

"The Hilo mine, the oldest in the district, was worked more systematically in the past than others of the group. A well-defined vein is exposed which dips into the mountain. A crosscut of the tunnel at 50 feet cuts the lode in a good body of ore. Work is now being prosecuted with vigor to get under the old workings, from which large quantities of ore were formerly taken. The vein has been prosecuted in an entirely new place and shows extremely well.

"The Guadalupe mine, like the Ladera, was worked formerly by a large surface cut, from which great quantities of ore were taken. The tunnel now being run to get beneath the old workings gives good indications to soon be in ore. Another tunnel being constructed is producing small quantities of rich ore.

"In the Mexica mine some years ago a crosscut tunnel over 300 feet long was run under the old workings. A body of rich ore was encountered and stoped out. From this tunnel a level has lately been run east and west. In the east level rich shipping ore has been found; thence a 35-foot shaft sink shows a pay streak nearly all the way down. Ore from the west level assays from 80 to 300 ounces. East level for 100 feet penetrates a mass of fine concentrating ore with bunches of good shipping ore.

"The Providencia mine is being worked by two shafts, and a tunnel on the vein is started. Shaft No. 2 shows a breast of 17 feet of pay streak."

The writer adds that a topographical survey was in progress by Lieut. H. O. Flipper, and a photographic survey by Mr. H. M. Stanley.

SILVER KING.

In 1896 there was a revival of mining of this celebrated property, which is reported to have produced several millions of ounces of silver, and to have paid out over \$2,000,000 in dividends. But the renewed prosperity of 1896 was not of long duration. The production has declined. It is more than probable that the ore body, which is so suddenly and sharply cut off at the seventh level, is a slide or mass broken from the main body or chimney of ore which has been moved. The

extent of the slide or faulted ground is not known, and can be ascertained only by the most patient, thorough, and skillful geological investigation. That there has been such a slide, and that somewhere in the mountain the downward prolongation of the Silver King ore ground exists, I have no doubt. The direction of the movement should have been most carefully noted on the rocky floor of the 700-foot level where the richest body of silver ore found in the property rested upon a barren rock floor, below which costly borings with the diamond drill from the adjoining shaft failed to find any trace of the Silver King lode. It seems probable that this problem will be left to the next generation to solve.

SILVER OF GLOBE DISTRICT.

The limestone which forms the hanging wall for the veins of copper is said to be some 6,000 feet thick, and is the foot wall of many of the old worked-out silver mines, such as the Alive, the Miami, Centralia, Dime, and several others, all of which have produced from \$30,000 to \$20,000 in silver. The silver country proper, however, is situated some 13 miles from the town of Globe. Here we find the old workings of the McMorris, Stonewall Jackson, Rescue, and Old Mexican, etc., which in early days proved bonanzas to their owners.

The country is essentially a limestone country, the silver being found in pockets usually small, but wonderfully rich. These pockets are mostly found under quartzite caps carrying red hematite. The silver is found as chloride mixed with huge masses of native silver, and has carbonates, some embolite, and vadaninite mixed with it. The whole mass is usually associated with hematite, and is invariably free from gold.

The history of these mines shows that they contained from three to seven of these pockets. In one case—that of the Old Mexican mine—only one pocket was found; this, however, netted the owners \$168,000 in value of silver. In the report for 1896 and 1897, a photogravure showed the form of one of the silver nuggets found 12 miles north of Globe in August, 1895, which weighed 31 pounds and was 0.900 fine.

TOMBSTONE.

Most of the mines at Tombstone are now idle, and the town is almost deserted. It is interesting to note that ore has been traced from the old claims of the Toughnut and Goodenough through the Way Up down into the Empire claim, and that at present the most promising field for prospecting and working lies in the region beyond the Empire, where, in fact, some ore is being taken out. A rich strike was reported in the Wedge.

The older and larger mines at Tombstone, such as the Contention, the Grand Central, and Way Up, which have yielded so generously in the past of gold and silver, are not now worked for account of the companies owning them, but there has been considerable chloriding in a small way. The dumps also have been partially worked over by the cyanide process. A large portion of the semi-decomposed porphyry thrown out from the Contention mine carried free gold in it, flakes spread in little specks and patches upon the cleavage joints and surfaces. Some of this porphyry in the upper levels was also more or less coated and impregnated by chloride of silver, occasionally in distinct but small cubical crystals. Such rock, if not too clayey and impervious for free leaching, should yield good results by the cyanide process. The great drawback to the working of these Tombstone mines in depth is the great influx of water and the cost of lowering it by pumping. The connection of the deposit or veins under ground is such that one claim can not be drained without draining the others. It therefore becomes essential to have a union of the interests of the various owners and a pro rata agreement to bear the cost of pumping from a central station.

SILVER HILL MINING DISTRICT.

The Liberty mine, worked by William Clark, has been a steady producer of argentiferous lead ore of high grade, and Mr. Clark has made regular shipment to the smelter. The ore is carefully sorted out to a high grade by hand. It often runs from \$400 to \$600 per ton. Dr. Purcell has a mine named the Wind Up in the same district, about a mile from Liberty Clark's mine, which is being developed.

VEKOL.

This famous mine, which has yielded quantities of very rich silver ore, has been reopened. In February, 1898, there were about 25 men at work upon it, under the direction of P. B. McCabe. Fine specimens of ore from this property were sent to the Chicago Exposition and are now in the museum of the university.

EMPIRE SMELTING COMPANY, CRITTENDON.

Under the general management of Dr. Eames, of New York, extensive preparations were made for opening mines and smelting silver lead ores at this camp. It was understood that one or two 100-ton furnaces would be required to meet the capacity of the mines. In September, 1897, Mr. Richard Eames, jr., the superintendent of the Columbia Smelting Company, was in Tucson, and reported that the smelting furnace, after a temporary closing down, was again in successful operation, and was turning out three carloads of silver lead bullion per week. They were working on ore from the Hardshell. The condition of the road was such as to render it difficult to get sufficient ore to the furnace to keep it running. Since then operations have been suspended or abandoned.

GALENA IN THE SIERRITAS.

There are several localities from which a galena of low grade in silver can be obtained in the Sierritas south of Tucson. A sample from one claim about 35 miles south of the city yielded 42 ounces of silver by assay.

HEINTZELMAN MINE.

This property, prominent in the early history of mining development under American domination, attracted great attention about 1857. It was acquired and worked by the Sonora Exploring and Mining Company, of which Col. Charles D. Poston was general manager. This mine was in the Cerro Colorado, and very rich ores having been found at or near the surface attention was specially directed to it, and the other localities secured for that company in the Santa Rita and San Cayetano mountains were for the time neglected or abandoned.

In August, 1857, the Heintzelman vein had been opened to a depth of 50 feet, and a pile of ore estimated by assay to be worth \$20,000 had been thrown out. Samples of the ore sent to New York and San Francisco for assay gave results confirming those made at the mine. Assays made at the United States assay office by Prof. John Torrey showed silver at the rate of 237 ounces to the ton and 33 per cent of copper. Samples were also examined by Dr. Charles T. Jackson, of Boston, with similar results. Dr. Jackson regarded this ore as stromeyerite, or sulphuret of silver and copper. Some of the specimens contained nitreous copper. This was the first determination of the occurrence of stromeyerite in Arizona. It occurs also, as I have shown, in the Silver King mine. Mr. Brunckow in 1857 reported the occurrence, also at the Heintzelman mine, of fine specimens of the iodide and bromide of silver and a silver amalgam.

Considerable shipments of Heintzelman ore were made to a smelter at San Francisco, where the ore was treated in a reverberatory furnace and yielded at the rate of \$450 per ton. It was found, however, that a large part of the silver had been lost in the furnace and residues. The poor success in smelting and the great cost of transporting these ores led to the adoption of the barrel amalgamating process—the Zeiberg barrels—for the greater portion of the ores, excluding those portions evidently of more value for smelting. The poorer and clayey ores were reserved for the patio process.

After many delays from the difficulties of transporting and setting up machinery in that isolated region, two barrels, each capable of receiving 1,060 pounds of ore, were set in motion under the superintendence of the late Guido Kustel, the noted metallurgist, who in May, 1859, stated that 35 tons of the ore yielded \$5,189.53 in silver, or an average of \$148 to the ton. A portion of the ore treated was very poor and better adapted to the patio process.

Mr. Ehrenberg, in one of his reports, explained this result and made the following estimate of the general or average richness of the ore, based upon the results obtained from the commencement of the treatment of the ores at the mine and elsewhere.

According to Mr. Lathrop and the different engineers, the ore extracted from the mine at that time amounted in quantity to 225 tons. Mr. Ehrenberg thought

this a low estimate. It was distributed as follows, and yielded in silver the amounts stated:

	Tons.	Yield.	Total value.
Sent to San Francisco.....	22	\$450	\$9,900
Smelted at Cerro Colorado.....	7	900	6,300
Ore stolen and sold in Sonora.....	11	900	9,900
Middling quality and poor ore amalgamated.....	35	148	5,180
On hand at time and works.....	150	150	22,500
Total.....	225	-----	53,780

This shows an average of \$238.13 per ton, but this was thought too low because of the large loss of silver in the furnace at San Francisco. The ores sent there were the richest and best and were expected to yield some needed working capital. The first bar of silver from these works at Cerro Colorado was produced in March, 1859. The largest bar made weighed 930 ounces, and at \$1.28 the ounce was worth \$1,200. It is probable that all the calculations of value were based upon the valuation per ounce.

According to Mr. Brunckow, the vein traverses strata of clay slate obliquely and has well-defined walls. The engine shaft was 100 feet deep, and a crosscut at 60 feet from the surface showed the vein to have a width of from 3 to 5 feet. (These data are chiefly from the article on "Silver and copper mining in Arizona." Mining Magazine and Journal of Geology, new series, vol. 1, pp. 5-7, November, 1859.)

SANTA RITA SILVER MINING COMPANY.

This company was organized in 1858 to work several of the veins of silver ore in the Santa Rita Mountains, discovered by the exploring parties of the Sonora Exploring and Mining Company. These veins and mines included the Salero, Ojero, Asugarero, Bustillo, and others east of the Santa Cruz River. Some of these veins were worked anciently and large amounts of silver were taken out. The Salero was described as a vein some 3 feet in width. An old shaft had been cleared to a depth of 80 feet without reaching the bottom. The Ojero was a mine of high reputation for value among the Mexicans, and was abandoned because of the caving in of one of the walls. The Bustillo was opened to a depth of 25 or 30 feet only. The ores from these claims are chiefly argentiferous galena, and are adapted to smelting rather than milling. One of the veins was said to be traceable by old workings for a quarter of a mile.

PATAGONIA AND OTHER MINES.

In 1859 the Patagonia was being prospected and worked under the direction of Captain Elwell and Mr. Brewor. It was near old Fort Buchanan. The ores are argentiferous galena, yielding from 40 to 80 ounces of silver per ton. The Compadre and French mines in the mine region were being opened by Colonel Titus. Furnaces were erected about 10 miles from the fort. (See Mining Magazine, November, 1859.)

OLD TUMACACORI.

This property, called the Old Mine in 1875, was believed to be the same as the Tumacacori. It was worked at an early period by the Mexicans, before the American occupation, and was reopened in 1875 by Mr. Darrah. He found old drill holes and human skeletons, leading to the belief that the miners were murdered there by the Indians. Rich ore was found in the mine and on the dump. It is about 75 miles southward from Tucson. (McCormick, 1875, Mining Industry, p. 343.)

OLD YUMA MINE.

This old mine is situated on the left side of the Santa Cruz, 2 miles from the water, in the foothills, and about 9 miles from Tucson. It was formerly extensively worked and yielded large quantities of lead ore. It is now idle. Assays of masses of galena left upon the dump show that it is poor in silver. From the

abundance of wulfenite and the large size of the crystals, it is fair to conclude that molybdenum is abundant in the galenite. The claims are easily accessible, and hauling ore to water at the Santa Cruz would not be expensive.

THE QUIJOTOAS.

The mines of the Quijotoa Mountains, which attracted so much attention years gone by, and upon which millions of dollars were expended without adequate returns, are now idle and are practically abandoned. The massive and costly machinery at the mines and mill and the pumping plant in the valley have long been for sale at very low figures. The whole appears to be a monument to ill-advised and misdirected energy.

PECK MINE.

The Peck mine, in the Bradshaw Mountains, has been a large producer of silver, and is credited with a yield of at least a million ounces. This is another of the many mines in the Bradshaws which have suffered or have been practically closed since silver fell so greatly in value. The Del Pascoe is another mine in the same district which was formerly worked to advantage, but which has been idle for many years.

DASON'S.

Location, Yavapai County, south of Prescott. Produces silver ore. A well-defined vein, with regular walls and vein stone. The vein stuff consists of quartz and iron spar, arranged in regular combs or layers, with crystals pointing inward upon the central layer of galenite and brittle silver ore. Native silver has been found in lumps in the gangue. This mine is opened by tunnels, and is credited with the production of over \$700,000 in value of silver up to the year 1887.

AMERICAN FLAG GROUP.

The American Flag group of mines was operated in 1881 by Col. J. M. Haskell and Prof. E. H. Cook, of Tucson. These mines are in Old Hat district, in Pinal County, a few miles west of Oracle, and on the northeastern flank of the Santa Catalinas and some 40 miles from Tucson by road. The district was organized about the year 1878. The principal locations in 1881 were known as the American Flag, Pioneer, Wedge, Good Luck, Black Bar, Bullion, and Commonwealth. There were also the Oracle, Mermaid, Summit, and Hoodoo, the four last mentioned being $3\frac{1}{2}$ to 4 miles distant from the first by the new road.

The American Flag claim was opened to a depth of 178 feet, with a drift at a depth of 36 feet to the east and of 90 feet to the west, as shown in the small longitudinal section. The course of this vein is north 40° west, dip easterly about 40° . It is a thin vein in hard syenite and granitic rock. It averages 6 to 8 inches in the lower part of the shaft at and below the water level. At the surface south and east of the shaft the croppings are heavier, being from 2 to 3 feet in some places. In the east drifts the thickness ranges from 3 to 20 inches, and along the west drift it pinches down to a few inches only. The ore carries both gold and silver, but is generally low grade.

At the claim known as the "Bullion," a shaft 102 feet shows a vein of quartz from 3 to 15 inches in thickness and containing some good ore. It has been drifted on 60 feet northwest and 56 feet to the southeast. The Black Bar is supposed to be the prolongation of the Bullion vein. It is a similar vein, but is more broken up.

The Commonwealth is a quartz vein in granite, and is gold bearing. It was opened by a shaft 44 feet deep, following the pitch of the lode. The claim is about a mile from the others, toward the mountain. The vein varies from 18 to 24 inches in thickness and carries a sprinkling of galena.

The Good Luck is on another small quartz vein traversing granite and resembles the quartz of the American Flag.

The Pioneer is on the line of prolongation of the American Flag, and has similar ore. Its direction is north 50° west, its dip easterly at an angle of about 45 degrees. The incline is 80 feet deep, width about 12 inches.

The Wedge claim was located between the Pioneer and the American Flag.

At the Oracle claim there was an incline shaft about 40 feet deep to drifts, one being 54 feet long and the other 18 feet. The vein in places has a thickness of 3 to 4 feet of good-looking ore.

The Mermaid claim has a 6-foot outcrop of hard quartz.

The Summit claim shows some good ore in a vein of quartz some 6 to 8 inches thick. A shaft 70 feet deep shows an easterly dip to the vein. It is claimed that some of this ore showed by assay a value of \$80 per ton. The croppings show well at the crossing of the old road.

The Hoodoo claim is upon a small 6 to 12 inch quartz vein in granite.

LEAD ORE IN THE CATALINAS.

Lead ore occurs in another portion of the Catalina range, and has been exploited for several years by Mr. Samuel Ramsdell. It was reported in February, 1898, that he had sold the property to Mr. H. C. Young, of Boston, who would proceed to develop it and to ship ore.

MINERAL HILL.

Many of the mining locations and the veins of this district were visited and examined by me in December, 1881, and the following notes upon the region were made at that time: The locality is about 15 miles west of Florence; the post-office was known as the Cottonwoods, in Pinal County, and was about 12 miles from Picket Post; some 500 or 600 mineral locations were reported as recorded in Florence; the oldest claim had then been occupied about four years; the ledges are large and numerous, and are upon the west side or slope of Mineral Hill Mountain; there are several springs, affording excellent water, and they do not dry up; a well 30 feet deep has 10 feet of water in it; there are five or more springs within a circuit of 3 miles. I was hospitably entertained at the home of Mr. C. D. Henry and his wife, from Vermont.

The Alice is probably the principal vein. It is a boldly cropping lode, standing up 15 to 20 feet or more in places above the wall rocks, and is from 8 to 15 feet thick. It is only one-quarter of a mile from the springs at the Cottonwoods, and is easily accessible. This lode cuts a mica-slate formation in a northwest and southeast direction. It forms a sharp crest to the hill, being of a quartz and harder than slates. It dips easterly at an angle of from 65 to 70 degrees. This vein is very well formed. It has clay gouge or selvage on the foot wall, and this selvage contains rounded masses of hard stone.

The veinstone is lamellar, consisting of layers of quartz and calcite, some of it being black or dark colored and bearing horn silver. It is a silver-bearing lode. It carries argentiferous galena, which, by oxidation, leaves lead carbonates and oxides and the chloride of silver. Toward the north end the lode splits up into several branches, and about midway of the long line of croppings the lode is cut away by a transverse gully or arroyo, thus making two parts or lines of cropping, the southernmost trending north 45° west, and the northernmost part trending north 65° west (magnetic). And near the southern end of the croppings there is a short twist or turn of the walls to the west, and beyond this a strong outcrop of black calcareous spar. A shaft sunk here 66 feet reaches and passes the level of a tunnel below. The vein, where intersected by this tunnel, is from 8 feet to 10 feet thick.

In a winze 34 feet deep, near the black spar, a streak or layer of fine-grained lead ore (steel galena) was exposed, but this ore is poor in silver, running only 7 or 8 ounces to the ton of ore.

Silver ore is found at intervals in the north croppings in the form of silver chloride. The gangue is friable. In places the silver ore is formed in small shot-like globular masses or grains, coated over with a layer of red iron oxide, forming a crust inclosing the cerargyrite. Evidences of the occurrence of embolite and bromyrite were also noted, but were not verified by examination.

Shipments of ore from the Alice vein were made to the Castle Dome Mining and Smelting Company, at Melrose, opposite San Francisco, with the following results:

	Shipments.	Silver.	Lead.
	<i>Pounds.</i>	<i>Ounces.</i>	<i>Per ct.</i>
Average	14,364	37.2	18
North croppings	894	163.8	3.5
Do	198	80.3	3

About 1 mile south of the Seven Cottonwoods and the Alice another claim has been located, called the Tully.

THE TULLY OR CARBONATE.

This is supposed to be upon the main lode of the Alice in its southward extension. The croppings are bold and in layers of quartz and calcite, like those of the Alice. A medial layer or seam of fluor spar occurs here, and the vein carries galena and lead carbonate derived from the decay of the galena. Silver chloride does not show in the croppings as freely as at the Alice, but there is more lead ore. Proceeding southerly toward the Gila River, over hills of mica slate, we pass the Leroy claim.

LEROY CLAIM.

A hard vein of quartz, about 6 inches thick, in granite. It may be described as a gash vein of no great extent, but it has considerable ore mixed in with the quartz, and is said to have yielded at the rate of \$85 in value per ton to Mr. Mosheimer from the croppings. The mica-slate country from this point toward the Gila River changes to granite, and there are several outcrops of copper ore, among them a location called the San Carlos, for a description of which see under the head of Copper.

WEDGE CLAIM.

This claim on a lode of argentiferous lead ore is in the Cholla group of claims, about 5 miles north of the Alice mine. It occurs in the mica-slate group of rocks, which are much plicated, and are filled with quartz, generally in barren veins. It is somewhat like the Alice vein, and is made up of alternate layers of quartz and calc spar, much of this spar being black or brown in color from the presence of manganese and iron. Much of the quartz is crystalline and some is amethystine. There are many open spaces or "vugs," and pseudomorphic impressions or casts of the dog-tooth form of calc spar are common. There is also much rusty iron oxide and ore near the hanging wall of the vein, where the quartz is formed in successive sheets and layers, and carries considerable lead ore in form of galena and carbonate, over a breadth or thickness of 16 to 18 inches. This was observed in the incline shaft at a depth of about 50 feet. Considerable galena ore has been extracted. A sample of 185 pounds yielded by assay at the rate of 66.3 ounces of silver per ton of ore, and 51.5 per cent of lead. The fluor spar occurs here in small cubical crystals with truncated edges—the dodecahedral planes. Some of the quartz crystals are brown and smoky. The ledge is very large. It trends north 32° west, and dips west at an angle of 45 to 50 degrees.

CROWN POINT GROUP.

Under this name are included 21 claims situated about 6 miles north of the Gila River, near Riverside stage station on Mineral Creek, in Pinal County, and about 50 miles north of Picacho station on the Southern Pacific Railroad. These claims are recorded as the Crown Point, Central, Maryland, Wedge, Silver Cloud, Gladstone, Buckeye, Cincinnati, San Francisco, Parnell, Hidden Treasure, Charleston, and others, that are located contiguously for working purposes. These claims are traversed from northeast to southwest by a series of lodes from 2 to 4½ feet in width, with a dip of 45 degrees to the north. The ores are sand carbonates of lead, running by assay high in lead, silver, and gold. The wall rocks are limestone and porphyry. Mr. Frank M. King, from whom this information is obtained, has not sampled the veins, but took average samples of the dumps about the openings.

Crown Point.—This is one of the principal claims of the group and has been opened by several cuts, tunnels, and shafts. Shaft No. 1 is 153 feet deep, cuts through the vein, and shows it to be about 6 feet thick. Water stands 30 feet deep in this shaft. No. 2 shaft, 50 feet west of No. 1, is 52 feet deep, showing a body of carbonate ore 4½ feet thick. There are other openings showing ore, and there are about 400 tons of ore on the dumps, which, the owners claim, will yield 40 per cent of lead and 20 ounces of silver per ton.

Central.—Three small shafts and one open cut. Vein 15 inches wide and about 15 tons of ore on the dump.

Maryland.—Opened by a tunnel showing a vein about 18 inches wide.

Wedge.—Shaft 14 feet deep and shows some ore.

Silver Cloud.—Opened by a tunnel 120 feet long to top of the vein in the Gladstone, and it is estimated that it will reach it within 20 feet.

Gladstone.—Opened by a tunnel 67 feet long, showing a vein about 12 feet thick. A shaft above, 14 feet deep, shows a quantity of ore.

Ores out.—There are over 1,500 tons of ores out on the various dumps. The samples taken by Mr. King yielded as follows:

	Silver.	Gold.	Value, gold.	Lead.
	<i>Ounces.</i>	<i>Ounces.</i>		<i>Per cent.</i>
Dump No. 2	5.41	0.62	\$12.81	52
Dump No. 1	7.90	.39	8.06	55.8
Bottom of 50-foot shaft	4.78	.76	15.71	42.5
Face of tunnel	8.56	1.40	28.94	37.3

This gold value is an important factor. The distance from Globe is stated to be 22 miles by trail and wagon road. There is a mill site in the river. The distance from the Ray copper mine is 4 miles, and to E. F. Kellner's sawmill, where sawed lumber and timber can be had, is 8 miles. Price of lumber delivered at the mine is \$17 per thousand.

DUNN MINE.

The Dunn mine, in the Chiricahua Mountains, was worked in the year 1881 by Chicago capital. It is located on the summit, or near it, at the head of the Pinery Creek, about 40 miles east of south of Willcox on the Southern Pacific Railroad, in Cochise County. Mr. E. N. Titcomb was sent out in charge of the property. He erected a smelter a mile west of the mine for smelting the ore from this mine and from other claims in the region. This smelter was taken down some years after and was set up near Tucson. The mine and others near it have of late been shipping ore to the smelters at El Paso by way of Willcox. The ore is argentiferous lead and occurs in limestone near dikes of porphyry and layers of slate.

The mine is now (1899) known as the Hill Top and is owned and worked by Mr. E. J. Hands, San Simon post-office. Shipments made by him of hand-sorted ore gave returns as follows: Lead, 73½ per cent; silver, 36½ ounces per ton. There are now two carloads out (February, 1899) ready for shipment, but the deep snow prevents. A crosscut tunnel has been run in 60 feet, exposing a body of concentrating ore the full extent of which is not yet shown. There are bunches of first-class ore in the midst of this ore of lower grade. Assays made from the croppings gave from 7 to 9 per cent of lead and from 1 to 3 ounces of silver. In the crosscut the average is from 20 to 25 per cent of lead and 6 ounces silver. Some of the best ore gave 69 per cent lead and 18 ounces silver.

GALENA QUEEN.

This claim, under the same ownership, is the extension easterly of the Hill Top. Ore is exposed on this claim in many places and apparently in the form of pipes or chimneys. But little development work has been done on this claim. The deepest pit is about 25 feet, without ore in the bottom, the vein being apparently a cleft filled in with soil, clay, and iron ore. It is only partially explored, and much ore may yet be found here and at other places in the limestone.

GREAT AMERICAN MINE, SWISSHELMS.

The elevations known as the Swisshelms form a spur from the Chiricahua Mountains, projecting westward into Sulphur Spring Valley. They are nearly west from Tombstone. The creek known as White River turns the northern end of this spur and then runs southward into Mexico. The mine is near the northern end of these mountains, a few miles south of Power's rancho on White Creek, and consists of a great outburst of quartz ramifying in many directions through limestone strata of Carboniferous age, and not far from the contact of the beds with plutonic rocks. There are many open cuts, tunnels, and shafts. A large amount of silver ore has been shipped away to the smelter, but at present the mine is not worked. It has been tested in depth by diamond drills as shown by the parts of cores left on the ground. Ore to the value of \$153,000 was extracted and shipped away from September to May, according to Col. William Herring.

MORNING STAR.

This claim, near Arivaca, has been known also as the Tennessee and as the New York, and has been worked at various dates by different parties. The last work

done was by Mr. J. W. Bogan, from whom the following particulars respecting the condition of the mine were obtained (December 21, 1896):

"The shaft is about 65 feet deep, with water in the bottom. There are drifts both ways upon the vein at a depth of 50 feet. The drift southerly is 18 to 20 feet long; the northerly drift is about 40 feet long. The ore exposed by the south drift is low grade, but the ledge is strong and well defined and is about 3 feet wide. The ledge in the bottom of the shaft is about the same width. In the north drift a kidney of ore was struck, near the water level. This ore body was about 30 feet long and 18 feet deep. It was about 3 feet wide in the widest place. From this bunch or mass of ore Mr. Bogan shipped about 8 or 10 tons, and nearly as it came out, without sorting or very little sorting. This ore yielded a little over 300 ounces in silver and some gold. The rest of the ore, not considered rich enough to ship, was worked at the Consolidated Arizona Mill, and yielded some 30 ounces per ton, and some gold. Before Mr. Bogan had this ore worked the mine was worked by Mr. John Weenis. He took out considerable ore and had it worked in the old Arivaca Mill and also shipped some. The results are not known. At the lowest part of the mine water comes in freely and it is necessary to have a pump to sink deeper. The mine had also been worked by Mexicans and prospectors at intervals for some eighteen years before Mr. Bogan worked it. It is not possible to state how much ore has been taken from the claim. Ore has been stoped out from both sides of the old shaft. There formerly was a long trench or open cut along the vein at the surface. This has since been filled in by dumping ore and waste from the shaft."

CONGLOMERATE MINE.

The Conglomerate mine, about 3 miles south of Greaterville, has been worked by John B. Anderson and his associates and has produced a considerable amount of argentiferous lead ore. According to Mr. Anderson this ore carries 75 ounces of silver to the ton and over 70 per cent of lead. The occurrence of this ore is geologically interesting as it is found in the limestone and not far from the contact plane. The large cave in the Conglomerate is only a short distance north of the mine and is supposed to be nearly in the line of the ore, but no ore in place has yet been found in the cave, though some loose masses of galena were found there and are supposed to have been taken in by some of the former occupants.

TOTAL WRECK.

The Total Wreck mine had a brief existence as one of the most promising properties ever discovered in Arizona. It was extensively "boomed" and over-estimated. A costly mill was erected and stands to-day as a monument of cupidity and error. It is south of Nail's station. In 1882 Director Burchard reported 50,000 tons of ore in sight. The 20-stamp mill was then about ready to run to turn the ore into bullion. The mine was opened to a depth of 325 feet by the incline shaft, which has a dip of 35 degrees to the south. Drifts have been extended each way. At the 105-foot level, 230 feet of drifting; at the 212-foot, 250 feet of drift. A tunnel 249 feet long had been run into the hill to intersect the vein at the 212-foot level.

RED CLOUD MINE.

The Red Cloud, in Silver district, under development in December, 1898, by H. Pomeroy Griswold, has about 75 tons of high-grade silver-lead ore on the dump and knocked down ready to transport to the smelter.

PAYMASTER.

In December, 1898, according to the Yuma Sun, Attorney Brown and Joe Werninger had 12 men at work on the Paymaster group of silver and lead claims, and ore was being taken out rapidly. A contract has been let for hauling. The nearest railroad station is Glamis, 20 miles from the mines, and the road is good.

ARGENTIFEROUS LEAD, COLORADO RIVER.

About the year 1864 the following-named claims had received considerable attention:

Pichaco.—Opened by a shaft 100 feet deep and a tunnel 100 feet long. Considerable crude ore on the surface.

Scottie.—Lead ores, opened by a shaft 50 feet deep and a tunnel 50 feet long; reported to have taken out 100 tons of ore averaging at the smelter 50 per cent of

lead and 16 ounces of silver to the ton of ore. Smelted with charcoal made from ironwood.

Salazar.—A company was formed and incorporated in California. Opened by a pit or shaft about 100 feet deep. The amount of silver-lead ore extracted was reported in the year 1863 at about 10 tons sent to San Francisco, which proved to be rich in silver and lead. Some ore was smelted at the mines.

Providencia.—In the La Paz district a lode or vein from 10 to 15 inches wide, from which some silver-lead ore had been extracted, opened by a shaft 15 feet deep. (1863.)

ELKHART GROUP.

The property of the Prescott Development Syndicate, Limited, is situated near Chloride, in Mohave County. Chloride is situated 23 miles by wagon road north-west of Kingman, a station on the Atlantic and Pacific Railway of the Santa Fe system. Kingman is 31 hours by rail from San Francisco and 16 hours from Los Angeles. A branch railway extends from the main line to and beyond the town of Chloride. The property is owned in Scotland, and is under the general management of Prof. Theodore B. Comstock, formerly of Tucson. It has recently been examined critically by Prof. George W. Maynard, of New York, from whose report the following details have been compiled.

The Elkhart Group of mines consists of the following-named claims:

Elkhart.....	feet..	600 by 1,500
Elkhart mill site.....	do.....	200 by 438
Bullion.....	do.....	600 by 1,500
Dunfermlin.....	do.....	600 by 1,500
Dunfermlin mill site.....	acres..	5
Argyle.....	feet..	600 by 1,500
Victoria.....	do.....	600 by 1,500

The chief development work is upon the Elkhart. The vein traversing porphyritic rock ranges in width generally from 2 to 5 feet. The general course of the lode is north and south. It is opened by one main shaft to a depth of 351 feet, and by four levels and several winzes. It is practically vertical.

The gangue of the vein is quartz and decomposed porphyry. The ore is a mixture of galena and pyrite, with some blende. It carries some gold and silver, but the chief value is in the lead contents. The ore as mined is not rich enough to send direct to the smelter, and is crushed and concentrated, and the concentrates are shipped to the smelter, generally to the El Paso Smelting Company.

For the concentration of the ore a jigging mill has been erected with a capacity of 100 tons of crude ore per day of 24 hours. The jigs consist of one two-compartment jig with screen of one-half inch mesh, and four compartment Harz jigs with screens of graduated size of mesh. The trailings from the upper four jigs pass to a Huntington mill, where they are ground to pass a 24-mesh screen, and are then passed over a Brown sizer to the fifth jig and the Frue vanners.

The mill has been in operation since December 24, 1897, and up to December 24, 1898, it is estimated that not more than 2,000 tons have been passed through it. The water supply is obtained from the mine and is not as large as is desirable. It is pumped up to a tank to the back of the mill from a tank at the 300-foot level, and amounts to a little over 5,000 gallons in 24 hours.

From a series of samples taken from all the levels of the mine by Prof. George W. Maynard in 1899, it appears that the ore contains from 8 per cent to 43 per cent of lead, from 0.16 ounce to 0.50 ounce of gold, and from 3 to 14 ounces of silver per ton of ore.

It is observed, as would be expected, that the gold content of the ore increases with the increase in quantity of the pyrites. In eighteen of the results by assay, where the pyritic has been above 40 per cent, the gold ranged from .19 to .52 ounce—the average being .30 ounce, valued at \$6.20. The silver also increases with an increase in the percentage of galena, the range above 50 per cent of galena, being 13 ounces up to 20 ounces.

As the pyrite alone is not valuable enough to ship it is mixed in with the lead concentrates. This mixing is rendered necessary by the high cost of freight and the smelter charges. It is the custom to mix the low-grade concentrates with those of higher grade in order to obtain a product which shall not run below 35 per cent in lead. Silica sulphur and iron are not determined at the mine. According to Dr. Comstock, the general manager of this property, the zinc contents of the ores do not exceed 10 per cent, and presumably rarely reach this figure.

The expenses of haulage from the mine to Kingman are \$4, and from Kingman to El Paso the freight is \$7, making a total of \$11 per ton from the mine to El Paso.

In the computation of smelter returns it is customary to figure as follows: (1) Compute net weight in tons of 2,000 pounds—say 39,900 pounds is 19.95 tons. (2) Estimate gold always at \$19 per ounce—say $\frac{1}{4}$ ounce is \$7.60. (3) Estimate silver at 95 per cent of New York quotation on day of release (date of settlement)—say quoted 60 cents is .37. (4) Estimate lead at 55 cents per unit on New York quotation (not exchange) of \$4.00 per cent; deduct 1 cent for each 5 cents per cent below \$4; add 1 cent for each 5 cents above \$4.00, say quoted \$3.75, 50 cents; 40 per cent, \$20. (5) Estimate all iron in excess of silica at 15 cents per unit, say of 19 per cent iron and 3 per cent silica, 16 per cent excess; 16 at 15 cents, \$2.40. Gross proceeds per ton, \$36.98. If lead contents are 55 per cent, no charge for treatment. If lead contents are above 55 per cent, some premium paid. If lead contents are below 55 per cent the treatment charge 50 cents for each 5 per cent less; thus, 50 per cent lead treatment, 50 cents ton; 45 to 49 per cent lead treatment, \$1 ton; 40 to 44 per cent lead treatment, \$1.50 ton; 35 to 39.9 per cent lead treatment, \$2 ton; 30 to 34.9 per cent lead treatment, \$2.50 ton. Below 30 per cent add 50 cents per ton for each 5 per cent less, and also add \$2 more per ton as charge for roasting.

In figuring returns the smelter does not include iron in the original gross computation, but deducts the iron bonus from the treatment charge. Sulphur is not regarded except to classify the product. If below 12 per cent the product could be regarded as oxidized.

PRIDE OF THE WEST MINING COMPANY.

In Washington camp in the new county of Santa Cruz, A. R. Willfley, owner; Emerson Gee, manager, Washington post-office. The ores contain copper, silver, and lead, and have an average value of \$30 per ton. Opened by 500 feet of shafting and 1,500 feet of tunneling. A concentrating mill of 100 tons daily capacity is now (June, 1899) building, as also a tramway to convey the ore to the mill. In the first part of the year 5,000 tons of ore were shipped, and 200,000 tons have been blocked out in the mine preparatory to mining and milling when the mill is ready. (From statement of E. Gee, manager, June, 1899.)

HILLSIDE MINE.

This property, also known as the Seven Stars Group, is in Yavapai County, about 50 miles from Garland station on the old Prescott branch of the Atlantic and Pacific Railroad and about 80 miles west of Prescott, is on the head waters of the Santa Maria River. It is now best reached from the Phoenix and Prescott Railroad. The region is elevated about 4,500 feet and salubrious, and is favorable for working at all seasons of the year. Boulder Creek has here cut its way downward through a mesa of malpais and into a region of slates, syenite, and granite standing nearly on edge. These are ancient rocks and are traversed by the metalliferous vein nearly parallel with the adjacent contact of the slates and granite. The vein is strong, and all the appearances promise permanency and depth and a very uniform mineralization with gold, silver, and lead ore of high value. At the croppings the oxidized ore contained a notable quantity of free gold and ore were mined and shipped away in quantity, the proceeds being to open up and explore other parts of the vein. In the month of July, 1888, the aggregate length of drifts and tunnels was over 2,300 feet and of shafts of over 800 feet. Much more has since been done.

In 1889 the ore-bearing ground, which had been opened continuously, measured about 2,000 feet in length, and the vein had been proved to extend for the whole length of two claims or 3,000 feet.

The property was incorporated under the laws of the State of New Jersey about the year 1892 under the title of the Seven Stars Gold Mining Company, with 600,000 shares, at \$5 par value each. A part only of these shares were sold, and a failure to acquire title to the property led to litigation and the stoppage of work. The mine has since been idle. This property will undoubtedly be a great producer as soon as the litigation now pending is ended.

The Peck Mine, of Yavapai County, was one of the most valuable silver mines ever worked in the Territory, and the mines now being worked at White Hills, Mohave County, are producing largely and profitably. The silver mines of Mohave County are very active, especially in the vicinity of Chloride, to which point a railroad has just been constructed.

This county's mineral resources—gold, silver, and copper—are now attracting great attention. Silver mining in the Territory has received a decided impetus during the year, and the products will show a large increase over last year. It is impossible to mention in detail all of the promising silver properties.

ZINC, IRON ORES, MANGANESES, TUNGSTEN.

The ores of iron are abundantly distributed in Arizona, especially the specular or hematite varieties, of which many samples are sent in in the course of the year to the Arizona School of Mines under the supposition that they represent deposits of wolframite. The specular varieties are usually fine grained and in small, shining grains or thin plates. In this form it appears to have been sought for by the aboriginal races for facial adornment as a face powder probably, for it is readily spread over the skin and produces a brilliant effect in the sunshine, as if the skin were covered with small mirrors. It is interesting to note also that this same mineral when finely ground and lenzated gives the blood-red powder known as rouge, with which some persons of the highest type of highest civilization are not unfamiliar.

Large masses of hematite in transported blocks are found in the gulches and arroyos of the western side of the Tucson Mountains. So also the abundance of heavy masses of this ore upon Bill Williams Fork of the Colorado gives evidence of the existence of extensive beds in that region. This occurrence, tending perhaps to show the existence there of the ancient Archæan rocks, was noted by me in 1865 and reported in the American Journal of Science for 1865 and 1868.

Magnetite is also found in considerable quantities in the Tucson Mountains. A mass presented to the Territorial museum by Mr. Samuel Hughes shows polarity.

The hydrous form of iron ore is common in the croppings of veins which contain sulphide of iron, and also in connection with the oxidized form of copper ores, though the copper gossans are often made up largely or wholly of the soft red hematite without water of combination. Such very red gossans mixed in with the green and blue carbonate of copper are sometimes mistaken for the red oxide of copper. Iron ores, especially if convenient to a smelter, are sought for for flux, especially if the ore contains even a trace of gold. Tests of the assay laboratory of the School of Mines, Tucson, show that many of the specular ores are slightly gold bearing.

It does not appear probable that for many years at least the iron ore deposits of Arizona can be economically utilized for the production of iron or steel. The cost of fuel and transportation is too great, and besides, the product would not find an extensive home market. We have only to consider that the enormous beds of both specular ore and magnetite of Iron County, Utah, with coal and limestone in close proximity, lie undeveloped, to conclude that the day is distant when the ores of Arizona shall be sought for to convert into iron.

The large beds of magnetite of Hanover Gulch, in New Mexico, not far from the Arizona line, being connected directly by rail with the great trunk lines, have been worked extensively for ore to be sent to Pueblo and Denver for fluxing purposes. These ores occur in limestone and are generally of high grade and purity, but some of the beds are very siliceous and contain traces of copper and zinc. The analyses of ore from two of the mines are subjoined.

	Hanover mine.	Iron Queen mine.
Iron, metallic	65.571	68.838
Silica	4.930	.850
Phosphorus .....	.016	.002
Sulphur .....	.038	.061
Titanic acid	None.	None.

ZINC.

There are no distinctively zinc mines, as such, worked within the limits of Arizona, but zinc ore in the form of sulphide (sphalerite or blende) is a frequent associate of other ores, notably of galena and iron pyrites. It also accompanies ores of copper in the Helvetia and other districts. The massive yellow copper of the Mohawk claim is closely associated with blende in a massive, granular state. At the San Xavier mine it forms an essential part of the bulk of the ore and similarly at other mines in the southern part of the Territory. At the Silver King

mine, Pinal County blende of a beautifully light sea-green color was in close association with the native silver and similarly at the Tiger mine, Yavapai.

MANGANESE.

Several localities of manganese ore have been brought to notice during the year through samples sent to the School of Mines for determination. It is not yet ascertained whether at any of these places the mineral occurs in sufficient quantity or under conditions favorable for commercial utilization. The distance from any market is also so great as to prevent profitable exploitation. Manganese ore can, however, be used as a flux for other ores, notably in place of iron ore in smelting lead.

A manganiferous limestone occurs near Tombstone. It appears by its decomposition to have given rise to deposits of oxide of manganese which are silver bearing. These ores have yielded not less than 750,000 ounces of silver. The limestone belt in which these ores occur has an easterly and westerly trend, is about 1,680 feet wide and rests on granite on the north, the plane of contact being nearly vertical. See paper by Charles W. Goodale on the occurrence and treatment of the argentiferous manganese ores of Tombstone district of Arizona. (Trans. Amer. Int., XVII, p. 767.)

The ores are best developed upon the claims known as the Lucky Can, Luck-sine, Knoxville, and Wedge. They occur in chimneys or pipe-like deposits, which dip easterly at an angle of 40 to 50 degrees. Some of these have been developed to a depth of 400 feet. The milling ores contained from 41 to 74 per cent of sesquioxide of manganese. The smelting ore contained nearly 45 per cent of manganese (calculated as metal).

There was some question as to the origin of the manganese oxide. It was my opinion, and still is, that the manganiferous limestone is the source. Some analyses showed less than 1 per cent of manganese in the limestone, but one analysis of the limestone from the west end of the Knoxville claim, made by F. C. Earle, gave 2.85 per cent of carbonate of manganese, a quantity quite sufficient to account for the origin of the deposits.

There is another belt of limestone in the eastern part of Tombstone district, where manganiferous silver ores are found, but not to the same extent or richness in manganese as in the Knoxville belt.

Specimens of massive manganite in rolled, smooth, water-worn masses, compact, dense, and nonmagnetic, occur in the Kenilla Mountains, Pima County. Specimens were sent to the School of Mines for determination by F. Schumacker, Fort Huachuca.

WOLFRAMITE.

The discovery of veins containing the comparatively rare mineral known as wolframite within the limits of the Territory of Arizona, made and reported in 1896 from the Arizona School of Mines, is as follows:

“Deposits of wolframite, a mineral containing tungsten, have been made known as existing in the Arivaca mining district, and if the quantity is sufficient this mineral may add to the useful mineral products of the Territory.”

A similar notice appeared in the Engineering and Mining Journal, Vol. LXV, page 608. These deposits consisted of the tungstate of iron and manganese diffused in crystalline grains and bunches in the quartz of gold-bearing veins at Guijas upon properties located by Bent and Sampson as gold-bearing veins.

In May, 1898, the Territorial geologist also reported the discovery of other and more extensive deposits in quartz veins traversing the granitic rocks of the Dragoon Mountains at Russellville, about 6 miles north of Dragoon Summit, on the Southern Pacific Railroad. At both of these localities the mineral occurs in workable quantities sufficient to form the basis of the industry of tungsten mining in the Territory. But the quantity is by no means unlimited, and there is no danger of the supply exceeding the demand, at least not for some time, if the demand continues at the present rate.

The Russellville ores consist for the most part of clean tungstate of manganese with but little or no iron. To this variety of wolframite the name hubnerite has been given. It is equally as valuable as the iron variety and contains as much tungstic acid.

The Russellville veins have been purchased in part by Messrs. Stein & Buericke, of Philadelphia, and in part by the Chrome Steel Company, of Brooklyn, N. Y. Mr. Asa Walker and associates also hold and have worked claims and shipped ores, selected by hand from the outcropping masses and the loose “float” specimens on the croppings.

The two firms above mentioned have made considerable shipments of ore obtained in this way, but the operation was slow, tedious, and expensive and also wasteful, as much of the lower grade material was necessarily left at the mines, being too poor to bear the cost of shipment to New York or Philadelphia. Such material needed concentrating machinery for the separation of the quartz. Messrs. Stein & Buericke therefore sought the aid of the Arizona School of Mines and sent several carloads of the cyanide ore to be experimented with to determine the best form of mill, or the best forms of crushing and concentrating machinery for working this peculiar ore. The experiments, as anticipated, were entirely successful. By the preliminary course, crushing and jigging, the bulk of the coarse-grained hubnerite was separated in the first compartment of the top-discharge jigs, while the fines were best secured in the bottom-discharge jigs of the Hartz pattern, a thick bedding of clean, coarse ore being used on the beds. Both sizes of the product ran very high in tungstic acid—about 70 per cent; while the second grade from the second and third top discharge averaged about 50 per cent. The coarse tailings contain less than 1 per cent. There was, of course, a considerable amount of "chats" quartz, containing some attached ore, which requires recrushing to liberate the wolframite and a subsequent concentration on some form of concentrator, such as the Frue vanner or Wilfley table. The deportment of this wolframite ore under concentration processes is very much like that of tin ore and the methods and appliances in use in Cornwall for cleaning or "duning" tin are applicable in this case. So far, however, the wolframite not being associated with any sulphides or arsenide calcining.

It is known, however, that in one or two wolframite-bearing veins there are portions, in the form of chutes or chimneys where iron pyrites occur accompanied by gold. This is true particularly of the Arivaca veins, where they were originally located as gold-bearing lodes. In such veins the problem is presented of securing the free gold from the surface or oxidized ores and collecting the finely crushed wolframite as a second product, and at one operation. When the lower levels on the veins are reached and the auriferous pyrite presents itself in its original condition, the separation will be more difficult and expensive. Here, however, we may avail of magnetic separation. Samples of the hubnerite sent from the Arizona School of Mines to the Wetherill Separating Company, of New York, have been tested with remarkable results. Under the intense magnetic energy of the Wetherill magnet the tungstate of manganese responds like the tungstate of iron, and may be lifted from pyritic mixtures, for it is found that iron pyrites is comparatively inert and magnetically not affected by magnetism. From the trials so far made it would appear that magnetic separation may be resorted to successfully not only for the mixed ores, but with ores of tungstate in a quartz gangue, especially in localities where water for jig separation is scarce or not obtainable. A good field is also presented in such cases for pneumatic jigs.

In addition to the associated minerals already mentioned in this article and in the communication to the American Institute of Mining Engineers, it should be stated that deeper work on the veins of the Russellville locality has shown increasing amounts of the lime tungstate—scheelite—which is so closely mingled with the quartz gangue of nearly the same color as to escape casual observation.

When the ore was first jigged the constant appearance of white or cream-colored fragments in the midst of the clean black wolframite discharging from the first compartment excited surprise, the white grains being of equal weight with the wolframite and therefore not quartz. On testing the heavy white grains they were found to be tungstate of lime of equal value with the wolframite.

Another mineral associated with the wolframite was found below the surface croppings. This is fluorite, or fluor spar, and in one of the veins is comparatively abundant.

The clean wolframite separated from the quartz by the jigs was dried and sacked as fast as produced, and was shipped by Stein & Buericke to their works in or near Philadelphia, where it is stated it was smelted to a high-grade tungsten metal and was sold to consumers in the United States and abroad.

In addition to the shipments of high-grade concentrates from the mill, the owners of claims at the Dragoon localities have been able to cull many tons of high-grade clean ore from the surface croppings. Masses weighing from 10 to 100 pounds or more have been found with but little attached quartz. This source of clean ore is now practically exhausted, though in mining there is a small amount of massive ore broken out which can be separated by hand.

In regard to prospective quantity of ore and commercial supply, it must be understood that mining, especially upon small veins, is slow and costly. The wolframite occurs in detached bunches, or pockets, here and there, but not in

continuous sheets, and in mining it becomes necessary to drift for considerable distances in the barren portions of the vein and to move much worthless material in order to reach the ore-bearing portions. Thus the costs of mining per ton of clean ore are large and will be an increasing factor as depth is attained. The supply of wolframite will thus necessarily be more restricted when it depends upon deeper mining.

The market price of wolframite appears to be very variable, owing probably to the fact that the demand is variable, as well as the supply. At the time of the discovery at Guijas, Arivaca, only \$80 per ton was offered for clean, 70 per cent ore. This figure was not encouraging to those who had to mine, sort out, sack, and ship such high-grade ore. But the offerings at the mines from various sources rapidly advanced to \$120, \$200, and even as high as \$400 per ton for small lots. The demand seemed to be suddenly stimulated.

Mention should be made of a locality at Separ, N. Mex., from which several shipments were made in 1895 and 1896. The ore was the manganiferous variety, of good quality, and was sold for \$80 per ton. The locality is regarded as exhausted.

The wolframite or hubnerite, to be commercially available, should be quite free from sulphur or arsenic or any excess of quartz and should contain at least 60 per cent of tungstic acid. The pure mineral contains over 70 per cent. Foreign quotations of value per ton are for long tons of 2,240 pounds, net.

Tungsten is a word of Swedish origin, meaning heavy stone; from tung, heavy, and sten, a stone. It appears to have been applied first to the mineral now called scheelite, named for the distinguished chemist, Scheele.

EFFECTS OF TUNGSTEN ON STEEL.

The useful effect of the addition of small quantities of tungsten to steel has long been known. The famous Damascus sword blades have been found to contain from 0.05 to 0.10 per cent of tungsten, and it has been used to produce damasked steel. According to Crookes & Rohrig, Jacob first produced tungsten steel experimentally on a large scale in 1855. The steel made by him showed an exceedingly fine, conchoidal, silk-like fracture. It combined great hardness and density and was superior in tenacity and weldability to all others.

The properties of tungsten steel are exhaustively discussed by Howe in his celebrated monograph. He gives not only a general view of the literature of the subject and an account of the results obtained by various investigators, but a statement of his own original experiments with this alloy.

The alloy of the tungsten and iron was first made by the brothers D'Elhuyar in 1873, and later by Berthier and others. Bernouilli, at the Royal Foundry of Berlin, made tungsten steel by melting tungstic acid (WO_3) with turnings of gray cast iron. The carbon in the cast iron in the form of graphite he found would reduce the tungstic anhydride to the metallic state, but the combined carbon alone did not. The iron alloy may be made by heating wolframite or scheelite with iron or iron oxide in a brasqued crucible. It required a long continued and high heat. It has even been made in a blast furnace. At the last International Exhibition at Paris P. E. Martin reported having made ferro-tungsten of 28 per cent in the blast furnace. The tungsten renders the fusion more difficult. It raises the melting point of iron. Tungsten alone is difficult of fusion. It is considered infusible under ordinary conditions. With iron it unites apparently in all proportions up to 80 per cent, but commercially alloys containing more than 40 per cent of tungsten are rarely made. Ferro-tungsten has been reported for sale in the European markets containing from 20 to 50 per cent of tungsten and from 1.5 to 6 per cent of manganese. The 50 per cent alloy is questioned by Professor Howe.

A table analysis of ferro-tungsten given by Howe shows in six different samples from 24.25 per cent to 77.8 per cent of tungsten. The amount of tungsten in tungsten steel is much less, ranging in thirteen samples or analyses from 1.94 per cent to 11.03 per cent, this last being from a steel made by Schneider. An analysis of Mushet's special steel showed 9.99 per cent, and another 7.81 per cent. In the Crescent hardened steel of Pittsburg 6.73 per cent was found.

The useful effect of tungsten upon steel is not only to render it harder, but the steel becomes less liable to lose its tempered hardness under the heating to which tools, especially those used in machines, are liable. The tungsten steels are usually hard enough to scratch quartz. Howe could not detect any increase of hardness or quenching in Mushet's steel. Mushet's steel, the Crescent hardened, and the Imperial steels are used without hardening by quenching, which is regarded as liable to produce cracks. Whether quenched or not their hardness is sufficient to scratch glass, but not quartz. As heat does not draw the hardness, such steels may be used to great advantage for machine tools. Thurston says he has found both

chrome and tungsten steels far more desirable than the carbon steels, with which they compete. On the other hand, the difficulties and peculiarities noted in working them are obstacles which retard their introduction. When the carbon steel can not be made to stand, these peculiar steels are the only metals which can be used for cutting tools. Their great wearing power gives them especial value where gauges or standard sizes of tools are especially desired to retain standard size as long as possible while in use.¹

Tools made of ordinary tungsten steel according to Thurston may be forged into shape at a red heat, but the harder grades can not be cut with a file and can not be tempered, and after being forged into shape roughly must be ground into the exact form when cool.

Howe states that steel may contain a much larger proportion of tungsten (at least 10 per cent) than of carbon without losing its power of being forged.

Ores of tungsten when occurring together with the sulphides such as pyrites, copper pyrites, and with the arsenides are unsuitable for making ferro-tungsten without careful purification by calcining or roasting. Even after these processes have been carefully completed some noxious residues may remain, enough to impair the quality of steel made from the product. An ore of tungsten absolutely free from such noxious ingredients is therefore of great industrial importance and should be in great demand.

The clean, pure tungstate of manganese of Arizona, without sulphur or arsenic or other noxious elements, would appear to promise unusually good results in the production of a tungsten-manganese steel, combining the qualities of extreme hardness from the tungsten and toughness from the manganese.

The use of tungsten steel is increasing. This was noted by Professor Howe at the late international exhibition. At least six exhibitors displayed tungsten steel. It is recommended by most of them for cutting such hard metals as hardened steel and chilled cast iron. The St. Chamond Company recommends it for springs, claiming that its carrying power for a given size is about one-third greater than that of the best carbon spring steel.

TUNGSTEN AND NICKEL ALLOY.

The magnetism of nickel and tungsten alloys had been studied by John Trowbridge and Samuel Sheldon. (Proceedings of the American Academy of Arts and Sciences, reprinted in the Amer. Jour. Sci. XXXVIII, p. 462.) The investigation was instigated by Mr. Wharton, proprietor of the American Nickel Works. The fact that different kinds of steel alloyed in small portions with tungsten or wolframite and magnetized to saturation increase in specific magnetism, had long been known, and it was desired to ascertain whether similar effects would result from the combination in alloy of tungsten and nickel.

The alloys prepared for the experiments were in two groups. The first consisted of three bars of the same shape, one being of pure nickel, and the other two of nickel containing respectively 3 and 4 per cent of tungsten in alloy. These bars were rolled from cast ingots, toughened by the addition of magnetism after Fleitman's method. These were hot when rolled. The bar of pure nickel was placed into regular shape; but the bars of tungsten alloy were too brittle for this. There was also a bar with 8 per cent of tungsten which was ground into shape.

The second group consisted of simple cast bars without the addition of magnetism. They were of pure nickel and alloy, with 1, 2, 3, and 6 per cent of tungsten. These were all extremely hard and brittle. The results obtained "indicate that tungsten greatly increases the magnetic moment of nickel if the alloy be forged and rolled, but on the other hand has but small influence if the bars are simply cast. And it was also found that changes in the amount of tungsten did not appear to cause corresponding changes in the magnetic properties. The specific magnetism of all the bars were found to be small when compared with good steel magnets.

The experimenters conclude their article with the following statement: "If forged nickel and tungsten can be made to maintain a specific magnetism of 10, it will form a useful addition to the resources of physical laboration. From the high polish from which it is susceptible and its freedom from damaging atmospheric influences, it will be most highly suited for the manipulation of mirror magnets when magnetic damping is to be employed."

STEIN AND BUEKICKE GROUP.

This group of tungsten-bearing veins consists of nineteen claims—the Blue Bird, Black Beauty, Dividend, Cracker Jack, Hidden Treasure, Surprise, Last

¹ A treatise on Iron and Steel, fourth edition, p. 270.

Chance, Mayflower, Wolfram, Queen, Gray Warrior, Oregon, Red Bird, Juniper, Aetna, Yankee Pride, King, Little Jessie, Ada—all located in the early part of the year 1898 near Russellville, 6 or 7 miles north of Dragoon Station, on the Southern Pacific Railroad, in Cochise mining district, Cochise County, with the post-office address at Dragoon.

These claims have in whole or in part been acquired by the firm of Messrs. Stein & Buericke, limited, of Philadelphia, which has expended \$3,000 or \$4,000 in pits, shafts, and tunnels. They have also shipped away several carload lots of hand-selected hubnerite of high grade, besides 100 tons or more for concentration at the experimental mill of the Arizona School of Mines at the University of Tucson. The ore, as elsewhere described, consists of hubnerite and scheelite in quartz.

OTHER LOCALITIES OF TUNGSTEN.

The importance and success of tungsten developments at the Dragoons and at Guijas, have stimulated exploration and search for other places, and several new localities are reported, and samples of good quality have been examined at the School of Mines, among them ore of massive scheelites, but as but little is yet known regarding the quantity and accessibility, descriptions must be deferred. Great quantities of iron are found in Maricopa County, west of Castle Creek.

SODA, SALT, SULPHUR, COAL, ETC.

Large deposits of sulphate of soda, in association with halite (rock salt), occur in the Verde Valley, a few miles south of old Camp Verde. They form large banks and hillocks, slightly discolored by soil and dust. It is the mineral known to mineralogists as "thenardite" and to druggists as "glauber salts." It is a powerful purgative, and has this effect in a marked degree upon the cattle which resort to it. The mineral is quarried out in large blocks and is sold to rancheros and stockmen for their cattle ranges. The salt occurs in crystalline blocks, very clear and pure, in the midst of the thenardite, and is not easily separated from it. Analysis shows that this mineral contains about 53 per cent of sulphuric acid and 43 per cent of soda. The mineral called "glauberite" occurs at this locality, and is sometimes altered to calcite. The crystals are from half an inch to 2 inches or more in length, as shown by me in a paper in the American Journal of Science (1890, pp. 39, 43), which follows:

THENARDITE, MIRABILITE, GLAUBERITE, HALITE, AND ASSOCIATES OF THE VERDE VALLEY, ARIZONA.

The deposits of sulphate of soda of the valley of the Verde River, near the military post of Camp Verde, have long been known and extensively quarried by the rancheros of the region as a substitute for salt for cattle and horses. The occurrence of thenardite in Arizona was first made known to science by the late Prof. B. Silliman in 1881, but he had not visited the locality and it has not been described. A recent visit to the place and a somewhat hurried and superficial examination enabled me, however, to collect and identify other allied species in association with the thenardite and a peculiar pseudomorph of carbonate of lime after glauberite.

The deposits of the thenardite and the associated minerals are of considerable magnitude, covering several acres in extent, and reach a thickness of some 50 or 60 feet or more. They appear as a series of rounded hills with sides covered with a snow-white efflorescence and a greenish-colored and yellow clay at the bottom and top, partially covering the saline beds from view.

These beds are doubtless remnants of a much more extended deposit which occupied a local lake-like depression or basin, probably at the close of the great volcanic era, during which most of the mountain valleys of central Arizona were filled up by sediment and then overlaid by successive streams of lava. Sedimentary beds of volcanic origin remain throughout the Verde Valley and its chief tributaries, and in the region of Camp Verde are deeply eroded, but rest on the uneven floor of ancient pre-Silurian slates standing on edge. High above the deposits of the valley vertical cliffs of hard lava mark the edges of extended mesas of malpais, under which all the other formations are hidden and protected. But the excavations in the banks of the sulphate of soda are insignificant in comparison with the magnitude of the beds, and have failed to show conclusively any bottom or top or to reveal the true relations of the beds to the surrounding formations. Whether or not they are members of the volcanic series of a later and more local origin is yet uncertain.

THENARDITE.

This salt constitutes the bulk of the deposits. It is a coarsely crystalline mass, so compact and firm that it can be broken out only by drilling and blasting powder. It varies in its purity. Some portions are more or less contaminated with a greenish-colored clay, but it is obtained also in large masses, nearly colorless and transparent, with a slight yellowish tint, but seldom showing crystalline forms.

MIRABILITE.

The hydrous sulphate of soda occurs in close association with the thenardite and appears to penetrate its mass in veins, but may prove to be an overlying bed. It is this species which, by its rapid efflorescence when exposed to the air, covers the whole deposit with a white powder and a thick crust through which the quarrymen must cut before they reach the solid banks of the anhydrous sulphate.

HALITE.

Rock salt, in beautifully transparent masses, is sparingly disseminated in portions of the great beds. These crystalline masses, so far as observed, do not exceed an inch or two in thickness, and no evidence of the existence of any separate workable beds could be seen. It is irregularly disseminated in the sulphate. Some masses exhibit beautiful blue tints of color, like those seen in the salt of the Tyrol and of Strassfurt. Good fragments for optical and thermal experiments could be obtained here.

GLAUBERITE.

This anhydrous sulphate of lime and soda is an interesting associate of the other species. It occurs chiefly near what appears to be the base of the deposits, in a compact green clay. It is in clear, transparent, colorless crystals, generally in thin rhombs, lozenge-shaped, with the plane angles of 80 and 100 degrees, and from half an inch to an inch or more broad and one-eighth to one-fourth of an inch in thickness. The prismatic planes (11) are generally nearly obliterated, or are absent, through the great development of the hemi-octahedral planes (7) replacing the obtuse terminal edges. The terminal plane (o), is chiefly developed, and this, with the broad planes replacing the obtuse edges, gives to some of the crystals the appearance of rhombohedrons of the minus series. The general habit of the crystals is similar to those from Westergeln, near Strassfurt, described by Zepharovitch (Sitzungber. Akad. Wien, Vol. LXIX, 1874), and the predominating pyramid on the acute edges has also been noted. There is evidence that the crystals vary greatly in size and in their habit in different parts of the deposits. They occur also in the midst of portions of the solid thenardite as inclusions, and in one instance a small crystal was found in the midst of a transparent mass of halite. Close inspection of the transparent tabular crystals from the green clay reveals the presence of crystalline cavities with fluid inclusions, made evident by the movement of small bubbles. When heated the decrepitation is violent.

CARBONATE OF LIME PSEUDOMORPHS.

Where the lower bed, containing the bulk of the glauberite, crops out at the surface and has become oxidized and dried, the glauberite disappears and is replaced by carbonate of lime in an amorphous condition, but having the exact form of the glauberite crystals whose matrix they have filled. These pseudomorphs are firm, compact, and dense, but are without cleavage or interior crystalline structure. Color, cream yellow. They weather out in great numbers, and show that the glauberite must occur in a great variety of sizes and forms of aggregation, in some places in rosettes and in others in crystals 2 or 3 inches long.

BOURNONITE IN ARIZONA.

Bournonite occurs sparingly at the Boggs mine, in the Big Bug district, Yavapai County, Ariz., associated with pyrite, zinc blende, galenite, and copper pyrites. The crystals are brilliant and characteristic, with interesting modifications not yet studied and compared. This is believed to be the first discovery of this species in the United States. I am indebted to Fred E. Murray, esq., superintendent of the mine, for specimens.

NATIVE SODIUM CARBONATE.

Extensive deposits of a native sodium carbonate in northern Sonora, near to the Arizona line, are known to exist and are under exploration by citizens of Tucson. In the month of February, 1898, an investigation of the nature of this material

statement of the results was printed in the Engineering and Mining Journal of was completed by me in the laboratory of the Arizona School of Mines, and a brief New York, February 12, 1898. A résumé of this article is appended:

“The Arizona School of Mines in 1898 completed an investigation of the ‘trona,’ or crude carbonate of soda, brought in from a deposit near the head of the Gulf of California. It is known as the Santa Helena soda deposit, and has been taken up under the mining laws of Mexico by Messrs Andres and Joseph Rebeil, of Tucson, Ariz.

“The location is the northernmost portion of the State of Sonora, Mexico, in the mining district of Altar, about 2½ miles from Adair Bay, and directly upon the shore of the Gulf. It is thus not far from the international boundary line, and is most directly accessible by water from Yuma or the Colorado, or overland from the Gila Bend station on the Southern Pacific Railroad. The shores of the eastern side of the Gulf at the place are generally low and shelving, and broad areas are left bare at low tide. At this particular point it is claimed that the water is deep enough for vessels of moderate draft to lie safely at anchor, where they can take in cargoes of soda from lighters.

“The soda is found in the central portion of a basin-shaped depression, described as a dry lake about 1 mile in length and 1 mile in breadth. The soda is spread out in a white sheet or layer over an area of some 60 acres, and resembles a mass of snow and ice or the surface of a frozen lake. The few tests that have been made by digging and boring down into this deposit show that it has a thickness varying from 1 to 3 feet, partly overlaid by a stratum of sandy earth some 3 inches thick. The lowest portions of the soda bed are saturated with water, or rather with a solution of soda in water, and this seems to underlie the bed for a depth of 2 feet. The solution is so strong that when exposed to the air and sun soda rapidly crystallizes out and forms in layers to a depth of nearly 3 inches in less than thirty days. The valleys appear to have several permanent springs of water of small volume, but in the very center of the deposit there is a spring or water hole, where potable water can be had in quantity. No investigation has yet been made of this spring water, which may on analysis be found to contain enough soda in solution to give origin to the great deposit by long-continued evaporation. The existence of water fit to drink is a most important advantage in that arid region.

“The purity of the sodium carbonate of this deposit is remarkable. It is brought in from there in large masses almost free from sediment or earthy impurities. It may be obtained in clean crystals and crusts by solar evaporation of the concentrated or saturated water from the bottom of the bed, but in digging in a large way there appears to be a notable mixture of insoluble clay and very fine sand, an earthy impurity which probably has been blown in upon the soda lake by the winds from the surrounding hills of Colorado River silt, as shown by the analysis of the average sample :

Composition of the average sample.

	Per cent.
Sand, silt, etc., insoluble in water.....	13.00
Iron oxide and alumina.....	2.80
Lime.....	1.14
Salt.....	4.70
Sulphate of soda.....	4.70
Carbonate of soda.....	75.86
<hr/>	
Total.....	100.00

“One avoirdupois pound of this sample leached with cold water gave 75 per cent of clean white sodium carbonate, including the small quantity of other soluble salts. Hot water gives a larger product. There appears to be an increase of weight by absorption of water. The weight and bulk of the product by lixiviation is much reduced by ignition, thus driving off a considerable amount of water. It would appear to be desirable to dissolve the trona and to filter and decant to get rid of the insoluble impurities, but this would perhaps remove the product from the free list and subject it to a considerable import duty in the ports of the United States.

“Another sample of selected crystals was analyzed by Prof. H. Forbes and Mr. M. H. Walker, jr., in the chemical laboratory of the agricultural experiment station of the university. They found the specific gravity to be 2.33. The qualitative examination showed, in addition to the carbonate of soda, a trace of chlorine and sulphates, no sulphides and no lime, barium, or silica, no potassium or ammonia. Some of the sodium was in the form of bicarbonate. The equivalent of 71.96 per cent of Na₂CO₃ was found by titration with standard HSO.

"The owners estimate that this deposit will yield 1,000 pounds of soda to each square yard of area, and that the soda can be taken out and put on shipboard for about \$2 per ton. In one test it was found that one man could throw up 4 tons of the soda in one day.

"The height of the deposit above mean tide is about 27 feet. The plan is to construct a tramway to the water of an inlet navigable for lighters drawing less than 6 feet of water, by which the mineral can be transferred in bulk to a vessel lying in deep water.

"It is proposed to ship this trona to San Francisco, where an important use for it will be found in making borax from the crude tincal or boracic acid, of Nevada. It has been suggested, also, that the borate of lime (colemanite) of Nevada might be brought to Yuma, and there meet the carbonate of soda and produce borax.

"There is a scarcity of fuel at this locality, but for purposes of evaporation the ardent rays of the sun and the dry air are satisfactory."

GYPSUM.

Arizona has enormous deposits of gypsum both in the northern and in the southern counties. The transparent variety in clear sheets is known to the old Spanish residents as "yeso," and has been used in place of glass to admit light, while excluding air in the walls of adobe houses. In the fibrous form, with a satin-like luster, this mineral occurs sparingly, and is known as satin spar. But the common and most abundant form or occurrence is the massive and amorphous variety, the massive uncrystallized gypsum, useful as a fertilizing material and for the production of the quick-setting cement known as a plaster of paris. The native massive gypsum as quarried out from its beds contains 20 per cent of water of combination, which can be driven off by heat, leaving a white powder which has the property of rapidly taking up and combining with water again so as to set and harden.

At present the uses of gypsum in Arizona are few. It will hardly pay to transport and grind it for a fertilizer, though there is little doubt that it might be used to advantage upon some of the lands. Mr. Monier, the enterprising builder, of Tucson, has made use of the gypsum from the Sierritas Mountains to prepare plaster of paris in quantity at Tucson. This plaster of paris was used by him in finishing the walls of the interior of the new cathedral.

The occurrence of extensive stratified deposits of gypsum in the Santa Rita Mountains, about 25 miles from Tucson, was reported in the report for 1896. The deposits have not yet been worked.

SULPHUR.

The demand for sulphur having notably increased during the war with Spain, there were many inquiries for sources of sulphur in Arizona. The projected establishment also of works for the manufacture of sulphuric acid in Los Angeles has directed attention to any deposits of free burning iron pyrites of large extent, and near enough to rail or water transportation to avoid any large outlay for its delivery at the works.

Among other sources the banks of sulphur reported to exist at the head of the Gulf of California, and more accessible from Yuma than from any other point, have received special attention. It is stated that these deposits form a series of low hills of various colors, blue, red, green, and black, making the hills conspicuous objects for miles. They rise from the desert near the south boundary of the eastern end of San Diego County, Cal., about 20 miles above the mouth of the Colorado River.

COAL IN ARIZONA.

Investigations which I have made show that the rocks of the true Carboniferous period have a wide extension and distribution over the Territory, even as far west as Tucson. They are largely developed in the Chiricahua Mountains, and are there accompanied by coal measures, with thick beds of black carbonaceous shale and impure graphitic coal, showing indisputably the former extension of the ancient carboniferous flora far westward of the limits usually assigned to it. Although efforts have been made to find in these carbonaceous graphitic beds some seams of workable coal, suitable for fuel, they have not been rewarded with success, and the question whether good coal can be had from these coal measures is still unanswered. There have been small quantities taken out as samples which burn very well and could be claimed as hard anthracite, but most of the coaly mass carries a large amount of ash and burns with difficulty,

like the graphitic anthracite of Rhode Island, which it resembles. One bed of this material, about 12 feet, between the roof and floor, is a brilliant looking anthracite mass of graphitic shale. It certainly marks the horizon of a basin of ancient carboniferous vegetation of large extent. Similar croppings are reported for miles north and south. The beds are not horizontal, but are strongly uplifted and plicated.

Local intrusions and disturbances may also account for the extreme degree of metamorphism and the conversion of the former coal shale into a graphitic anthracite.

These carbonaceous beds are believed to be on the line of the southern extension of the San Carlos coal fields, so called. It is reported that southward, in Mexico, a fair coal is secured from the southern extension of the same mountain range and that it is used by smiths. Notwithstanding the fact the outcrops so far opened have not produced coal, I consider it highly probable that at some place upon this coal horizon a good seam or basin may be found. The discovery of good mineral coal is of such importance to the people of the Territory that special explorations of the coal formations should be undertaken.

If reports are true, there are outcrops of good coal north of the Gila, upon the southern part of the San Carlos Indian Reservation, but the quantity and quality are both doubtful.

The existence of true coal measures in the Chiricahuas prepares me to lend credence to these reports. I certainly advise an exploration of this region.

The foregoing from my report of 1896 serves to introduce a copy of a more formal paper on the subject which I contributed to the pages of the American Geologist in June, 1898.

ANTHRACITE COAL IN ARIZONA.

Beds of graphitic anthracite coal occur in the mountains of the southeastern portion of Arizona. They crop out in considerable magnitude in the Chiricahua range of mountains near the bold summit, known as Cochises Head, south of the old camp Bowie and about 30 miles from the Southern Pacific Railroad at Teviston. The chief exposures are near Bridger's camp, at the head of Wood Creek. The beds are there in close association with shales, sandstones, limestones, and massive conglomerates, in regular strata, resting upon or against a crystalline gneissic and granitic foundation. The stratified formations are believed to be Carboniferous in age, and the coal is presumably a member of the series, but its exact relations stratigraphically have yet to be satisfactorily shown. The sequence of strata appears to be conglomerate—limestone, sandstone (quartzite), black siliceous shale coal, shales, plutonic dike, gneiss. The stratified formation attains a thickness of 2,000 feet or more. The limestones are largely developed and are generally blue and but little changed. They contain encrinities and here and there brachiopod shells, apparently *productus*. Other portions of the rock have been altered to white subcrystalline beds. There is an abundance of flint nodules and layers of flint. The strata dip northward at various angles, but generally less than 45°.

The coal beds crop out in a ravine. They have not been much explored, and some of the tunnels in which it is claimed that three beds were cut have caved in so as not to be accessible, but the great heaps of slacked coal and black dust at the mouths of such tunnels show that the material was found in quantity. The only accessible opening showed a thickness of glossy black graphitic anthracite over 12 feet in thickness. It reminds one of the hard graphitic anthracite of Rhode Island, but, except in selected specimens, it appears to carry more ash than the Rhode Island samples and to be even less available for fuel. It is hard to ignite. The percentage of ash is large, as will be seen from the following tabulated results of analysis made by me in the laboratory of the Arizona School of Mines:

Analysis of Arizona anthracite.

No.	Specific gravity.	Ash.	Combustible and water.	Remarks.
1	1.49	13.20	86.80	Selected fragments.
2	1.73-1.80	30.45	69.55	
3	1.76	27.40	72.60	Slaty. Do.
4	1.85	30	70	
5		22.04	77.96	Black powder.

No. 1 had red ashes; No. 2, white ash; No. 3, white ash tinged with red; No. 5, red ash. All the beds afford glossy, black, lustrous and shining masses, but generally in curved layers, and having a graphitic luster, except Nos. 1 and 5. No. 5 is taken out of the mine in a fine black powder.

It can not be claimed that any of this material has much value as a fuel. It may be found useful in some metallurgical operations as a deoxidizing agent, or for lining (brasquing) crucibles and furnaces.

The presence of such large beds of carbonaceous material is significant of a great area of Paleozoic vegetation and of shallow seas and coal-forming basis analogous to those of the Coal Measures. If, as I confidently expect, further investigations shall show that these graphitic anthracites are metamorphosed coal beds of Carboniferous age, our present ideas of the westward extension of the flora of that period will require great modification.

There are many evidences in southern Arizona of shallow seas in Paleozoic time and of great tidal currents and of extensive shore lines. Coarse conglomerates of well-rounded pebbles of Paleozoic age abound in the Santa Ritas, in the Santa Catalinas, in the Babioquarari, and other mountain ranges, and in the low hills of Arivaca, south of Tucson, and near the boundary of Mexico.

Quartzites—probably Cambrian—are a striking feature of some of the mountain ranges between Tucson and the Gulf coast of Sonora.

THE COAL FIELDS OF NORTHEASTERN ARIZONA.

In northeastern Arizona, in Coconino County, there is an extensive coal field, the value of which has been demonstrated by careful explorations and tests by competent engineers during the present year. As at present determined, the area of these fields is fully 400 square miles. The coal is reported to be of a superior quality for steaming purposes, the tests showing that it burns freely without a heavy draft, and that it does not leave an excessive amount of ash—yielding better results in that respect than most soft coals, and sulphur being almost entirely absent. To give the field transportation facilities it would be necessary to construct a railroad between them and the Santa Fe Pacific Railway, a distance of some 70 miles. There appears to be no reason why these coal fields should not become the chief source of fuel supply to Arizona, at cheaper prices than those now prevailing. It is reported by the engineers who conducted the investigation of the district, that large deposits of alum and coal are found in the same locality.

PETROLEUM.

There are no springs or outflows of petroleum yet known to exist in Arizona. In December, 1896, the discovery of a variety of petroleum was announced at St. Davids, in Cochise County. While boring for water at this place a dark substance, having about the consistency of molasses, was found at a depth of 290 feet. This substance, supposedly a variety of rock, oil, or petroleum, was yellowish in color, and it is reported was found to be combustible, but samples have not been received at the School of Mines and nothing more definite than the above can be stated at this time, and it seems that no further investigations have been made.

Some parties, including Mr. McKay, of Tucson, who were prospecting for coal in the dark-colored shales (Coal Measures) of the Santa Ritas, east of Rosemont, took out masses of slaty rock which had the odor of petroleum. Samples submitted to me gave evidence of a very small quantity present, for oil could be distilled from it in a tube.

BUILDING AND ORNAMENTAL STONES.

The Territory of Arizona is well supplied with building materials of all descriptions in their crude or unworked state. Building stones are not only abundant, but are widely and generally distributed. Each mountain range is capable of contributing good stone for construction in some form. Granite, gneiss, and slates abound. So, also, limestones, sandstones, and materials for making mortars and cements. Marbles of various shades of color, white statuary marble to the black and veined varieties may be quarried in many places. There are several localities of onyx and marble of beautiful colors and grain.

Gypsum is abundant, and in many localities there are fine clays for the manufacture of brick and tile. Adobe clays suitable for the manufacture of adobe must not be omitted in this enumeration, for in the dry climate of the region,

adobes still maintain, as in the past, an important place in the list of materials for cheap construction, especially of dwelling houses.

The sandstones of Flagstaff and the tufas of Tucson have been utilized. The Flagstaff and other quarries on the line of the Atlantic and Pacific Railroad have supplied red sandstone and freestone of excellent quality and grain for important buildings in Phoenix and elsewhere. The white tufas of Tucson have been used in the construction of the university dormitory and for a private residence with great success. This material is excellent for building purposes. It is easily quarried and cut to dimension blocks. It has no perceptible rift, being homogeneous, and thus chips well in any direction. The fracture is conchoidal. It does not crumble. It is porous, a bad conductor of heat, and is durable and does not discolor.

FREESTONE, FLAGSTAFF.

The following is the result of an analysis by T. E. Chatard of a sample of the brown building stone from the Arizona Sandstone Company's quarries at Flagstaff. (Bull. U. S. Geol. Sur. No. 78, p. 124.)

Insoluble in HCl	79.15
Soluble in SiO ₂ .....	.04
Al ₂ O ₃	1.30
Fe ₂ O ₃	2.45
CaO	7.76
MgO .....	.23
CO ₂	5.77
H ₂ O at 110° .....	.32
H ₂ O at red heat	2.94
Total	99.96

THE TUFAS OR TUFFS.

Among the more generally utilized building stones at the present time, especially at Tucson, the soft, easily cut volcanic sediment known as "tufas" have a prominent place. These rocks are fragmental in character and consist for the most part of volcanic ejecta, the result of explosive action upon previously formed crystalline rocks. The rocks appear to have been thoroughly comminuted, crushed, and powdered, and to have then been spread out in valleys or basins in the condition of soft mud, which afterwards became compact and consolidated. They generally show the presence of more or less pumice stone in powder and in small fragments. The tufas are generally named from the rocks from the disintegration of which they have been derived. Thus the trachyte-lavas give trachyte tufas, the basaltic lavas basalt tufas or basalt breccias. The syholitic lavas furnish shoylite tufas, and the glassy lavas or obsidians give the pumiceous tufas and breccias. (Building and Ornamental Stones, p. 283, cited by Merrill.)

The tufas are largely used in the volcanic districts of Europe for building purposes. In the Haute Loire, France, they have been used in the construction of churches and dwelling houses. The "pepesino" of the Campagna of Rome and Naples is a tufa. According to Hull the tufas were used in the construction of the buildings of Herculaneum and Pompeii. They are largely used in Japan for building walls, particularly for retaining walls, foundations, and for the walls of the "yaskis" or cattle of the Dainaios. These tufas appear to have been derived chiefly from trachytic rocks, and are therefore classed as trachytic tufas.

Tufa has been used for building in England. The so-called Sarsen stone, of Rochester, England, is a tufa brought, probably, from France and used by the Romans and Normans. (Rochester Naturalist, vol. 11, p. 33, cited in Blake's Annals Brit. Geol., 1891, p. 324.)

The tufas are largely represented in the collection of building stones in the United States National Museum at Washington. According to Professor Merrill there are specimens of various kinds from the Western States and Territories; from California, New Mexico, Idaho, and Utah, and one from near Phoenix, Ariz. These collections have since been increased. Samples from the white tufa of Tucson have been sent there by the University of Arizona. The capitol of Arizona is being constructed of granite and tufa. The tufa is obtained from Kirkland Valley, Yavapai County.

Tufas are thus shown to be common in the volcanic regions of the West, and also of Mexico, where they are largely used in building. At Denver, Colo., the Union Depot building, the Windsor Hotel, and other buildings are constructed of the light-gray and pink syholitic tuff of Douglas County, Colo.

PINK TUFFA, TUCSON.

A tuffa of similar origin to that of the white tuffa of which the university dormitory is built also occurs in the Tucson Mountains on the west side, about 8 miles from Tucson, not far from the limekilns. The local name for the hills is Cerro El Gato. This is a recent discovery, and but a few loads of the stone had been brought into the city of Tucson in February, 1899.

The color is the salient feature. It is a very pleasing rose pink, which commands instant attention and admiration from all who see the stone. This color is uniform throughout the mass, and is due to finely disseminated oxide of iron, the vesqui oxide, or hematite. It is remarkable that it is so evenly spread, not showing in streaks or clouds or patches, but everywhere giving the uniform rose-colored shade.

The stone is homogenous, fine grained, and not granular or sandy, but is not suitable for polishing, being porous, yet firm in its texture. There are but few or no distinct inclusions, such as are found in the white tuffa. The original magma would appear to have been found under less violent disruptive conditions, but yet in very nearly the same manner. It breaks with a broad conchoidal fracture and equally well in any direction. It is firm and strong, and can be easily cut and chiseled. It is not calcareous, but siliceous, consisting largely of silica, which is the cementing material.

The specific gravity is 2.55. A cubic foot would thus weigh 159.17 pounds, and about 13 cubic feet would weigh 1 ton. A test of its capacity for the absorption of water shows that when thoroughly dried and afterwards immersed it will take up a little over 5 per cent of its weight; 5.14 was obtained.

TUFFA AT KINGMAN.

A good quality of tuffa for building purposes occurs at Kingman or near that place. A sample sent to the Arizona School of Mines, by Mr. Charles Metcalf, shows that it can be readily cut with a saw or other tools in any direction, and that it will dress with sufficiently firm sharp edges and angles. It does not crumble easily when dry. It is firm and solid enough for ordinary building purposes. Specific gravity, 1.72; a cubic foot would thus weigh 107.36 pounds. A test of its capacity for absorption of water showed that the air-dried rock will take up 23½ per cent of its own weight. This is a large percentage of absorption. It is darker in color than the tuffa at Tucson. It may be called fawn colored or mouse colored, flecked with small fragments of white or cream-colored pumice stone. The rock is largely composed of pumice. It is in visible grains and patches. There are also grains of transparent feldspar (sanidine.) There is an obscure layering or stratification of all these materials. So far as can be judged from the sample there are no inclusions of large solid bodies. It is a fair material for walls in positions where it will not be exposed to water, and where, if wet, it will not be subjected to freezing temperature.

PHOENIX TUFFA.

The tuffa from Phoenix appears to have been a friable variety. It is described by Merrill as follows: "It is of a white and gray color, sufficiently compacted to be cut in blocks of considerable size, and is stated to have (The Collection of Building and Ornamental Stones in the United States National Museum, by T. P. Merrill, Washington, 1889, p. 463) been used to some extent for building purposes." It is stated to occur in "blankets" from 3 to 15 feet thick, more or less tilted, and cropping out near the base of the Mazatzal Mountains, at the edge of the Verde River Valley. The microscope shows this to be composed of pumice fragments of about 0.25 mm. greatest diameter, and apparently identical with that described by myself from southwestern Nebraska, and quite similar to that from east of the Black Hills, Dakota, described by Dr. Wadsworth in Science of July 24, 1885. (American Journal of Science, vol. 32, p. 203, 1886.)

In a series of experiments upon the building stones of Great Britain to determine their crushing strength and other properties (Mem. Proc. Int. Civil Engrs., Vol. CVII, 341-369, cited by J. F. Blake, Annals Brit. Geology for 1892, p. 242, by T. H. Beare) their cubes measure 2½ inches on a side where used. The average crushing strength, stated in tons, per square foot was found to be: For granites, 112.2; oolites, 141.3; sandstones, 489.8; dolomites, 500.5. The density was obtained by calculation from the weight divided by the calculated volume, and the weight per cubic foot by multiplying by 62.42 pounds. For the additional weight due to quarry water, the weight of absorbed water was added. To determine the absorption the dried stone was weighed and then left in water for six or seven days and then reweighed. The average absorption was found to be: For oolites, 8.96; dolomites, 5.43; sandstones, 4.68; and granites, 0.27 per cent.

FELDSPAR ROCK—AMORPHOUS FELSITES.

Upon some of the tributaries of the Hassayampa River above Walnut Grove there are stratified formations of a milk-white rock, which is apparently made up of the finer débris or the elutriated crushed fragments of whole feldspar. This formation is largely developed upon Milk Creek; hence, no doubt, the name. It varies in consistence or hardness, some of the beds being quite soft, and others, though finer in grain, are compact and break with a subconchoidal fracture. As a rule it is amorphous, earthy, and without definite layering or marks of stratification except by the bedding of large mattes. It is fusible to a blebby glass and gives off a little water. It can easily be cut with a knife, or sawed into blocks, or hewed into shape for building purposes with an ax. It has been used frequently for lining fireplaces and wears well, resisting the fire to such a degree as to lead many to suppose that it would make good fire brick, but this is a mistake.

MARBLE.

The resources of the Territory in white, black, and mottled marbles are great, but for the present the cost for hauling and transporting by rail to markets precludes the development of the beds except on a moderate scale for local consumption.

The industry of making cemetery monuments has already been established in Tucson. The marble is brought from quarries in the Santa Rita Mountains, some 20 miles east of the city. It is chiefly white, with blue veins, and it takes a good polish.

Fine-grained black marble of excellent quality has been brought in by Mr. W. B. McClary, of Tucson, to the museum of the School of Mines. The beds are not yet opened, but will no doubt supply good blocks of this desirable marble. Some remarkably fine white statuary marble, in large masses, was noted by me on the northeastern side of the Santa Catalinas, on Marble Peak. It has not been explored. The grain and texture are excellent.

Fine variegated and brecciated marbles are found cropping out on the slope of the hill at the Total Wreck mine, in the eastern spur of the Santa Ritas. This is easily accessible, and would add greatly to the beauty and variety of any decorative marble work.

No especial search has yet been made for ornamental varieties, and the demand for decorative slabs, panels, and mantels has not yet grown sufficiently in the land of adobe houses to justify great attention to the development of quarries.

ARIZONA ONYX MARBLE.

The increasing production and exportation of the unusually beautiful onyx marble found upon Big Bug Creek, in Yavapai County, deserves special notice. The deposit covers some 200 acres, and has become the property of the Arizona Onyx Company. It is about 26 miles from Prescott, in the vicinity of Mayers Station, on the stage road from Prescott to Phoenix.

Prof. George P. Merrill, of the United States National Museum, says of this stone that "it is traversed parallel with the planes of the deposition by wavy bands of color in all shades of amber, white, ocher-yellow, deep ocherous red, and green of a most beautiful emerald shade." He likens this onyx to that of Mexico, which it resembles, but he considers the Arizona stone to be vastly superior to that now sent into our markets from the Mexican quarries. A deposit on Cave Creek has been opened and worked by Phoenix capital, under an organization known as the Phoenix Onyx Company.

The following description has been furnished:

"The only quarry is located at Cave Creek, 45 miles northeast of Phoenix. Mr. B. Heyman, the owner of the mine, started a plant here last year for the purpose of cutting and polishing the onyx, but through dissatisfaction and incompetency of people employed he concluded to close down until practical, competent onyx men could be found. The mine covers 20 acres on a sidehill, and it is found in decomposed limestone, in bowlders varying in size from 2 or 3 to 25 and 30 cubic feet. Large pieces can be found, but not of so fine quality. The onyx is brought to Phoenix in the rough and cut in any form desired by gang saws, the same as used in cutting marble. Then it is placed upon a rubbing bed from 7 to 10 feet in diameter; then taken and honed down, afterwards being put under a polishing machine. Mr. Heyman has shown samples of the onyx taken from his mine to New York dealers who are experts, and all have pronounced it the finest grade of onyx yet produced in this country. The variety of colors are numerous and

very beautiful. The onyx used in the counter of the Auditorium annex in Chicago was taken from this mine. There is a very handsome fountain in Mr. Hudson's drug store of this city, also a counter at the Wave confectionery, covered with this onyx. Mr. Heyman has received orders for several carloads, squared off, for shipping, but on account of the loss in squaring he decided not to ship in this manner."

BLACK AND WHITE ONYX.

A beautiful variety of calcareous onyx has recently (1899) been discovered in the Territory and promises to become important. It consists of black and white zigzag bands, producing a most striking and pleasing effect, quite different from any of the colored varieties heretofore brought to notice. Samples were sent to the Territorial geologist by J. W. Burson, of Kirkland Valley. In some of them a red coloration adds to the beauty of the black and white layers. The shipment of a carload of this onyx to the Peoria Polishing Works was reported in July, 1899.

GREATERVILLE ONYX.

Another locality of a good quality of onyx marble has been found on the limestone ridge near Greaterville. It has been opened and worked to a limited extent by Mr. John B. Anderson, of that place.

LITHOGRAPHIC STONE.

A compact amorphous lime rock has been prospected with a view to its utilization for lithography. Its value for such purposes depends not only upon the texture and adaptation to absorption of water and faulty ink, but upon the size and homogeneity of the blocks. The results of the trials of the material obtained at Big Bug have not been reported

LIMESTONE CEMENTS.

As with building stones, so with limestones suitable for making lime for mortar; they are abundant and accessible at nearly all points where they are needed. At Tucson good lime is burned in the Tucson Mountains a few miles west of the city.

At Tempe there is a limestone which makes an excellent hydraulic lime mortar. It is believed that abundant deposits of material suitable for the manufacture of hydraulic cement can be found among the many varieties of volcanic ejecta distributed through the mountains. There are remarkable examples of natural cemented breccias and conglomerates in the Bradshaw Mountains and elsewhere.

The caliche, which crops out along the mesas and gravelly deposits, makes a strong mortar when burned and mixed with sand.

Samples of the cemented material dug from the mesa near to the ancient ruins beyond Florence were sent to the Territorial geologist for analysis by Rev. J. F. Whittemore, the custodian of the Casa Grande. It was supposed that the ancient builders might have secured similar materials for making a cement for the foundation. The investigation showed that the mixture is much like the caliche of the Tucson mesa, and that by careful burning at a low heat a very good mortar can be made, after slacking, by raking out the coarser pebbles and stones. It seemed most probable to the writer that the buildings were reared upon the naturally formed cement or caliche, and that an artificial cement was not made for a foundation.

SILICIFIED WOOD.

The finest and largest specimens of silicified wood in the known world are obtained at Chalcedony Park, near Holbrook, Apache County, Ariz. Whole trunks of trees and stumps with portions of the roots are found there converted into stone as dense and hard as the finest agate. Every cell and fiber of the former wood is preserved in stone. The specimens are often called "agate wood" and also "petrified wood." A forest of trees appears to have been entombed in the rocks and to have been preserved by a slow process of replacement by silica from solutions permeating the beds. Subsequently the surrounding sediments have been washed away, while the enduring fossilized trees remained. Tons upon tons of specimens have been taken away from the locality by collectors and dealers. A large quantity was shipped to Sioux Falls, S. Dak., to the large establishment founded there by the Drake Company, James H. Drake, president, for cutting and polishing the granites and porphyries of the Northwest

for architectural and decorative work. Sections or these trees 4 feet in diameter and large enough for tops of tables were cut and polished. Many specimens were shown at the New Orleans Exposition and at the Paris Exposition in 1889, and at the World's Fair, Chicago, where they were greatly admired for the perfect preservation of every detail of structure of the wood, for the very high polish, and for the exquisite interblending of colors in the mass due to the presence of various oxides in the original silicifying solutions.

The silicified woods of this locality in Arizona were first made known to the world through the collection of M. Jules Marcou, the geologist of the thirty-fifth parallel (Whipple's) survey for a railroad route to the Pacific Ocean. (Vide Vol. III of the United States Pacific Railroad Surveys). The writer had the first specimen cut and polished from this collection in 1855. For a notice of the objects shown in Paris in 1889, reference may be made to the reports of the United States commissioners (1889), volume 1, page 414. For this exhibit of Arizona fossil wood, or "agatized wood," the exhibitor, the Drake Company, received a gold medal.

Very interesting specimens of silicified wood occur in quantity upon some of the mesas bordering the Colorado River, especially upon the mesas of the desert west of the Colorado, near the Vallecito and San Felipe, in California.

A very fine specimen of such silicified wood was procured by Herbert Brown, esq., superintendent of the Territorial prison at Yuma, and was presented by him in May, 1899, to the museum at the University of Tucson. It is about 8 inches in diameter and over a yard long; a straight stick or log with several notches and distinct grain, but now one solid mass of stone, the silica having replaced and filled every cell and pore of the wood so as to preserve even microscopic details in an imperishable adamantine form.

CHALCHUITL TURQUOISE.

Several localities of this ornamental stone or gem are known in Arizona. The two most important are one in Mohave County and the other in the Dragoon Mountains. At both these places there are ancient, prehistoric excavations, made by the original races in search of the gem known to them as the "chalchuitl." They prized this gem most highly, and it appears to have been known and valued all over the region formerly so thickly occupied by the prehistoric peoples in New Mexico and Arizona and southward in Mexico, even to and perhaps beyond the ancient Aztec capital. Montezuma held the chalchuitl in high esteem. He showed great favor to the royal home of Spain by sending four chalchuite stones as a present through Cortez.

The presence of fragments of this gem, or small ornaments made of it, in ancient ruins and places of sepulture in places widely separated, together with the far distant points at which veins of it were worked, show the universality of the appreciation of this gem. So also the high appreciation in which the gem is held at the present time by the Navajoes, the Zunis, and other tribes of Pueblo Indians shows, or at least indicates, that the Pueblo tribes of to-day are the living representatives of the people who dwelt in cities along the Salt River and Gila valleys.

Mr. A. B. Fenzel, civil engineer, of New York, has recently (1899) opened up the ancient workings in Mohave County and contributed an interesting article on his discoveries to the Engineering and Mining Journal of New York. He opened an ancient shaft which was filled up with debris and overgrown by shrubs and mesquite trees, and unearthed a large amount of loose pieces of turquoise, and masses of rock penetrated by veinlets of the mineral, and in addition a great number of stone tools, such as hammers, mauls, and chisels, which evidently had had hard usage in the work of getting out the gem.

POTTERS AND BRICK CLAYS.

The Territory is rich in the possession of numerous and excellent deposits of clays suitable for many purposes. These clays are of all grades, from the coarsest and most common brick clays to the finest description of potter's clay especially well suited to the manufacture of tiles. Most of the deposits are undeveloped. They remain in their original state and await the touch of enterprise and capital. The brick industry has, however, been established locally at many places, notably at Tucson, where many of the kilns are burned annually. The material is dug in the valley of the Santa Cruz, not over a mile from the central part of the city. A fair article of red brick is produced and is now largely used in the construction of buildings, not only stores and warehouses, but dwellings and cottages of small size. Brick is rapidly displacing adobes for such constructions, as they cost but little more, and are much more durable and satisfactory.

FIRE CLAY.

The coal seams at Bridgers, in the Chincahuas, furnish some excellent fire clays. Some of it is quite white and other samples are nearly black from the carbon mixed in. Two samples examined by me at the School of Mines show that the white is very clean and pure and is an excellent fire clay. So, also, a sample of a hard black mass, breaking like a stone, is easily cut with a knife and exhibits a fine, dense grain. It becomes white in heating and appears to be an excellent fire clay charged with carbon.

Deposits near Benson have been more worked than those at Bridgers and have supplied the furnaces at Bisbee with material pronounced by Mr. Lew. Williams equal in quality to any fire clay he has ever used. This clay is like that at Bridgers, highly charged with carbonaceous matter, and has a black coal-like appearance.

GRAPHITIC FIRE CLAY.

A large deposit of graphitic fire clay is found in the northern end of the Whetstone Range, in Cochise County, about 7 miles from Benson. The cropping which is best known is situated about a mile and a half from the base of the mountains, near to the old Kinnear place. The clay was discovered and located by an old-time resident by the name of Dan Duty. During the time of the running of the smelter at Benson he found a market for considerable quantities of the material, which was very useful about the furnace. Since Mr. Duty's death, several years ago, and the closing down of the smelter, the deposit has not been regularly worked, and the ownership has passed through several hands. At the present time claims are owned by L. D. Redfield and A. A. Castenada. Shipments by rail from Benson to the copper-smelting furnaces of the Copper Queen at Bisbee are occasionally made, where the material is mixed with silica for the lining of the pneumatic converters and for other purposes.

The sample forwarded by request to the Arizona School of Mines is said by F. S. Webster, the Southern Pacific Railroad agent at Benson, to be about an average of the product, but it is claimed that there are streaks or portions of the bed that are much softer and finer in grain and quality. The general aspect of the mass is that of an impure, slaty anthracite coal. It is black and graphitic, is easily reduced to powder, and, with water, makes a black, plastic mass.

It evidently contains diffused carbon. When heated, with access of air, this carbon is gradually burned out on the surface and the mass loses color, becoming ash gray. When pulverized and ignited for some time, the carbon disappears, a loss of weight of $8\frac{1}{2}$ per cent indicating its amount, together with a very small quantity of hygroscopic moisture. That the earthy body of the substance is not either pure clay or pure silica is shown by its fusibility at a high heat to a slag-like, glassy substance. It thus "frits" at a temperature below fusion and forms a coherent mass, which gives it a desirable building quality, and the diffused carbon is a desirable ingredient.

There appears to be practically an unlimited amount of this material. The bed is described as having a thickness in places of 30 feet or more, measured at right angles to the dip, which is about 65 degrees. The trend or direction of the outcrop is east and west. It occurs in "red slate" between croppings of granite. It would appear to represent an ancient horizon of vegetation, probably of the Carboniferous period, and similar to the graphitic coal beds of the Chiricahuas further east beyond the Dragoon Range and the broad Sulphur Springs Valley, giving us another link in the chain of evidence of the former existence of a rich Carboniferous flora in this part of Arizona.

This clay can be had f. o. b. Benson at from \$8 to \$10 per ton. The rate of freight per ton from Bisbee to Tucson is \$4.20, but it would appear, probably, that this could be modified for a rough, crude material of manufacture conducive to the success of smelting operations.

SCOURING STONE.

A superior article of stone suited to general scouring purposes on wood or metals has been discovered and opened up at Flagstaff by A. F. McDermid and his associates. This stone is snow-white and homogenous, and can be hewed with an ax or cut out with a saw into brick-like blocks of any required size. It has a soft, open grain of sharp, but fine, grit, which adapts it in an eminent degree to scouring work. It is like the holystones of best quality used for scouring the decks of ships, and it can be similarly used, but is a finer grain. It is adapted to scouring and nibbling down woodwork as a substitute for pumice stone or sandpaper, and it can also be used for scouring brass, copper, iron, and steel, and could replace bath brick for cleaning table knives.

NOTES ON THE GEOLOGY OF ARIZONA.

It is not possible at the present time to give a general connected view of the geology of the Territory of Arizona. The field is a broad one and is comparatively unknown and unexplored. Years of faithful labor and the correlation of the results of many observers are essential to the preparation of any generalized view of the varied and intricate structure of the mountains, valleys, and plateaus of the Territory. From one point of view much has already been accomplished. There have been many very important contributions to our knowledge of geologic structure of the Territory. The greater portion of the contributions made by official governmental surveys relates to the region in the northern portion of the Territory contiguous to the Grand Canyon of the Colorado.

We are indebted to Dutton for his superb monograph upon the Tertiary History of the Grand Canyon, and to Powell for the results of his explorations. Marcou, who accompanied Whipple and Ives on the survey of the line 35° parallel, gave us the results of a mining reconnaissance across the Territory to the Mohave in California. Newberry with Ives on the Colorado River expedition gave us additional knowledge.

Publications relating to the geology of the central and southern part of the Territory are few in number. Blandy has written a paper with a map of the mining region about Prescott (*Trans. Amer. Inst. Min. Engr.*, XI, 286, 1883), but the field of middle and southern Arizona is comparatively new and unknown. He has also published a notice of the occurrence of Secondary or Triassic sandstone in southwestern Arizona. (*Engr. Min. Jour.*, November 4, 1893.)

Pumpelly, in a contribution to the Academy of Science of California, gave some glimpses of the geology of the Santa Cruz valley and the mountains bordering it near the Patagonia, the Heintzelman, and the Santa Rita mines.

The importance of all accurate information concerning the mining region of the central mass of mountains, known as the Bradshaws, justifies the reproduction here of the paper written by Mr. John F. Blandy, the former Territorial geologist, and published originally in 1883 in the *Transactions of the American Institute of Mining Engineers*, with a map, which last, however, is here necessarily omitted.

THE MINING REGION AROUND PRESCOTT, ARIZ.

With the report of mining statistics for the year 1872 there was published a geological map of the United States and Territories. This is, I believe, the only map which represents the geology of Arizona, and is, as far as my observations go, correct. It is, however, on so small a scale as to be of little practical value to the miner. I know of no other maps, even of localities of this Territory. The topographical maps are also on so small a scale as not even to serve as guides from place to place; the largest, that of Eckhoff and Ricker, being only 30 by 30 inches to represent a territory of 135,000 square miles. For these reasons it makes it exceedingly difficult to describe the various mining centers in an intelligent manner, and equally so to examine such a hilly country as it is intended to describe in this paper.

When I first came into this Territory I soon realized the trouble I had to encounter in trying to form an opinion, or even to get the needed information on the geological contour. I have, therefore, labored as best I could to get a topographical diagram of the section of country represented by the map which accompanies this paper. (By C. H. Hitchcock and Wm. P. Blake—the same map with few corrections which was contributed to the reports of the United States census under Gen. F. A. Walker.)

The lines run by the land department up the valleys of the Aqua Fria and those west of the Hassayampa, and connected east and west to the north of Prescott, enabled me to correctly inclose the space covered by the Bradshaw and Sierra Prieta mountain groups, but the territory covered by these mountains, and the most difficult part, I have had to fill up as best I could. I have met with such success as to meet the approbation of those most familiar with the country, and with the map in hand anyone would be able to cross it in any direction. As there has not been a single line of survey across it this has been no small undertaking, and I have had to depend upon sights from prominent points with the pocket compass, or, in absence of that, to make observations with watch in hand and guess as near as possible the meridian direction. But one main wagon road passes through the district, that from Prescott to the Peck mine.

Having constructed a map with approximate correctness, it remains to mark in the general geology, but it is still difficult to draw accurately the distinct lines of junction between the formations. To do this requires an amount of muscular

exertion that no one can understand unless he has tried it in such a hill country, a region of gulches and steep, rocky hillsides, most of it covered with a growth of tangled, thorny bushes or prickly, poisonous cactus plants. I have therefore only marked the general run of the rocks, without attempting the line of the boundaries of any. It is only meant as a skeleton upon which others may assist in filling in the detail as they may be able. It is the detailed geology of a region which is of the most assistance to the miner, and it cannot be too minute. I am not aware that a geological map has been issued of any locality of Arizona.

I shall refer only to that part of the map which shows the country between the Peck mine and the town of Prescott. The Peck mine is situated in a primary slate formation, the north boundary of which is at Bear Run. This sweeps around in a northerly direction, crossing Turkey Creek and the mouth of Wolf Creek, the head of Cedar Creek, and after crossing the Big Bug Creek to the north of the station passes northward by the Silver Belt mine, and is lost to view under the Aqua Fria flats and Lonesome Valley, or what is marked on the Government maps as the Prescott Plains. To the north of this formation we have a porphyritic-granite ridge, passing from the Tuscumbia mine through the Trinity, crossing Turkey Creek at the mouth of Pine Creek, thence over the high divide between Pine and Wolf creeks. This does not show itself at Big Bug Creek, unless the small field of granite near Boggs be a continuation of the same. Next north of this granite ridge we have a syenite gneiss, covering the country up to the foot of Mount Union, with the exception of a narrow belt of hornblende slate, which crosses Turkey Creek at the Masterson Mill. This brings us to the great granite center of Mount Union. From its sides start out the various streams of Main and East Hassayampa, Turkey, Big Bug, and Lynx creeks. Mount Union is said to be the highest peak, with the exception of San Francisco Mountain, in Yavapai County, which would make it about 10,000 feet above tide. It, with two neighboring peaks, one to the north, the other to the south, appears more like a north and south ridge of granite, and throws out a finger forming the dividing ridge between the Big Bug and Lynx creeks, reaching nearly to the Silver Belt mine, where it abuts against the high tilted slates of the first-mentioned formation. Another finger is thrown out to the southwestward, forming the divide between the East Hassayampa and Turkey Creek, the highest point of which lies between the Bodie and Bully Bueno mines. At the point where the Peck road crosses this divide, at the lowest point, it is hidden by a thin covering of the syenite gneiss. Between Big Bug Creek and the head of Wolf Creek lies a high plateau called the "Mesa." This is a sheet of malpais or lava from 50 to 100 feet or more in thickness, which rests upon the vertical strata of the syenite gneiss. The valley of Lynx Creek is occupied by a more or less stratified granitic rock, which extends southward across the head of Hassayampa, and beyond the Senator mine. This is separated from the large field of granite which surrounds Prescott by the ridge of hornblende schists which crosses the Hassayampa at the bridge and forms a divide between it and Lynx Creek, and in which heads the North Wolf, Groom, and Granite creeks, the highest point of which is Spruce Mountain. The Prescott granite extending northward to the great mass of Granite Mountain, here and there incloses patches of hornblende slates and syenite gneiss, and is intersected by trap dikes and protrusions of columnar basalt. Of the latter, two fine examples are to be seen near the town—Thumb Butte and a hill near the mouth of Banning Creek. To the north of Prescott on the east side of Granite Creek can be seen the syenitic gneiss which underlies the county eastward to lower Lynx Creek. We now have a general outline of the geology of the space lying between the Peck mine and Prescott. I have seen too little of that lying to the westward or of that lying to the east of the Aqua Fria to refer to it at present. It only remains to make some reference to the veins occurring in the various formations.

The large majority of these, whether in the stratified rocks or in the granite, have a northward and southward trend, varying, say, from north 20° east and south 20° west to north 20° west and south 20° east. The exceptions do not vary greatly from this, though I have noticed a few that have a nearly east and west course.

Among the stratified rocks a large number are what might be called "layer" veins; that is, they strike and dip with the formation and are limited in length, seldom extending for more than three or four mining claims. In many instances I have supposed these to be formed by the warping of the strata, causing openings to be made between the strata. This is particularly the case where the white quartz ledges occur, as in the belt in which are the Bully Bueno, Yaho, and the gold ledges on Pine Creek.

The veins in the slate formation of the Peck district occur in, or in contact with, heavy quartz strata, locally called quartz dikes, and carry silver in form of

chlorides, sulphides, and in galena. In some of the veins large amounts of carbonate of iron occur. The quartz dikes are the conspicuous features of the district, standing like high walls, sometimes as much as 50 feet above the slates. The finest examples of these walls can be seen near the mouth of the Wolf Creek, where they occur not more than 6 feet thick at the base and stand at least 50 feet high, terminating in pinnacles, a fair representation also of the dip of the strata.

The veins in the granite ridge next north seem to occur in groups, as at Tus-cumbia, Trinity, and on the east slope of the Wolf Creek ridge. In these the ores are also silver bearing, in form of chlorides with lead, brittle silver ores, and in galena and blende. The principal vein matter is quartz and barytes.

In the syenitic gneiss region the veins are all silver bearing with the exception of the belt referred to above, which passes through from the Bully Bueno mine across Pine and Wolf creeks, which are gold-bearing quartz veins. Between this belt and the granite on the south the rest are much the same in nature as those of the granite, with the exception that there is but little antimony in combination. The vein stones are the same. To the north of the gold belt up to the foot of the Mount Union granite the amount of galena in the vein increases in quantity as you go northward until finally argentiferous galena with much pyrites is almost the only ore. The barytes also becomes less and less, and quartz increases in quantity. In this section I have found the only lime spar, in form of nail head, that I have seen in this region. This occurs in the Goodwin vein.

The veins in the Mount Union granite are all gold bearing, many of them also carrying silver in combination with galena, and large amounts of pyrites. The gold in the croppings of the veins, and to a limited depth, is free, but below altogether in the pyrites. Some veins are found containing large amounts of carbonates of lead which yields well in silver. The decomposition of these veins and of those in Lynx Creek Valley is the source which has supplied the gold to the placers in all the streams heading in this mountain, more particularly to the Hassayampa and Lynx creeks. In some of the veins of this formation is to be found much blende of a very dark character.

The veins of Lynx Creek Valley are, as a rule, the largest of the region, varying in width from 2 to 20 and 30 feet. They carry gold and silver in varying quantities. Sometimes pockets are met with yielding at the rate of several hundred dollars per ton in gold. The occurrence of silver is much more uniform. Most of these veins have been prospected largely in the cropping and the ore worked in arrastres. This has been, however, to a limited depth, I believe never over 30 feet, and most of them much less, as the baser ores occur, and the miners have had no means of treating them.

Below the decomposed croppings the ores are the basest of the region, being a mixture in every conceivable variation of sulphurets of iron, zinc, antimony, lead, and copper. Of course, all are not equally contaminated, as in some pyrites form the mass of the ore; in others but little copper is to be seen. As a rule, it may be said that the ores will average some \$60 per ton in the precious metals. This district is generally regarded as the gold section of the region. The prevailing vein stone is quartz and decomposed wall rock. The only rare metals I have heard of as recurring in these veins are molybdates and phosphates of lead in the Occidental mine, but I have seen none.

The veins of the hornblende schist range are gold and silver bearing, apparently in about equal quantities. The silver occurs as chloride, and also in galena, many very rich and large specimens of the former (horn silver) having been found. In some of the veins very rich streaks of gold have been encountered by the prospectors. Much of the vein material is of a talcose, slaty nature near the walls, and the ore streak is largely made up in many of the veins of a very flinty, yellowish-brown, massive quartz. This is particularly the case where galena occurs in the vein. But few veins—and hardly any of note—have been opened in the Prescott granite. On the southern edge of it, along the Hassayampa, some strong veins of gold-bearing pyrites have been opened. A strong galena vein, with a small amount of pyrites and a large vein of copper pyrites, has been developed to some extent.

To this meager description of the region I might add that a band of porphyritic slate extends on the east side of the Aqua Fria, from the Homestake mine, at the western foot of the Black Hills, southward to Copper Mountain. Whether this formation lies next, east to the slates of the Peck district, or not I can not tell, not having closely examined it. So far as examined, these porphyritic slates show veins of copper ore of high grade, containing silver in greater or less quantities from \$7 to \$35 per ton. On the map I have marked approximately the sections covered with timber. This consists of pine, oak, and juniper.

The streams—called creeks for the want of a better name—might more properly be called sluiceways to carry off the heavy falls of water in the rainy season.

There is, however, a small amount of running water in all of them for most of the year, particularly in the winter and spring, caused by the melting of the snows.

As I have said, this is but a meager description of the geology of a large and important mineral district; but I have meant it only as a beginning by furnishing an outline of the district and giving an opportunity for others to assist in building upon the foundations which are thus begun.

It will be understood that the mineral district extends much beyond that part which I have attempted to describe. It reaches southeastward to the Tip Top mine region, the copper deposits of Castle Creek, the Tiger district, and southwestward to the Vulture mine near Wickenburg, and the gold mine of Antelope Peak; westward to include the copper mines in Copper Basin, and on the east it covers the copper and silver mines of the Black Hills and Ash Creek, and the gold region of Cherry Creek near the Verde. To these may be added the gold mines and placers of the Black Canyon and Squaw Creek. This region possesses as fine a climate as can be found in the United States—fine open weather in winter with but few storms, and those of snow. The nights, from November to April, are cold, although the days may be clear and balmy. In summer, though the thermometer may register 105° to 110° in the shade, the atmosphere is by no means as oppressive as in the Atlantic States at 85° to 90°. There are but very few days in the year when it is too disagreeable to work in the open air. Many severe things have been said of "dry Arizona," but it has never been called the "land of beautiful and glorious sunshine," to which it is entitled.

ARIZONIAN SLATES, BRADSHAW MOUNTAINS.

The following notes upon the rocks of the Bradshaws are from my own observations:

The great central mountain mass of Arizona, generally known as the Bradshaws, includes many subdivisions, known as Granite Mountains, Weaver Mountains, Kendrick Mountains, and Wickenburg Mountains, as shown on the latest Government maps. The topography there given is largely according to the best fancy and skill of the topographical draftsman in the absence of any good field work. The area is wide and diversified, but it may be said that the rocks are chiefly crystalline and very ancient, representing the Archæan, Laurentian, and Huronian. There are large areas of compact homogeneous granite, much of which seems to be intrusive. There are ancient gneissic rocks of varying degrees of metamorphism, of compression and folding, such as those above the Walnut Grove Dam, and in the ridges above toward Minnehaha Flat. Granite abounds around Prescott. It crops in fine gray masses at the Tiger Mine. It is there fine grained, with small even-sized crystals of black biotite mica and some sphene. It weathers into large boulders of disintegration. Just beyond the Tiger vein, which is near the contact, this granite is succeeded by slates, sandy and siliceous, with traces of pebbly beds forming a part of an extensive development of distinctly sedimentary rocks which form great hills, and extend over eastwardly to and beyond Humbug Creek, the tributary of the Agua Fria, and noted in the mining annals of Arizona for its rich gold placers, which, no doubt, were fed from the many gold-bearing veins which traverse these slates. This is a slate formation which is extensively developed in Arizona. Lithologically it is like the Berkshire, Massachusetts, Taconic slates, and I have called them the Arizonian slates.

VULTURE TO WICKENBURG.

The vein at the Vulture is in ancient slates and gneissic rocks, probably more ancient than the slates at Cave Creek. From these outcrops we rise upon the undulating surface of low hills of volcanic origin or outflow, generally soft and amygdaloidal, of local extent, having been cut through by long erosion to the bed. In places the argillaceous slates pass into dark-colored hornblende slates, becoming compact, gneissic, and syenitic, and all much seamed and ribbed with dikes of feldspathic or granite rock, and with porphyritic dikes to the summit, about halfway, and thence upon granite to the Hassayampa. Passing up the Hassayampa above Grant's store and the old Vulture Mill, there is a bluff of comparatively modern lava, which flowed out over the terrace of river gravel and has protected it from washing away. From near this place, the long regular slope extends upward to the base of the mountains, about six miles. It is covered with grasses and cactæa, but very few or no trees nor shrubs of great size. The soil appears to be exceedingly rich and fertile whenever water is put upon it, and to be composed largely of volcanic mud, and ashes or the débris and silt from the decomposition of lavas and trufaceous deposits. This soil and slope appear to be

most admirably adapted to viticulture, and would no doubt produce grapes from which a most superior grade and variety of wine could be made. This slope and soil extend to the mountains at Antelope, and beyond Barney Martin's old place is near to the base of Rich Hill, sometimes called Weaver Mountain. The side next to Martin's is composed of a fine-grained white granite, with a large amount of quartz in it and black mica. It is gneissic, in regular layers, and appears like a highly altered old sandstone. The bedding pitches northerly at a low angle—about 30 to 35 degrees. It may be called a granulitic granite; it appears to form the lower part of the mountain, the upper portion having a darker and brown color.

West of Antelope (or Martin's) the slate formation crops out, and as at other places is marked by a white quartz vein, dipping northward and resembling the quartz lode known as the Leviathan, of which it is supposed to be a part, separated by some great fault, heave, or displacement. This quartz seemed quite barren and worthless for gold mining, though there may be rich pockets of coarse gold. Granite crops out west of the Leviathans lode hill. It is a granular gray granite of coarse texture, and has some isolated crystals of feldspar. The Marcus gold vein traverses this rock in an east and west direction and the granite is much altered and decomposed along its course.

RICH HILL TO WALNUT GROVE.

From Antelope or Stanton the road northward to the Hassayampa at Walnut Grove is upon granite, passing into gneissic rock. Much of the granite is compact, gray, and a homogeneous rock, weathering into great rounded masses, like that seen north of Phoenix, at Tombstone and other places. The rock is especially well developed and marked by disintegration boulder-like formations at People's Valley, where extremely picturesque avenues are formed by the linear outcrops of Cyclopean blocks, between which there is an abundant growth of the evergreen oak. Similar conditions are found at and near Russellville, north of Dragoon station. After passing the summit and approaching the Hassayampa Valley the granite becomes more gneissic, with a large amount of epidote and dikes or veins of granite traversing it.

COTTONWOOD CREEK.

A deep gorge-like canyon is bordered by volcanic sediments, the beginning of the extensive formation of this nature which occupies a large part of the Walnut Grove Basin or area above the great Hassayampa Canyon. The left bank of this creek is a bluff of the upturned beds of basaltic lava, alternating with volcanic sediments. A portion of the creek runs in the midst of such sediments which are largely formed of pebbles and fragments of plutonic rocks firmly cemented together by a gray cement, making a rock as hard as any artificial concrete.

THE DAM SITE AT WALNUT GROVE.

The rocks at the head of the canyon of the Hassayampa, where the dam was located, are granitic and gneissic. They are very firm and compact, and are evidently metamorphic. The planes of structure or ancient sedimentation are well developed, giving the rock a tabular form, well suited to rough construction. The portion of rock pierced by the tunnel for the pipe outlet of the dam was excessively hard, being formed largely of vitreous quartz, probably the altered form of an ancient sandstone, but without the preservation of its former granular condition. The rocks a short distance north are much more marked in their ancient sedimentary character, though now highly crystalline.

AGUA FRIA AND CAVE CREEK.

The foothills of the mountains north and northwest of Phoenix are formed largely of an ancient, regularly stratified slate, resting at an angle of about 40 degrees upon granite and dipping to the northeast. On the road to Cave Creek both granite and slates are crossed, the granite generally forming lower hills than the slates. The bed rock at the Phoenix mine on Cave Creek is slate. At the Chautauqua and Yellow Jacket claims, about 3 miles west, there are large hills of slate overlying granite at about the same angle as farther east.

BOS ARIZONICA (FOSSIL BOVINE).

A box full of fragments of bone, sent to the museum of the School of Mines for identification by Mr. P. J. Coyne and Thomas Deering, on being put together

proved to be the horn cores of a gigantic prehistoric bovine quadruped for which the name *Bos Arizona* is proposed. The find was dug by the gold placer miners from the gravel deposits of Greaterville, on the eastern side of the Santa Rita Mountains, in Pima County, some 40 miles from Tucson. Unfortunately the bones of the skull were too much broken up to permit of restoration, so it is not possible to gain any satisfactory knowledge of its dimensions and generic characters. The horn cores, however, show that the animal must have had a huge head and neck, so as to support and make use of horns of such great weight as the dimensions indicate. These dimensions are: Circumference of the largest end, near the base, where the horn joined the skull, 17½ inches; of the smaller end, 12 inches from the base, 13 inches; length of the portion restored, 17 inches; probable extreme length if complete, 23 to 24 inches. It is not much curved. The form is nearly cylindrical in section and is conoidal, but at least twice as large as the largest-sized horn cores of our domestic bulls. The form of the horn, it would appear, must have closely resembled the form familiar to us with the bulls of the Hereford breed rather than those of the Durham shorthorn, or the more elongated and crooked horns of the Holsteins. The form differs decidedly from any buffalo horn ever known. It does not resemble the horn of the East Indian buffalo.

Somewhat similar fossil horn cores have been found in Texas, in Ohio, at Big Bone Lick, Kentucky, and in Nebraska. And there is a resemblance in size at least to the great horn cores found in Europe which belonged to the recently extinct *Bos Urus* or *primigenius*. The affiliations of this species, once so abundant, with the American species have not been yet sufficiently studied, but Dr. Leidy thought that the American species were different from the European. He has described one of the fossils with horn cores 20 inches in circumference as *Bison latifrons*. Prof. O. C. Marsh has described two other species, based upon fossil horn cores from Nebraska, as *Bison ferox* and *Bison Alleni*. By the courtesy of Professor Marsh I was permitted to critically examine those fossils in the Peabody Museum at Yale University, and to compare them with the fossil from Greaterville, Ariz. This last is thicker than the Nebraska specimens in proportion to its length, and is less curved. A full notice of *B. arizonica* has been sent to the American Geologist for publication.

MASTODON REMAINS IN ARIZONA.

Two molar teeth of the mastodon were dug from the deep vegetable mold of borders of the great spring at Andrade ranch, on the western slope of the Santa Rita Mountains, in Pima County, Ariz., about 20 miles east of Tucson. These teeth, weighing 4 pounds each, are in an excellent state of preservation and do not appear to have very great antiquity, though ages must have passed since the animal which bore them was mired in the soft mud of this spring. The length of these teeth is 6½ inches. The roots are about the same length. The anterior fangs are separate from the others, and are much curved backward, and in one specimen are twisted one across the other. An enamel-like coating of a dark-brown color covers the whole of the roots, and when this coating is dry it easily breaks or scales off and shows a very clean white dentine below. The roots are also distinctly annulated, the annulations being about one-fourth of an inch wide.

The animal was advanced in years, for the crowns of the molars are worn down so much that the cone-like cusps, so characteristic of the dentition of the mastodon, are gone, and instead of them the dentine or ivory has a cup-shaped surface surrounded by ridges of the thick and hard enamel.

The mastodon from whose jaws these teeth came must have been over 10 feet high and perhaps 20 feet long. The discovery of these remains is important and interesting, showing that these great herbiferous animals once roamed over our valleys. They were great feeders, and there must have been a much more abundant growth of vegetation when they lived than now exists, and therefore a much larger water supply—another link in the chain of evidence of the gradual desiccation of the earth's surface and the much smaller rainfall and stream volume than formerly.

Two more finds of similar teeth have been reported, one near Bowie and the other west of Tucson toward the Quijotoas, but have not been sufficiently verified.

DEVONIAN AND SILURIAN FORMATIONS.

The great mass of the Santa Catalina Mountains is made up of granite and gneissic rocks of Archaean age; but on the northeastern slope, near to the American Flag mine, in the Old Hat district, there are extended outcrops of ancient Paleozoic strata dipping toward the east. In addition to basal conglomerates, made

up of thoroughly rounded bowlders and pebble, there is a thick series of red sandstones, shales, and quartzites, succeeded above by earthy and shaly limestones, in the midst of which there is a stratum of well-preserved corals, among which a branching form is much like a coral found on the Verde River and referred by Professor Meek to the Devonian. (See Paleontology of Fortieth Parallel Survey, IV, 27, and pl. 11, fig. 3.)

It is interesting to note that a large quartz vein traversing the basal red sandstones and shales is auriferous.

Farther south, in the Santa Rita range, in the region of Rosemont and of Greaterville, on the east side of the mountains, limestones and quartzites are extensively developed and upheaved. The basal rock on the west is the coarse granite above described, which has a great extension to the north and northwest, and appear generally to be gold bearing, as, for example, at the Mammoth and at Goldfields. In the Greaterville region this granite has a very massive flanking on the east of a coarse conglomerate of granite fragments, indicative of a stupendous current of water from the west eastward and at the same time showing that at an early period of the history of the continent there were shallow seas and shore lines in the region of Arizona. Other and different conglomerates farther north and south bear abundant testimony to the truth of the same general statement. Arizona was largely above water in the earlier ages. This granite conglomerate seems local. It requires further study. It is overlain by quartzites and limestones, and probably unconformably, yet it is not certainly older, for masses of quartzites have been noted in its midst. It is, however, auriferous. Small seams of quartz are numerous, and in some of them coarse gold can be seen. The extensive degradation of such rock would liberate a large amount of gold, and this formation, together with other quartz veins, may be the source of the gold of the Greaterville placer. (See under Placers, chapter on gold.) Directly above the quartzite and red beds there are heavily bedded limestones, which at Greaterville and Deerings Camp are fossiliferous. I collected corals and brachiopods representing the Silurian age. A well-defined and nearly vertical fault dislocates the red beds near to Deerings Camp.

SANTA CATALINA MOUNTAINS.

This massive range of mountains bounds the view from Tucson across the broad mesa northward. It is one of the most marked and extensive of the many mountain groups which form the diversified topography of Arizona. As seen from Tucson or the plain on which the university stands, its general directions appear to be east and west, for it stretches wall like for some 10 or 15 miles approximately in that direction, but if followed around its western extremity a northerly or northwesterly trend becomes apparent, and it may be followed up the Cañada del Oro for some 30 miles in that direction to and beyond Oracle, just over the line in Pinal County. The range is rugged and precipitous, especially upon the northern face of the ridges, due to the peculiar layering of the rocks. The highest and chief ridge culminates in Mount Lemon, the summit of which is reported to be about 10,000 feet above tide, or about 7,600 feet higher than the plain of Tucson. And the high ridge reaches its greatest elevation in Mount Rice. The higher ridges and summits are favored by snow falls in winter and an abundant precipitation during the season of summer rains. These higher ridges are thus covered with vegetation and support forests of splendid furs and pines, some of the trees attaining a diameter of more than 3 feet at the base of the brink. But the precipitation is not sufficient to maintain large flowing streams descending to the surrounding plains, except for a short time during the periods of excessive rainfall on the summits or when a heavy snow fall in winter is rapidly melted by the ardent rays of an unclouded Arizona sun.

The geologic structure of the central mass of the Santa Catalinas is but little known. The southern flanks, sloping off into the great mesa of Tucson, are made up of tabular gneiss in such regular strata as to look at a distance like ordinary mechanically formed sedimentary sandstones. The planes of stratification are flat, not in curves or folds. In this respect they are peculiar and almost unique. The low angle of dip and the tabular form both indicate very little disturbance since their deposition. The formation is very thick. It is penetrated by tabular sheets of granitic rock. Large portions of the gneiss contain feldspathic nodules enfolded in the micaceous layers, giving the appearance of a porphyry like our "bird's-eye porphyry" of the prospectors, and entitling the rock to the name of augen gneiss. Other layers are quartzose, sandy, and seemingly are quartzites or old sandstones. The whole series is ancient. I refer them to the Archæan.

On the extreme northeastern flank of the range there are coarse conglomerates made up of thoroughly well-worn bowlders and pebbles, in which white quartz predominates, thus indicating extensive mineral shore-line eruption and deposition. The Paleozoic beds are there developed; also a broad scale, with thick deposits of red sandstone and shales—the Devonian or older and fossiliferous limestones above elsewhere noticed.

Crystalline limestone in the form of statuary marble may also be found, and near Johnson's rancho, in the gulch, there are very interesting croppings of the Arizonian slates in a greatly compressed and contorted condition, showing sharp zigzag foldings and crumplings, evidently the result of intense lateral pressure.

Some deposits of copper ore are being prospected in different parts of this range and in the adjoining spur or branch known as the Rincon Mountains, lying northeasterly from Tucson.

THE NATURAL BRIDGE OF ARIZONA.

The remarkable natural formation of a chasm spanned by a rock bridge is one of the wonders of the world, and it far exceeds the natural bridge of Virginia in extent and grandeur. The bridge spans Pine Creek, one of the tributaries of the Upper Verde River, in Gila County, in the extreme northwest corner of Tonto Basin and about 4 miles from the town of Pine. A description of this natural bridge was given by Patrick Hamilton in his book upon Arizona, with a full-page lithographic illustration (p. 136), but I subjoin a more recent description, giving an account of a visit to the bridge, by Mr. Harry G. Logan, one of the students of the University of Arizona.

"Pine Creek at the bridge flows in a canyon with steep sides. Arriving at the brink of this canyon we see before and below us a nearly level flat of land some 5 or 6 acres in extent, reaching across the canyon to the opposite side, where there is an abrupt wall of rocks, the face of a mountain perhaps 1,500 feet high. Standing on this level tract of land, on which there are buildings, an alfalfa field, and an orchard, it is hard to believe that we are on the top of a natural bridge across a chasm and that the stream flows below us. But, looking to the right and to the left, as we face the precipitous bluff, we see the open canyon, perhaps 300 or 400 feet wide and 250 feet deep. The height of the bridge lessens as we approach the opposite side, and at one place there is a hole in the apparently solid rock through which one can look down for 126 feet to the bottom of the canyon.

"Desiring to get under this wonderful bridge, we take a trail to the left and note that the rocks lie in great benches or strata, like cave-like openings extending backwards into the buttresses of the bridge. Entering one of these openings and crawling sometimes upon our hands and knees we find a cave or vaulted chamber with beautiful translucent stalactites pendant from the ceiling and reaching nearly to the floor. These stalactites are resonant when struck, giving off musical notes. This cave is the abode of numerous bats and they made it uncomfortable for us to remain, so we descended to the bottom of the canyon where there is a pool of water 20 to 30 feet across and said to be over 50 feet deep. The opposite buttress or wall of the bridge is nearly perpendicular."

Other caves along the canyon give evidence of the flow of water carrying lime in solution, for twigs, grass, and other substances lying in the water are now covered with a crust or deposit of lime. The rocks of the canyon appear to be chiefly limestone.

Theorizing upon the origin of the bridge we may suppose that the springs and streams of calcareous water have gradually deposited lime in greater quantity above than below, and have in the lapse of time built out or cemented together the rocks and débris of the canyon until a firm cemented mass was formed under which the water cuts its way. Fossils obtained from the limestones of this locality indicate the period or age of the Lower Carboniferous limestone.

MESA FORMATION, TUCSON.

The mesa upon which the University of Arizona is located consists chiefly of horizontal deposits of washed gravel and sand derived from the breaking down of granite and gneissic rocks. The nature of the fragments indicates that they came from the canyons and cliffs of the Santa Catalinas and the Rincon Mountains. It is more than probable that a large part of the deposits came from the Sabina Canyon, the largest and most important drainage canyon from the Santa Catalina range, but at a remote period, when the rainfall was far greater than at present. In sinking a well to obtain water just north of the northwest corner of

the university tract to a depth of 85 feet the following succession of layers were cut through:

Section of the mesa formation.

	Feet.
Thin, sandy soil, 3 to 12 inches, then caliche and pebbles, hard cement.....	6
Coarse gravel, granitic.....	6
Sand and water-worn bowlders.....	6
Red and clay-like earth.....	2
Red sand.....	2
Soft caliche, a calcareous cemented mass.....	2
Hard sand.....	6
Hard sand and gravel.....	3
Sand, cemented and aggregated in lumps.....	11
Red clay.....	3
Red clay and sand.....	30
Sand and bowlders.....	8½
Water in sandy layers.....	3¼

Most of the closely cemented sand and gravel not enveloped in caliche is well filled with small, sparkling crystals of calc spar, which appears to be the cementing material holding the grains of sand together.

TRIASSIC FORMATION.

I have elsewhere mentioned the probability that the red sandstones of the Salt River Valley at McDowell Mount and near Phoenix are probably of Triassic age. Dr. J. F. Blandy in 1893 published a note upon the occurrence of the Trias in southwestern Arizona (Engineering and Mining Journal, November 4, 1893), and informs me that since then he has found remnants of the Cretaceous in places, but particularly in the Date Creek Valley west of Congress.

ANCIENT CHANNEL OF SALT RIVER.

There are good evidences that at a former period of the later ages of the earth's history, but possibly before the creation of man, the Goldfield region east of Mesa was the channel through which a greater part of the ancient floods now represented by the Salt River flowed westward. The chief fact in evidence is the presence upon the higher mesas and hills of drifted river gravel, so much rounded and water worn as to prove its transportation by water currents from remote sources, and at the same time showing by the composition of this rounded gravel its source in hills and mountains far to the eastward, and at the sources of the Salt River and the Gila. Among this transported gravel we find bowlders of the same peculiar kind of slate or sericite-schist as forms the bulk of the high mountains known as the Four Peaks, which rise majestically in the west and north. It is probable that before the Salt River had cut its way to its present low channel a part at least of the drainage was through this open gateway to the west. It should also be noted that the volcanic tufa which now surmounts the hills also contain considerable quantities of similar slate, lending strength to the belief that these sediments also were laid down by great currents of water sweeping westward from the Four Peak region.

GEOLOGY OF THE SUPERSTITION MOUNTAINS.

The Superstition Mountains, rising about 20 miles east of Mesa, and lying between the Gila and Salt rivers, are not, as usually shown, one continuous range extending north and south. The name should be restricted to the east and west line of table-topped hills extending along the road from Mesa to Pinal. Instead of a continuous range beyond these hills on the north there is a broad, open basin-like valley to which the name Goldfields has been given. It is an open space between mountains on each side, and has the general elevation of 2,300 feet or 1,000 feet above Mesa City. The hills on the north side of this valley rise from 500 to 1,000 feet higher, and are formed of volcanic tufas and shyolitic lavas laid down upon a granitic foundation. So also are the summits of the hills on the south side volcanic in origin, but are harder and more porphyritic and basaltic. The general dip of all these beds of plutonic origin is to the eastward. The floor or foundation of the whole region is a coarse-grained and porphyritic granite. The distinct feldspar crystals are generally from half an inch to



HEAD OF ARIZONA CANAL DAM, ON SALT RIVER.

inch in diameter. The mica is biolite, in fine, irregular scales and evenly spread. The rock weathers freely and does not appear in bold ridges of a rugged aspect, but the surface is smooth and rounded.

It is the ancient foundation arch and appears to extend northward to and beyond the Salt River, for the same kind of rock is found at the head of the Consolidated Irrigation Canal, where the Salt River comes through the mountains. It there forms the two sides of the arch, cutting through which the water of the canal is taken out. This granite has at least two interesting peculiarities. It is water bearing to an unusual degree in the Goldfield region, and is also auriferous to a large extent.

HILLS SOUTH OF MESA:

From Mesa southward the country is open to the Gila in some directions, and in others is interrupted by low ranges and buttes rising isolated above the plain like islands from an ocean. One of these buttes on the right bank, or the north side of the Gila and in the Indian reservation 20 miles or more south of Mesa, was visited and was found to be made up of the ancient mica-slate formation—the Arizonian, probably the equivalent of the Huronian. The slates are much crinkled and contorted, together with numerous thin-bedded layers of quartz. The general direction of the lamination is north 10° west. The relics of an ancient canal just north of this butte, and evidences of aboriginal dwellings, show that the place formerly had a large population. The direction of the bedding or laminations of the mica-slate rocks is not in any way favorable to artesian conditions, trending as it does nearly at right angles with the general descent of the valley, unless we may regard the formation as indicative of a rugged underground topography, rising in underground ridges across the valley, tending to throw any underground flow toward the surface.

SOFT TUFA, TUCSON MOUNTAINS.

The white, soft rock underlying the inclined capping of volcanic rock lying to the east and north of the Yuma mine is a very remarkable mineral aggregate. Its general aspect is that of a granular granite a granutite. But large portions of the weathered rock are reduced to a powdery mass, like a pile of ashes or dry clay and sand. It is not easy to secure masses large enough for specimens that will hold together for transportation. Such specimens, on examination, prove to be distinct mechanical aggregates, made up chiefly of granite débris with small included fragments of red and gray siliceous pebbles. Biotite mica, in small but sharp and brilliant hexagonal plates, is abundant. The siliceous, feldspathic, and other grains are firmly cemented in place by a gray or white magma, which is neither calcareous nor siliceous, but is felicitic and fusible. The whole mass is slightly cavernous and porous, and the cavities are lined with small crystals, apparently of albite. Little siliceous pebbles when broken out leave a cast of their form in the magma. Surface specimens are often incrustated by thin layers or deposits of lime carbonate, a superficial and exotic accumulation very common on the rocks of the region and in the seams or crevices of the croppings. In this peculiar aggregation we have apparently all the constituents of an albitic granite in a comminuted condition, which mixture under favorable conditions of moisture and pressure might readily assume the crystalline condition of a normal granite or granulate.

We must assume that this rock has resulted from the breaking up and destruction of a previously existing granitic mass by active volcanic agencies. It may be called a feldspathic or albitic tuff, but it is very different in its composition from the light-colored tuffs near Tucson. Its position is similar, being underlain and overlaid with plutonic beds of stratified red-brown and chocolate-colored porphyries, but the beds are not horizontal or nearly so as at Tucson. They are uplifted and dip at low angles to the northeast. And at Tucson the overlying-plutonic beds are more modern and lava-like in aspect and are full of amygdaloidal cavities, indication of surface flows.

In both localities the underlying beds of soft, white tufa have, in a large measure, determined the topography of the region, for by yielding readily to eroding agencies the harder overlying beds have been undermined and left unsupported, have broken off at the edges. In the croppings northwest of Tucson the constant caving down of the underlying soft, white strata is shown by the numerous slips, leaving a white track in the soft slopes.

THE SOILS OF ARIZONA.

All soils are derived primarily from the decay or decomposition of rocks, or from the abrasion and breaking down of rock masses, by the various mechanical eroding and chemical agencies constantly acting upon them. Soils are thus as varied in their chemical composition as the rocks from which they are derived. Granitic rocks produce granitic soils; volcanic rocks, volcanic soils; sandstones give sandy soils. But all have been more or less modified by the sorting action of water, which separates, to a great extent, the fine particles from the coarse. The detritus brought out from the steep, rocky gorges of the mountains is coarser than the materials transported by the slower flowing streams of the valley lands. The rushing torrents from the mountains bring down large boulders and gravel. As such floods spread out at the mouths of canyons, and the volume and speed are checked, the larger masses of rock are dropped, and gradually fan-shaped slopes are built up around the mountains, while the finer materials are swept onward to the lower and more nearly level lands.

Thus, as a general rule, the soils of a region partake of the nature of the adjacent mountains, the coarser and more rocky soils being highest and nearest to the parent ridges, while, as the slope lessens, the soil materials are finer, but do not necessarily differ greatly from the coarser in their chemical composition.

The soils of the great Salt River and Gila valleys are not local in origin. They are the result of the eroding and transporting agencies of the rivers which drain the vast region of central, northern, and eastern Arizona. Both the Gila River and the Salt River and their tributaries are but remnants of more powerful streams, which once swept over the region and filled the valley with debris. It is to those earlier rivers we owe the extended plains and mesas now above the reach of the highest floods of the present period. The ancient floods brought with them contributions of gravel, sand, and salt from the mountains far away at their sources. And, as in the mountain ridges so laid under contribution there was a great variety of rocks, both crystalline and sedimentary—granitic, volcanic, limestones, sandstone, and slates—so the fragments torn from their flanks were varied in composition, and gave soils with a great variety of constituents. To these constituents, made up of the trash from distant mountains, we add those derived from the nearer ridges and from local-drainage flows—such, for example, as the slopes and mesas formed chiefly by the Hassayampa, the Agua Fria, Cave Creek, and the Verde. The comparatively local wash from the granitic area of gold field east of Mesa has also had a marked influence upon the nature of the soils lying directly west of it.

Prof. Robert A. Forbes, chemist, and now the director of the agricultural experiment station of the university, Tucson, has made an exhaustive study of the soils of the Salt River Valley, and has reported the results in one of the station bulletins. After giving in detail the results of the analysis of twenty-one different samples, he states the general results, as follows:¹

“Considering the more critical plant foods in order, it is observed, first, that lime averages no less than 2.372 per cent for the twenty samples from the valley, and is mostly in the form of the carbonate, which is so useful for the flocculation of clay soils and their consequent improvement in tilth. In arid regions this is a fortunate compensation for the small amounts of humus which prevail. In humid regions the situation is reversed. Lime being present in but small amounts in such soils tilth is more largely influenced by humus, which is found most abundantly in damp, cool situations.

“The abundance of lime is characteristic of arid regions, and is one reason for the fertility of these soils under irrigation, since this substance not only improves the physical condition, but preserves humus, and renders phosphoric acid and potash more available to vegetation.

“Potash is abundant everywhere, being deficient in not a single case and showing an average of 0.821 per cent, or more than twice what is usually considered essential to fertility. The feldspars which are found in the granites of this region are rich in potash, and by their weathering and decomposition contribute this element of fertility abundantly to the tilth of the valley.

Table of average results.

	Per cent.
In fine earth, water free.	64.575
Insoluble matter—sand, etc.	13.781
Soluble silica, from clay	6.433
Alumina (Al ₂ O ₃)	4.922
Iron oxide (Fe ₂ O ₃)	

¹Salt River Valley Soils, Bulletin No. 28.

	Per cent.
Organic and volatile matter	3.569
Lime (CaO)	2.372
Potash (K ₂ O) .....	.821
Soda (Na ₂ O) .....	.425
Magnesia (MgO)	1.835
Manganese oxide (Mn ₂ O ₄) .....	.055
Phosphoric acid (as P ₂ O ₅) .....	.130
Sulphuric acid (as SO ₃) .....	.059
Carbonic acid (as CO ₂)	1.025
Chlorine .....	.110
Net total	100.112
Humus .....	.650
Nitrogen .....	.045
Alkaline salts .....	.167
Total soluble salts .....	.167
Sodium carbonate .....	.044
Sodium sulphate .....	.030
Sodium chloride .....	.041

"Phosphoric acid makes a fairly satisfactory showing. The average of 0.13 per cent is somewhat in excess of the necessary amount, and, as stated before, the large percentage of lime associated with it should tend to make it more available. In particular cases these soils are undoubtedly deficient in this element of fertility; such, for instance, are samples Nos. 12, 11, 20, 13, 14, and 1, and it may be something more than a coincidence that Nos. 1, 12, 13, and 20 are from localities where fruit trees are in an unhealthy condition. These soils would quite probably profit by the addition of fertilizers containing phosphoric acid. Commercial phosphates are beyond the reach of most farmers of this region, but phosphoric acid may be supplied, with other needed materials, in barnyard manure. Bat guano also contains much phosphoric acid, our samples showing from 3.36 to 6.91 per cent. It is possible also that the local supply of bones could be ground and treated profitably for this purpose, but some machinery and considerable skill are needed for this work.

"*Zeolites*.—It will be noticed in the table that the soluble silica averages more than twice as much as the alumina (13.781 to 6.433 per cent). This excess of silica suggests the presence of zeolites, since, as Dr. Hilgard points out, the ratio of silica to alumina in pure clay is only about as 46 to 40. The existence of zeolites is further indicated by the fact that lime, magnesia, potash, and soda are far in excess of the amounts necessary to combine with the carbonitic, sulphuric, and phosphoric acids present. The importance of zeolites, as emphasized by Dr. Hilgard, consists in the fact that they are repositories of plant foods, from which, by slow decomposition, these compounds are gradually given up, as needed. The existence of zeolites in large amount, therefore, augurs well for the wearing qualities of soils containing them.

ALKALINE SALTS.

"These are not as a rule present in unmanageable amounts, though in connection with heavy soils they occasionally make a good deal of trouble. Just south and southwest of Tempe is a tract of low, heavy land containing an excessive amount of alkaline salts. In its virgin state this tract, which is represented by sample 16, supports a bushy growth of atriplex and a few hardy weeds, but has not been reclaimed for agricultural purposes. An examination of the analysis of soil 16 will show that the alkali in this tract, as indeed nearly everywhere in the valley, is chiefly "white" in character and contains a relatively small proportion of the more injurious sodium carbonate or "black alkali." Consequently these lands must be reclaimed, not by treatment with gypsum, which is an antidote for black alkali, but by drainage and the entire removal of the objectionable salts. The Australian salt bush, which is not only an excellent forage, but grows readily in excessively alkaline soils and removes large amounts of the injurious salts, may also prove useful in some situations hereabouts.

"The silt brought down with the water has a manifest effect upon the physical nature of our irrigated soils, but we have not confirmed the popular notions regarding its fertilizing value by any investigation of its composition.

THE CHIEF DEFICIENCIES OF OUR DESERT SOILS AND SUGGESTIONS FOR OVERCOMING THEM.

"Nitrogen is probably seriously lacking in most of the soils of this valley. The average of 0.045 per cent is low and includes amounts running from 0.029 per cent in soil 4, to 0.108 per cent in soil 16. The smallness of these figures may be seen by comparison with the average amount of nitrogen (humic nitrogen only) in 18 arid soils, stated by Dr. Hilgard at 0.101 per cent ore, more than twice as much as the Arizona average.

"That these soils are nitrogen hungry is indicated also by a leaf-curl disease, which has been noticed among the peaches and apricots on the Phoenix substation by Professor Toumey, who attributes the trouble to a weakened condition resulting from a lack of soil nitrogen.

"The problem of supplying deficient nitrogen is, therefore, a most serious one, inasmuch as nitrogen is the most costly plant food sold in commercial fertilizers. Fortunately, however, a cheap method exists for accomplishing this work, namely, by cultivating leguminous crops upon the land, such as alfalfa, crimson clover, sour clover, cowpeas, vetches, beans, peas, or other members of this class of plants, according to circumstances of climate, water, and soil. These plants, as mentioned before, maintain upon their roots colonies of peculiar bacteria, appearing as small lumps or tubercles, which have power to convert nitrogen from the air into the nitrate form available to vegetation. Upon the decay of the whole plant, which may be plowed under as green manuring, or of the roots and stubble, if the crop is harvested, the nitrogen contained, in combination with humus, remains behind and is available to other crops which have not the power of deriving their nitrogen supply from the air.

"Doubts have been expressed, when alfalfa is cut for hay, that the nitrogen returned to the soil by decaying roots and stubbles make up for that which is taken away from the soil during the growth of the plant; for alfalfa is known to feed upon soil nitrogen as well as that indirectly obtained from the air. Of course, this return will be made, with interest, when the whole crop is plowed under, and the same will be true when it is pastured, the nitrogen being then returned in the excrements of the animals on the ground.

"In Salt River Valley most alfalfa fields have been used both for hay cutting and pasture. In order, therefore, to determine the effect of the prevailing management of this crop upon soil nitrogen samples were taken from nine fields in the valley which had formerly been in alfalfa from five to fifteen years. These samples gave 0.052, 0.073, 0.060, 0.056, 0.090, 0.068, 0.097, 0.095, and 0.115 per cent, respectively, or an average of 0.078 per cent as compared with the average of 0.045 per cent for the virgin soils of the valley, an increase of about two-thirds. It is noteworthy that of the percentages of nitrogen in alfalfa ground, not one falls below the average of that in virgin soils, while in but one case, No. 16, does the nitrogen of virgin soils exceed the average in alfalfa ground. The effect of alfalfa upon soil nitrogen in ordinary practice is therefore sharply marked so far as our observations go.

"The examinations made in the laboratory thus confirm in part the experience of the farmers of southern Arizona as to the most profitable method of handling our desert soils. This consists simply in growing alfalfa upon the ground before attempting other crops. It has repeatedly been stated to the writer by residents of Salt River Valley that orchards, wheat, and various other crops were conspicuously thriftier on old alfalfa ground than on adjacent virgin tracts. It was also observed in 1897, during the work on sugar beets, that the best beets came from alfalfa ground, being richest in sugar and of greatest purity.

ALFALFA IMPROVES THE PHYSICAL CONDITION OF THE SOIL.

"The beneficial effects of alfalfa, however, are due not only to the increase of nitrogen in the soil, but to a great improvement in its physical condition. The compact character of our desert soils is forbiddingly evident to most observers, especially those accustomed to the loose virgin tilth prevalent in humid climates. This denseness and solidity so necessary to overcome is due to various causes. In the first place, alkaline salts, especially sodium carbonate, destroy the flocculated or grainy character of soils, which is chiefly caused by lime. Now, although lime is abundant in this region and the alkali very mild in character, the sodium carbonate present, averaging 0.044 per cent for the valley, undoubtedly contributes materially to the undesirable physical condition of our virgin desert soils. Again, the tremendous though not very frequent downpours of rain which occur throughout southern Arizona, descending upon the bare and nearly unprotected desert,

undoubtedly puddle the soil and pack it into an increasingly solid mass. Finally, the intense and prolonged heat of our summer favors the slow combustion of what little organic matter the soil contains, and thus leaves it nearly without one very efficient cause of good tilth.

"Although the humus of arid regions is generally low, it seems unusually so in southern Arizona. Dr. Hilgard states the average for 313 arid soils from California, Washington, and Montana at 1.84 per cent, while that from 19 samples of Salt River Valley is only 0.65 per cent, or about one-third. This unusual deficiency, together with the peculiar value of humus in an arid region, through its water-holding and tilth-producing powers, makes the problem of increasing its amount a very important one.

"Alfalfa and other green manuring crops and barnyard manure are the chief means at hand for effecting this addition. Alfalfa is particularly mentioned because it is the best known crop for our conditions of soil and climate, but other forage plants are attracting notice. Among these is sour clover (*Melilotus Indica*), which thrives vigorously here. The practice of plowing barley under for green manuring, indulged in by some farmers, is of limited value for the reason that barley does not assimilate atmospheric nitrogen and add it to the soil after the manner of clovers and other legumes.

"Leguminous crops should therefore be chosen for green manuring in this region, and the work of discovering new plants and improving the methods of handling those already known for this purpose is a most important branch of agricultural inquiry with us at the present time.

"Alfalfa in particular, however, improves the condition of our soils in yet another way. The strong numerous roots of this plant penetrate to great depths (about 12 feet in dry soil was observed by Professor Headden in Colorado) and in so doing open up the soil to air and water and prepare the way for the less vigorous roots of other plants. This view of the usefulness of alfalfa is supported by the observation that there are other strong-rooted plants not leguminous in character, and which consequently can not add nitrogen to the soil, whose good effects upon subsequent crops are noticeable. The spiny aster, one of our rankest weeds, and sorghum, which taxes soil severely for plant foods, have both been observed to benefit subsequent crops, for no other apparent reason than the loosening action of their roots upon the dense virgin earth.

A COMPARISON

"Finally, although comparisons are said to be odious they are apt to be instructive, and it may not be amiss to compare the soils of Salt River Valley with those of other arid regions. The following table, compiled from Dr. Hilgard's figures and those of this bulletin effect this comparison:

Comparison by States of arid region soils.

	California.	Washington.	Montana.	Arizona.
Number of soils averaged	198	76	39	20
Insoluble residue	67.882	75.021	66.141	64.575
Soluble silica	8.960	3.673	6.235	13.781
Potash .....	.644	.777	1.005	.821
Soda .....	.277	.249	.226	.425
Lime	1.075	1.378	2.483	2.372
Magnesia	1.488	1.171	1.494	1.835
Manganese oxide .....	.062	.049	.057	.055
Iron oxide	6.303	5.530	4.459	4.922
Alumina	8.721	6.063	7.145	6.433
Phosphoric acid .....	.083	.173	.178	.130
Sulphuric acid .....	.048	.028	.029	.059
Carbonic acid	¹ 1.148	.403	2.398	1.025
Water and organic matter	4.396	5.226	7.133	3.569
Chlorine .....				.110
Total	99.939	99.741		100.112
Humus	1.040	1.155	3.321	.650

¹ Not included in total.

"It appears from this table that in potash, lime, and phosphoric acid, Arizona occupies an intermediate position, being richer usually in these constituents than the average California and Washington soils, but poorer than those of Montana.

"It is noteworthy that in Arizona the amount of soluble silica is remarkably large, being even more than twice the alumina present, while in California and Montana these constituents are about equal, and in Washington the soluble silica is much less in quantity than the alumina. This points to the peculiarly zeolitic character of the soils of Arizona and leads to favorable inferences regarding their wearing qualities, at least so far as mineral ash plant foods are concerned.

"Humus is conspicuously deficient in Salt River Valley. Montana soil contains five times as much humus as those of Arizona. This is doubtless largely due to the temperature, the warmer climate of Arizona favoring the slow combustion of organic matter.

SUMMARY OF RESULTS.

"1. The soils of Salt River Valley, generally speaking, are amply supplied with the more essential mineral ash plant foods, including lime, potash, and phosphoric acid.

2. Nitrogen and humus are undoubtedly deficient in quantity, and the addition of these soil ingredients is desirable, perhaps imperative.

3. Alkaline salts are not prevalent in excessive amount except in occasional localities of limited area. The alkali is very "white" in character, and consequently its injurious effects are minimum.

4. Probably the most serious difficulty with our virgin soils is a physical one. Their dense, compact condition must be remedied by suitable methods of culture.

5. The cheapest and best methods of supplying the lack of humus and nitrogen, and of improving the tilth and water holding power of these soils is by growing leguminous crops upon the lands and plowing them under as green manuring. So far as now known, alfalfa and crimson clover are the best of these, and their use for this purpose is undoubtedly an essential part of any scheme of crop rotation for this region.

"It is proper to note the effect of the annual overflow of the Colorado upon the narrow strip of bottom land bordering its course, and upon the much broader stretches of alluvial lands south of Yuma toward the head of the gulf. The Colorado may be compared to the Nile of Egypt. It is the Nile of America. With its immense drainage area, it lays the table lands and the valleys of the heart of the continent under cultivation, and fetches down the lighter and richer portions of their soils to spread them in successive layers over the bottom lands of its lower valley. The red color of the silt of the Colorado not only gave the river its name, but it tells the geologist of the erosion of the red sandstones formations along its course. But other rocks contribute their quota and make a complex mixture containing all the element essential to plant growth. Such bottom lands are suprisingly fertile. All they require is water to start and sustain a most luxuriant vegetation. And this water the river can supply."

LAW REGULATING THE LOCATION OF MINES.

AN ACT to amend an act entitled "An act concerning mines," being act No. 42 of the eighteenth legislative assembly of the Territory of Arizona, approved March 5, 1895.

Be it enacted by the legislative assembly of the Territory of Arizona, That act numbered forty-two of the eighteenth legislative assembly of the Territory of Arizona, approved March fifth, eighteen hundred and ninety-five, be amended so as to read as follows:

SECTION 1. Every notice of location of a lode mining claim shall contain, first, the name of the claim located; second, the name of the locator; third, the date of location; fourth, the number of feet in length of said claim and the number of feet claimed on each side of the center of the discovery shaft, lengthwise of the claim; fifth, the general course of the lode, deposit, or premises located; sixth, the locality of the claim with reference to some natural object or permanent monument that will identify the claim; and shall be filed with the county recorder for record within ninety days after same shall have been located.

All lode-mining locations hereafter located, the certificate of location of which shall not contain, first, the name of the lode or premises; second, the name of the locator or locators; third, the date of the location; fourth, the number of feet in length of said claim, and the number of feet claimed on each side of the center of the discovery shaft, lengthwise of the claim; fifth, the general course of the lode or premises, as near as may be; sixth, the general locality of the claim with reference to some natural object or permanent monument that will identify the claim, shall be void.

Before filing such location certificate with the county recorder of the proper county the discoverer shall locate his lode claim by, first, sinking a discovery shaft upon the premises so claimed to a depth of at least ten feet from the lowest part of the rim of said shaft at the surface, and deeper, if necessary, until there is shown by such work or lode deposit or mineral in place; second, by posting at the point of discovery on the surface a plain sign, or notice, substantially conforming to the location certificate; third, by making such claim or premises on the ground so that its boundaries can be readily traced.

Such surface boundaries shall be marked by eight substantial posts projecting at least three feet above the surface of the ground, or by substantial stone monuments at least three feet high, to wit: One at each corner of said claim and one at the center of each end and side line thereof.

Any open cut, adit, or tunnel which shall be made as above provided for as a part of the location of a lode-mining claim, and which shall be equal in amount of work to a shaft ten feet deep and four feet wide by six feet long, and which shall cut a lode or mineral in place at a depth of ten feet from the surface, shall be equivalent as a discovery work to a shaft sunk from the surface.

The discoverer shall have ninety days from the date of discovering the lode and the posting of the notice thereon to perform said discovery work thereon.

If at any time the locator of any mining claim heretofore or hereafter located, or his assigns, shall learn that his original certificate was defective or that the requirements of the law had not been complied with before filing, or shall be desirous of changing his surface boundaries or of taking in any additional ground which is subject to location, or in case the original certificate was made prior to the passage of this law, and he shall be desirous of securing the benefits of this act, such locator or his assigns may file an amended certificate of location subject to the provisions of this act regarding the making of new locations.

The amount of assessment or representation work or improvements to be done or made during each year after the completion of the location as heretofore provided, and the time for doing the same shall be as provided by the laws of the United States.

Within three months after the expiration of the period of the time fixed for the performance of annual labor or the making of improvements upon any lode, mining claim, or premises the person on whose behalf such work or improvement was made, or some person for him knowing the facts, may make and record in the office of the county recorder of the county wherein such claim is situated an affidavit in substance as follows:

Territory of Arizona, county of _____, ss.:

_____, being duly sworn, deposes and says that he is a citizen of the United States and more than twenty-one years of age, and resides at _____, in _____ County, Arizona Territory, and is personally acquainted with the lode, mining claim, and premises known as _____ mining claim, or lode, situated in _____ mining district, Arizona Territory, the notice of which premises is recorded in the office of the county recorder of said county in book _____ of records of mines, at page _____, that between the _____ day of _____, A. D. _____, and the _____ day of _____, A. D. _____, at least _____ dollars' worth of work and improvements were done and performed upon said premises or lode, not including the location work of said claim. Such work and improvements were made by and at the expense of _____, owners of said premises, for the purpose of complying with the law of the United States pertaining to assessments or annual work, and (here name the miners or men who worked upon the claim in doing the work) were the men employed by said owner, and who labored upon said premises and who did said work and improvements, and said work so done upon said premises is described as follows, to wit: (Here describe the work done.)

Signature _____

Subscribed and sworn to before me this _____ day of _____, A. D. _____.

My commission as notary public expires on the _____ day of _____, A. D. _____.

[NOTARIAL SEAL.]

Notary Public.

Such affidavit when recorded shall be prima facie evidence of the performance of such labor or the making of such improvements, and said original affidavit after it has been recorded or a certified copy of record of same, or the record of same, shall be received as evidence accordingly by all the courts of this Territory. The relocation of forfeited or abandoned lode claims shall only be made by sinking a new discovery shaft and fixing new boundaries in the same manner and to the same extent as is required in making a new location, or the relocater may sink the original discovery shaft ten feet deeper than it was at the date of the commence-

ment of such relocation, and shall erect new or make the old monuments the same as originally required. In either case a new location monument shall be erected, and the location certificate shall state if the whole or any part of the new location is located as abandoned property.

SEC. 2. The locator of a placer mining claim shall locate his claim in the following manner: By posting a notice of location thereon containing the name of the claim, the name of the locator or locators, the date of location, and the number of acres claimed; by marking the boundaries of his claim with a post or monument of stones at each angle of the claim located. When a post is used it must be at least four inches square by four feet six inches in length, set one foot in the ground and surrounded by a mound of stone or earth four feet in diameter by two feet in height.

Where it is practically impossible, on account of bed rock or precipitous ground, to sink such posts, they may be placed in a pile of stones. And if for any reason it is impossible to erect and maintain a post or monument of stone at an angle of such claim a witness post or monument may be used, said witness monument to be placed as near the true corner as the nature of the ground will permit. When a mound of stone is used it must be at least three feet in height and four feet in diameter at the base.

The locator of any placer claim shall, within sixty days after the date of location of such claim, have the location notice of said claim recorded in the office of the county recorder of the county in which said placer claim may be situated, which record must contain the name of the claim, designating it as a placer claim, the name of the locator or locators, the date of such location, the number of acres thus claimed, a description of the claim with reference to some natural object or permanent monument that will identify the claim. Any record of location of a placer mining claim which shall not contain all the requirements of this section shall be void.

SEC. 3. If at any time the locator of any placer-mining claim heretofore or hereafter located, or his assigns, shall learn that his original location notice was defective, or that the requirements of the law had not been complied with before filing, or shall be desirous of changing his surface boundaries, or of taking in any additional ground which is subject to location, or in case the original notice of location was made prior to the passage of this law, and he shall be desirous of securing the benefits of this act, such locator or his assigns may file an amended notice of location subject to the provisions of this act, regarding the making of new location.

SEC. 4. The amount of assessment work or annual labor or improvements to be done or made during each year shall be as provided in the laws of the United States.

SEC. 5. Within three months after the expiration of the time fixed by law for the performance of assessment work or annual labor, or the making of improvements upon any placer mining claim, the person on whose behalf such work or improvement was made, or some person for him knowing the facts, may make and cause to be recorded in the office of the county recorder of the county wherein such claim is situated an affidavit in substance as follows:

Territory of Arizona, county of _____, ss:

_____, being duly sworn, deposes and says that he is a citizen of the United States and more than twenty-one years of age, and resides at _____, in _____ County, _____ of _____, and is personally acquainted with the placer-mining claim and premises known as _____ placer-mining claim, situated in the county of _____, Territory of Arizona, the notice of location of which placer-mining claim is recorded in the office of the county recorder of _____ County, in book _____ of records of mines, at page _____; that between the _____ day of _____, A. D. _____, at least _____ dollars' worth of work and improvements were done and performed upon said placer-mining claim. Such work and improvements were made for and on behalf of _____, who are the owners of said placer-mining claim, and said work so done upon said placer-mining claim is described as follows, to wit: (Here describe the work done.)

Signature _____.

Subscribed and sworn to before me this _____ day of _____, A. D. _____.

[NOTARIAL SEAL.]

Notary Public.

SEC. 6. Such affidavit when so recorded, or the record thereof, shall be prima facie evidence of the performance of such labor or the making of such improvements and said original affidavit, after it has been recorded, or a certified copy of the record of same, or the record thereof, shall be received as evidence accordingly in all the courts of this Territory.

SEC. 7. That placer mining locations heretofore made since the passage of the act of March fifth, eighteen hundred and ninety-five, the locations of which have not been in conformity with said act, shall not be held to be void by reason thereof.

SEC. 8. All acts and parts of acts in conflict with the provisions of this act are hereby repealed.

SEC. 9. This act shall take effect and be in force from and after its passage.

Approved March 2, 1899.

CLIMATE OF ARIZONA.

The following is by W. L. Woodruff, M. D., Phoenix:

Arizona is a vast Territory mostly embraced in the Rocky Mountain plateau and presents physical features found in no other subdivision of the United States. With an extreme breadth of 335 miles from east to west and length from north to south of 400 miles, with snow-capped mountains of great elevation at the north and east, dropping to sandy deserts which extend down to sea level and from the shores of a vast tropical sea with an area of 53,000 square miles at its southwest corner, one will find within its confines any desired climate.

With this great diversity of physical and climatic conditions, it is no wonder that the climate of Arizona is as little understood as are its unlimited mineral deposits, its inexhaustible soil, and its capacity to produce and mature almost every known plant of the temperate and semitropic zones alongside of fruits heretofore grown only in the tropics. Within the borders of this Territory is reproduced in miniature almost every climatic and physical feature of the North American continent, and its diversified products are here brought to as high a state of perfection as in their native location.

That the diverse climatic and physical conditions of this unique corner of the earth may be better understood, Mr. William G. Burns, section director of the Phoenix weather bureau, has set off the Territory into three divisions, cutting off the western 80 miles by the one hundred and thirteenth degree of longitude, throwing the counties of Mohave and Yuma to the west of that line. He then separates the remaining portions into the northeastern and the southeastern divisions upon the line of the thirty-fourth degree of north latitude. For the year 1898 four stations, two in each county of the western division, gave a mean temperature of 68.90 degrees; six stations in the northeastern division gave a mean temperature of 52.03 degrees, while twenty-two stations in the southeastern division gave a mean temperature for the year of 64.01 degrees.

Much of the land in the western division does not exceed 500 feet above sea level, is practically a continuation of the Mohave Desert in California, and essentially tropical. This region is free from frost, is quite dry, and when irrigated from the Colorado River, which forms its western boundary, or its tributaries will be found almost unlimited in fertility and in the production of tropical plants. The tillable lands will be found mostly in the valleys. Much of the surface of these two counties is covered by broken mountain ranges reaching, of course, a much greater altitude and abounding in many localities with mineral wealth. As the altitude increases, naturally the weather, both winter and summer, becomes cooler.

The northeastern portion, with Prescott as its principal city, and Jerome, Flagstaff, Kingman, Williams, and Holbrook important shipping points, consists of high mountain ranges and table-lands ranging in altitude from 3,000 to 13,000 feet. In summer the climate of these higher valleys and plateaus is mild and invigorating, with scarcely a day too warm for heavy clothing and never a night when blankets are not a necessity. The valleys and lower mountains are usually covered with green vegetation. Here the apple grows to perfection, also all other fruits and plants indigenous to New England or the northwest. In this region are located immense pine forests, and at no great distance as the eye wanders to the highest mountain peaks in plain view are seen regions of almost perpetual snow.

The southeast corner of Arizona, embracing the counties of Gila, Graham, and Cochise, is in surface and climate quite similar in general characteristics to the region just described, but considerably warmer in summer and with less snow in winter. During four months of the year, except in the deeper valleys, much of this region is under a blanket of snow varying from a few inches to several feet in depth. This whole elevated country of about 60,000 square miles, with its vast snow fields and an annual precipitation of from 20 to 50 inches, is one of the features which contribute to produce the possibilities of the remaining portion of the Territory.

The altitude of south central Arizona, composed of the counties of Maricopa, Pinal, and Pima, has an altitude ranging from 500 to 2,500 feet above sea level

and a semitropic climate that is fast becoming famous the world over. I have heretofore attempted to describe it in the following language:

“This part of Arizona is divided into high mountain ranges, varying from 2,000 to 6,000 feet in elevation, gradually degenerating into foothills, valleys, and tablelands, usually called mesas. The valleys and mesas vary in elevation above sea level from 109 feet at Yuma to 1,100 feet at Phoenix and 2,400 feet at Tucson. In the valleys, lower mesas, and foothills we find the mild, salubrious climate that is fast making the Salt River Valley famous as the world's greatest sanitarium. This is more or less true of all the southwestern quarter of Arizona. Southern Arizona has been compared to Persia. If southern California is our Italy, southern Arizona is our Persia—in soil, in climate, in productions, and in the character of its landscape. It is much more like Persia than it is like any other locality in the United States, and in the next ten years it may well show the world what Persia might have been about the dawn of the twentieth century if it had fallen into the hands of the Anglo-Saxon. The date and lemon, the fig and pomegranate flourish in this region perfectly ripened every year, and undoubtedly the lemon reaches greater perfection in the Salt River Valley than in any other place in the United States if not in the world.

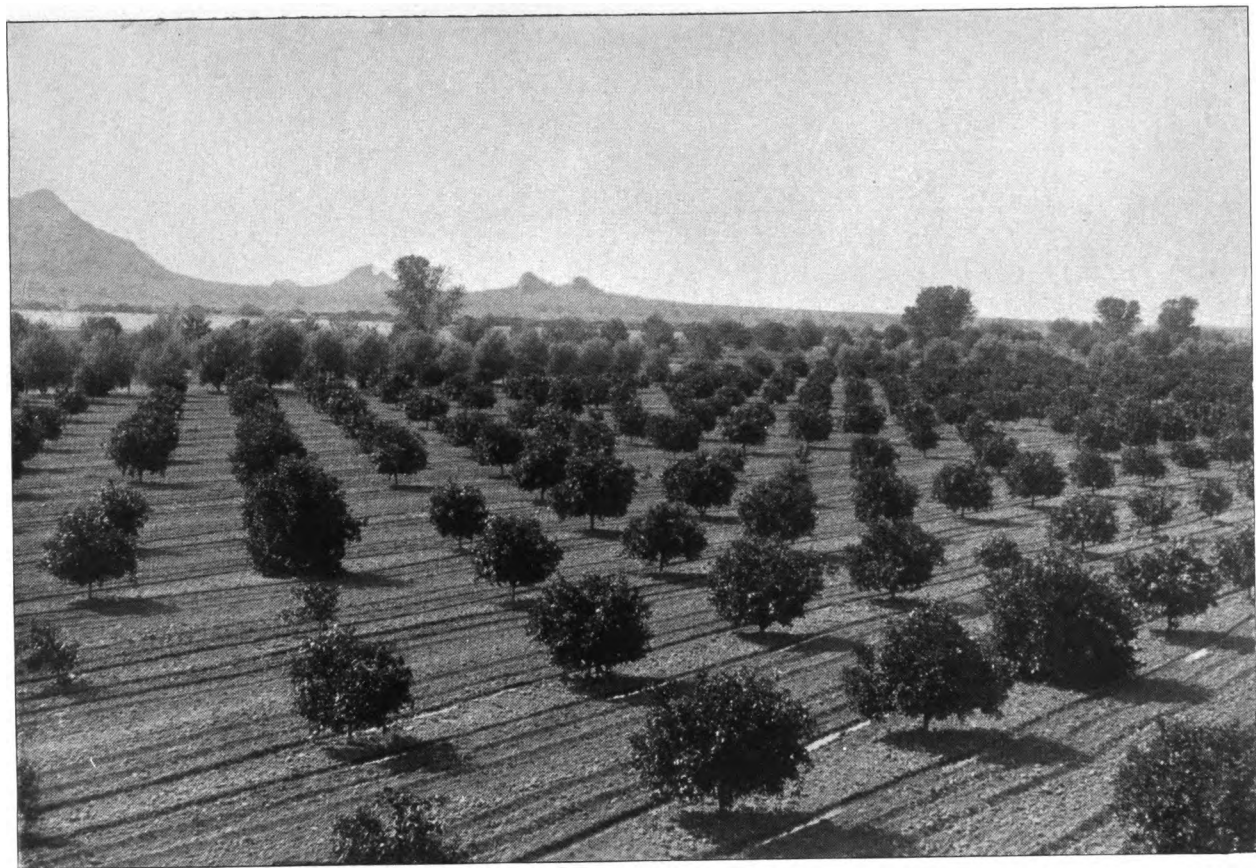
“It is in the Salt River Valley, with Phoenix as its center, where these unique climatic conditions exist in greatest perfection, although at Tucson and other localities in Pima County the climate is very similar, with a lower average temperature in the summer. Phoenix is the center of population and of cultivation of the soil, both agriculturally and horticulturally. Here human health and bountiful fruit production go hand in hand. The same causes that produce the one are always thriving under nature's programme to promote the other.”

The details of climatic phenomena will appear from the following table of the Weather Bureau's climatological data for Phoenix, Ariz., for the year 1898:

Months.	Temperature.																
	Mean.				Extreme.		Mean.				Mean.						
	Dry bulb.		Wet bulb		Highest.	Lowest.	Maximum.	Minimum.	Monthly.	Normal.	Below 32.	Above.					
	8 a.m.	8 p.m.	8 a.m.	8 p.m.								41	50	59	68	77	90
January	40	54	35	44	73	23	58	36	47	49	0	23	10	3	0	0	0
February	47	70	40	52	81	26	74	44	59	54	0	28	28	13	0	0	0
March	46	68	38	49	83	23	71	43	57	61	0	31	27	10	0	0	0
April	59	83	48	58	102	41	87	57	73	67	0	30	30	28	19	7	0
May	60	86	48	58	99	48	88	59	73	75	0	31	31	31	24	8	0
June	70	98	55	66	110	57	100	69	85	83	0	30	30	30	30	29	8
July	81	102	68	72	111	73	104	80	92	90	0	31	31	31	31	31	18
August	80	98	68	72	109	71	101	78	90	88	0	31	31	31	31	31	15
September	70	96	58	66	106	64	99	69	84	81	0	30	30	30	30	30	0
October	57	83	43	57	99	47	89	54	72	69	0	31	31	31	24	3	0
November	45	66	37	49	90	30	73	42	57	58	0	30	25	11	2	0	0
December	41	55	36	44	73	28	61	37	49	53	0	33	15	0	0	0	0
Year	58	80	48	57	111	23	84	56	70	69	0	354	319	249	191	139	41

Months.	Precipitation.			Mean relative humidity.	Weather.				Percentage of possible sunshine.	Average hourly velocity wind.
	Total.	Normal.			Clear.	Partly cloudy.	Cloudy.	.01 inch and over.		
January	1.63	0.57	56	15	7	10	7	62	4.1	
February	T.	.89	41	20	6	1	0	83	3.3	
March	.03	.68	33	19	3	3	3	82	4.9	
April	.18	.30	30	22	3	3	3	86	4.9	
May	.01	.16	27	24	1	1	1	89	4.4	
June	.08	.07	25	24	1	1	1	90	4.1	
July	.24	.85	37	22	2	1	1	80	4.7	
August	1.03	.97	44	15	12	4	9	74	4.6	
September	.04	.54	32	29	1	0	1	98	4.5	
October	.00	.62	23	25	4	0	0	95	3.2	
November	1.01	.44	35	24	4	3	3	92	3.7	
December	1.70	1.12	51	20	4	7	4	73	4.1	
Year	5.95	7.21	36	259	71	35	36	84	4.3	

Other climatic statistics will be found in county reports.



YOUNG ORANGE GROVE, SALT RIVER VALLEY.

THE FLORA OF ARIZONA.

There are but few States in the Union that have a more varied flora than Arizona. The Sonorean character of much of the southern portion of the Territory, with a maximum amount of sunshine and a minimum rainfall, is productive of vegetation not found elsewhere in the United States. The high plateau of the north and numerous mountain ranges which break the surface of our southern plains, ranging from a few hundred to 13,000 feet above sea level, are productive of all degrees of climate, from the extreme heat of the lower valleys to that found at the summit of the San Francisco Mountains, where snow banks remain as late as August. Going hand in hand with this variation in climate is an equal variation in plant life.

The flora of the Colorado Plateau, and to a considerable extent of the many mountain ranges south of this plateau, is strikingly similar to that of southern Colorado and Utah. Here, among trees, are found pines, junipers, oaks, firs, balsams, and poplars. At the higher elevations the valleys are usually well covered with perennial grasses.

All of southern and central Arizona, with the exception of the higher mountains, has a flora entirely different. Succulent plants, including cacti, yuccas, and agaves, are here the most conspicuous forms of plant life. The plains are for the most part more or less thickly covered with a great variety of shrubs and bushes, in the protection of which many annuals and the weaker perennials find a home. Many of these shrubs enter largely into the forage of southern Arizona, and in many seasons of extreme drought to a great extent take the place of the grasses, other annuals, and small perennials which under normal conditions constitute the greater portion of our forage. The greasewood or creosote bush grows in abundance on the driest of our plains, and is the most conspicuous and widespread shrub of the Territory. The water courses are lined with quite a variety of trees, the mesquite, cottonwood, willow, sycamore, and ash being the most abundant and, in the order named, probably of greatest economic importance.

At first sight there is a wonderful sameness about the flora of the plains, which has not escaped the notice of casual observers. The uniform sage-green character of the foliage, with the great preponderance of red and yellow flowers, argues to the unscientific mind but few species. This is a misconception, as the flora of the plains is an exceedingly varied one, the great number of species only resembling each other in color of foliage and in other superficial characters. The monotonous character of the flora disappears in a great measure when on examination these plants, so uniform in general appearance, are found to include a large number of genera and species only differing from one another in the small variations compatible with their environment. These plants as a rule have diminutive or no leaves; hence the evaporating surface is brought down to the minimum. During the rainy season the tissues become gorged with water, which they retain with wonderful tenacity, enabling them to withstand many months of continuous drought.

The plants of the plains are usually covered with thorns and spines, or the surface of the leaves and younger stems are covered with resins and other protective agents. They have become toughened and hardened by generations of exposure to heat and drought, and are able to withstand the direst vicissitudes of their nativity.

The mountain flora shows a marked contrast when compared with the flora of the plains. The greater variations in the color of flowers and fruits, the deeper green of the foliage, and the larger leaves, reminds one of the flora of humid regions. This difference is due to the usual greater precipitation in mountainous regions and the higher elevation being productive of a slower evaporation.

The timber of the Territory practically belongs to the mountain flora; however, a large number of both deciduous and evergreen trees are scattered over the foothills and along the river courses of the southern plains.

A number of indigenous plants—a list much too long to enumerate here—have a local reputation for their medicinal qualities, many of them being kept for sale in our drug shops. It seems not at all improbable, on investigation, that in some of these will be found meritorious qualities which will give them a permanent place in our pharmacopœia.

The greater number of our weeds, and all of our more injurious ones, are introduced plants that do not properly belong to our flora.

The value of canaigre, a plant indigenous to southern Arizona, is already quite beyond the experimental stage, and bids fair to prove in the near future of considerable commercial importance as a source of tannic acid.

NATIVE GRASSES OF ECONOMIC IMPORTANCE.

The soft and succulent grasses of the Eastern and Central States in Arizona give place to a great variety of grasses with short, rigid leaves, and hard stems or culms. These grasses are eagerly eaten by stock, and as a rule contain a much higher percentage of nutritive matter than the grasses of more humid regions. As yet but few of our indigenous grasses, which number nearly 250 species, have been thoroughly tested in cultivation. It is known, however, from their natural environment, that many of them will grow with a minimum amount of moisture. Our range grasses may be conveniently divided into two general classes:

First. The large number of species growing along rivers and creeks, in the vicinity of springs and tanks, and in other moist places.

The most widely disseminated of these grasses is the common salt grass. This grass, although inferior to many others, is on account of its abundance the most important forage grass in many of the southern valleys. Two or three large species of the genus *Sporobolus*, known to cattlemen as Sacaton grasses, are important valley grasses of southern Arizona.

Second. The grasses which grow on the mesas and mountains cover large areas. These grasses are by far the more important, as they constitute the greater portion of the grass forage of the Territory and include those recognized by stockmen as mesquite grass, gramma, needle grass, and gietta. The greater number of these grasses are perennials, having hard, wiry leaves and stems, but very nutritious, and usually well liked by all classes of stock. They grow rapidly after the summer rains and provide fine forage for the fall and winter months.

Much of the fall forage consists of a variety of annual grasses known as six-weeks grass, from the fact that they spring into existence and grow and mature in from four to six weeks. These grasses appear after the summer rains and soon cover the plains with a more or less luxuriant growth of valuable forage. Drying on the ground and containing an abundance of seed, they retain a high percentage of their nutritive qualities for months after maturing and are a large part of the forage during the winter months.

The frequency of the summer rains during the past two years generally throughout the Territory and the greatly diminished number of cattle on the range have brought the natural pasturage into better condition than it has been for several years, so far as grass forage is concerned.

Overstocking has a tendency to kill out the better grasses, and when this is augmented by one or more dry seasons the range is several years in regaining its normal condition. Many of our grasses grow in isolated bunches or scattered about here and there, only a few culms in a place. These are the grasses that suffer from close cropping, for when the top is continually eaten to the ground no seeds are matured and the roots gradually die or are trampled out by horses and cattle.

FORAGE PLANTS OTHER THAN GRASSES.

Probably in no other portion of the United States do we find so great a variety of plants, other than grasses, which may be properly termed forage plants. In many localities during a portion of the year grasses add but little to the forage. Cattle subsist largely upon the foliage of the mesquite, buck brush, white sage, pig nut, salt bush, and other shrubs and hardy perennials, many of which provide excellent forage.

Several plants belonging to the genus *Atriplex*, closely related to the celebrated Australian bush, recently introduced into the arid regions of the Southwest for purposes of forage, are abundant throughout south and central Arizona.

The leaves and ripened pods of mesquite are valuable forage. The beans, according to the report of Dr. Lowe, contain about 30 per cent of grape sugar, are very fattening and readily eaten by both horses and cattle.

We have another tree somewhat similar to the mesquite, known as the screw-bean, but smaller and less abundant. In some localities it also provides excellent forage.

During late winter and early spring or in periods of extreme drought, when grasses become scant, the value of this class of forage becomes apparent. It is a means of keeping stock alive and in growing condition, when without it they could not subsist. As the greater number of these plants are evergreen shrubs they are fed upon to some extent during all periods of the year. However, it is only in times of necessity that they become a large feature in range forage.



PALM ROAD, BARTLETT RANCH, MARICOPA COUNTY.

SPECIES OF INDIGENOUS TREES.

Arizona has about seventy-five species of indigenous trees, a number excelled by but few States in the Union. Of this number about half are evergreen, including a large number of species of pine and oak.

We have nine species of oak, ranging in size from a mere shrub to the black oak, which sometimes reaches a diameter of more than 4 feet. On our mountains and high plateaus are found eleven pines, from our large yellow pine to the small nut pine of our southern mountains. Four willows grow along our water courses, and two cottonwoods and an aspen find a home at varying altitudes. Four junipers cover large areas between 4,000 and 6,000 feet, or occur as isolated specimens on the foothills and lower mountains. A spruce, two firs, a balsam, and a cypress mingle with the higher pines, and farther down are found two maples, three ashes, three species of mountain mahogany, two ironwoods, and species each of madrona, juneberry, buckthorn, redbud mulberry, cherry, walnut, sycamore, alder, locust, and hackberry.

The following are more southern species, which extend along the water courses, or are found on the foothills of southern Arizona, viz: Three paloverdes, three arborescent cacti, and one species each of soapberry, screwbean, mesquite, and desert willow. One species of each of the following genera occasionally reach the size of trees in southern Arizona, viz: *Vanguelina*, *Canotia*, *Bernulia*, *Koerberlinia*, and *Cowania*. Among these may be mentioned the Douglas fir (*Pseudotsuga douglasii*), commonly known as Arizona pine, which reaches its southern extension on the high peaks of the Arizona mountains. Growing with the Douglas fir we find the western spruce (*Picea engelmanni*), the white pine (*Pinus flexilis macrocarpa*), and the close-grained foxtail pine (*Pinus aristata*). The latter species has very close-grained compact wood and little resin. In mining operations it is valuable for timbering purposes, but in Arizona its inaccessibility has rendered it of very little importance as yet.

About 9,500 feet, where the forests have been cut away or swept by fires, the aspen (*Populus tremuloides*) comes in and reforests the denuded districts. Large tracts in the San Francisco Mountain region, that in past years have been swept by fires, are now thickly covered with a growth of aspen.

At the lower border of the zone of yellow pine, pin oak (*Quercus gambellii*), cedar (*Juniperus occidentalis monospernia*), and juniper (*Juniperus pachiphloea*) begin to appear, and as we pass below the belt of yellow pine its place is taken by a scattered growth of nut pine, represented in Arizona by three species (*Pinus edulis*, *Pinus monophylla*, and *Pinus cembroides*), worthless for purposes of manufacture into lumber. These small pines are characteristic of the low mountains and foothills of Arizona, and one or more species are found in nearly all the mountains of the Territory.

Large areas of the Colorado plateau, below the pine zone, are covered with a scattered growth of juniper. Mingled with the pines and firs on some of the higher mountains are a number of deciduous trees, including a maple (*Acer grandidentatum*) and a locust (*Robinia new Mexicana*), while below the pines, at an elevation of from 6,000 feet to as many hundred, are more than 40 deciduous and evergreen species which may properly be termed trees, but nowhere, with the exception of mesquite, growing in sufficient proximity to be termed forests. Nearly all, however, are valuable for fuel and other domestic purposes.

The forests of southern Arizona are confined to the high mountains and to the banks of the water courses, and disappear entirely from the valleys and low mountain ranges which constitute all of the southwestern portion of the Territory. The most important and widely distributed species, peculiar to the water courses of southern Arizona, is the mesquite (*Prosopis juliflora*). The foothills are covered with a scattered growth of palo verde (*Parkinsonia microphylla* and *Parkinsonia torreyano*), mountain mahogany (*Cercocarpus parvifolius* and *Cercocarpus ledifolius*), giant cactus (*Cactus giganteus*), and a number of less conspicuous species. The canyons are lined with cottonwood (*Populus fremonti*), alder (*Alnus oblongifolia*), ash (*Fraxinus velutina*), willow (*Salix nigra* and *Salix taxifolia*), walnut (*Juglans respestris*), and black oak (*Quercus emongi*).

A number of rare and local trees are found in portions of the Territory. The Arizona cypress (*Cupressus arizonicus*) is a conspicuous tree in a number of the high mountain canyons of the south and central regions. An ironwood (*Ostiga Knowltonii*) is restricted to the Grand Canyon of the Colorado, while an oak (*Quercus touneyi*) is only found on the Mule Mountains.

NATURAL SCENERY.

Arizona has more magnificent and diversified natural scenery than any other locality in the known world. The Grand Canyon of the Colorado in northern Arizona is indescribable. According to Dutton, "it is a superlative manifestation of natural scenery. No imagination can construct out of its own material any intelligent conception of its awful immensity and splendid beauty. Distinguished savants and celebrated travelers do not hesitate for a moment to pronounce it by far the most sublime of all earthly spectacles. Its colossal buttes, its wealth of ornamentation, the splendor of its colors, and its wonderful atmosphere all combine with infinite perplexity to produce a scene which at first bewilders and then overpowers. As the mind strives to realize its proportions its spirit is broken and its imagination completely crushed." Science can not grasp its meaning, nor can the genius of poesy and art describe this masterpiece of omnipotent creation.

The way to the canyon is through magnificent forests and beautiful parks of fragrant pines, by picturesque hills and valleys and lofty snow-capped mountains. The trip can be comfortably made in a day from either Flagstaff, Williams, or Ash Fork, on the line of the Santa Fe Pacific Railroad, and all along the route is a continually changing panorama of scenic grandeur.

Notwithstanding the accessibility of this grandest of earth's natural wonders comparatively few Americans have been there, and it is stated that more people come from Europe every year to see the canyon than visit it from the United States.

Arizona has great ranges of majestic mountains, towering peaks with summits of snow, bordered by great plains and beautiful valleys; immense forests of pine and oak of unequalled area in the United States; marvelous canyons with cataracts and waterfalls of indescribable beauty; a forest of petrified or agatized wood unlike anything else in the world; a natural bridge, compared with which the Natural Bridge of Virginia fades into insignificance; great springs of mineralized water, hot and cold, and unexplored caverns in the earth of unknown extent.

HOT SPRINGS.

Arizona is especially favored with thermal springs possessing curative qualities of great value. The waters are very beneficial in curing rheumatism and nervous ailments, and for stomach and kidney troubles as well as skin and blood diseases. The water from some of the springs, either charged or still, are unexcelled for table use. The Castle Creek Springs, in Yavapai County, are situated among picturesque mountains, and have become popular as a place of resort for pleasure as well as health seekers.

There are many hot springs in the world, but in no other clime is there an open-air pool, fed by unfailling streams of hot medicinal water, where one may bathe at any hour of any day in the year without fear of taking cold.

This pool, fashioned by nature in the midst of towering peaks, has almost perpendicular walls on three sides and the blue Arizona sky for a covering. It is large enough for a comfortable swim. Into it pour unceasing streams of water at a uniform temperature of 114°. So dry and pure is the climate that one may enter this pool at any hour of the day, winter or summer, with absolute safety. These springs have modern hotel accommodations.

The Agua Caliente Springs, in Maricopa County, have become justly famous for the curative qualities of the water, and are a veritable Mecca for invalids troubled with blood or skin diseases. The Agua Caliente Springs, near Tucson, in Pima County, have been popular for their medicinal advantages for many years, and the same is true of Hookers Hot Springs, in southeastern Arizona, and the Thermal Springs of Graham County.

The following is an analysis of the water of the Castle Creek Springs, as made by the Division of Chemistry of the Department of Agriculture at Washington. Reaction slightly alkaline:

Grains per United States gallon	43.6
Ammonia	None.
Nitrates	Trace.
Nitrites	None.

The mineral matter has the following composition, expressed in grains per United States gallon:

Sulphate of soda	18.2
Chloride of soda	12.9
Silica	3.5
Bicarbonate of potash	1.1
Bicarbonate of soda	0.2
Bicarbonate of iron	0.7
Bicarbonate of lime	7.0
Alumina	Trace.
Magnesia	Trace.
Lithia	Trace.

As will be seen from the above data, the sample is a mild mineral water. The sample was found to be remarkably free from organic matter or any contamination therewith. It contained a faint trace of lithia as revealed by the spectroscope, but not a sufficient quantity for gravimetric determination.

The temperature of the water is 114°. The other springs have qualities largely similar. The value of these thermal waters for health purposes, when taken in connection with the great salubrity of climate where they are situated, must be admitted.

HUNTING AND FISHING.

It is not generally known that Arizona can boast of some of the finest fishing and hunting in the United States—a veritable paradise for the sportsman. The trout fishing in the Black and San Francisco rivers and in Oak and Clear creeks can not be excelled in the country. Deer, bear, and wild turkey abound in the Mogollon Mountains and in some sections of the Territory mountain lions, jaguars, wild cats, and lynx are quite numerous. In former years there were a great many elk in southeastern Arizona, although they are now almost if not quite extinct. Beaver, raccoon, and other fur-bearing animals are frequently captured, and wolves, foxes, squirrels, and rabbits are thick in different localities. Quail, ducks, wild pigeons, and doves, and occasionally geese and snipe, are plentiful in season in the lower valleys.

WHIPPLE BARRACKS.

The people of Arizona are gratified to learn that the proposed abandonment of Whipple Barracks has been reconsidered, and that the Secretary of War has set aside a sum of money for the rehabilitation of that famous post. Healthfully situated, overlooking the growing city of Prescott, with quick railroad communication to the north,

south, east, and west, and so located that it is the only garrison between the line of posts on the eastern border of the Territory and the Pacific coast, Whipple Barracks should be maintained as one of the important military posts of the West. It is especially well situated to control local disturbances, should any occur, being near the center of population in the Territory and within easy reach of the great mining camps and railroad lines, where large forces of men are employed, and its restoration and retention will insure security to life and property and establish confidence that law and order will at all times be upheld.

The post can be maintained with exceptional economy on account of cheap supplies obtainable from the Salt River Valley. New water-works and a system of sewerage are being constructed by the city of Prescott, which can be made available by the post. The sanitary advantages of this location can not be excelled in the country.

I earnestly concur in the recommendation heretofore made by Gen. E. S. Otis that at least three companies should be the minimum garrison as soon as the existing exigencies of the situation abroad will permit.

THE NATIONAL GUARD.

I regret to report that no appropriation for the maintenance of the National Guard during the current biennial period was made by the legislative assembly at its last session; but notwithstanding this discouragement, it is gratifying to announce that the organization and discipline of the guard have not suffered and that popular pride and interest therein have not been diminished.

The war with Spain and the military operations in the Philippines have brought out numerous evidences of the patriotism of the citizens of Arizona. The long roll of enlistments and the many other proofs of loyalty to the policy of the National Administration abundantly prove that our people are lacking neither in military spirit nor in steadfast patriotism, and the enthusiastic maintenance of the National Guard despite the oversight of the legislative branch is not the least of these manifestations.

During the past year no event has called for the services of the guard. During July and August there has been some disquietude along the southern border of the Territory, due to apprehension that the outbreak of Yaqui Indians in the State of Sonora, Mexico, might result in raids on Nogales and other settlements on the international boundary line, and it was feared in that locality that the services of the guard might be required to repel attacks from renegade Yaquis, but such fears proved to be groundless. As the best and most economical means of assuring security to our citizens on the border, I suggested to the Secretary of War that a company of United States troops at Fort Huachuca, which is but a short distance from Nogales, should be held in readiness, and, if deemed best, stationed at Nogales during the outbreak. The honorable Secretary replied that the War Department would take precautions to protect American citizens from incursions across the line, and so far there has been no occasion for further action.

Following are extracts from the report of the adjutant-general:

The National Guard of Arizona consists of 1 regiment of infantry, composed of 10 companies, the regimental band, and the staff of the commander in chief. The aggregate strength of the guard is 505 officers and men. The officers and men of the National Guard of Arizona are imbued with praiseworthy enthusiasm in the work of promoting the efficiency of the guard, and have, by commendable pride, military bearing, and excellent discipline, justified the confidence of the people.

The military code provides that the National Guard of Arizona, when on duty, shall wear the uniform of and shall be equipped, drilled, and disciplined in the same manner as the Army of the United States.

To date the undress uniform is all that has been furnished them, and for service and utility it is all that can be desired. Under regulations from this office, officers except those of the general staff are permitted to wear the dress uniform for social occasions only.

The United States Government has, in the eight years since the National Guard was reorganized, issued for its use some \$18,000 worth of arms and equipments (including \$2,308.06 apportioned to Arizona for the fiscal year ending June 30, 1899). These supplies have been issued to the commanding officers of the various companies, who are under bonds to the Territory for their safe-keeping. With this amount of valuable property on hand to be cared for, the amount appropriated by the Territory for armory rental is absolutely necessary and essential for their preservation.

The Territory has made no appropriation whatever for supplies for the equipment of the National Guard.

As indicating the superior physique of our people, only 20 per cent of those who applied for enlistment in the volunteers from this Territory were rejected for all causes, notwithstanding that the most severe and rigid examination was made by the United States mustering officer, a percentage less than that in any other State or Territory, and which bespeaks the physical stamina and moral worth of our people, who gave to the nation a magnificent body of men. I am justified in saying that the National Guard of Arizona is composed of officers and men that have no superiors as soldiers.

The National Guard of Arizona has adopted the Army of the United States as its standard in military matters, and though embarrassed by lack of adequate appropriations, inefficient equipments, and unsuitable armories, yet there is evidenced everywhere by manifest proficiency that there is a determined purpose on the part of the organizations to reach a superior degree of excellence.

The National Guard of Arizona is not perfect, but it is in a highly creditable condition. It has healthy and strong military sentiment. Its officers are, as a rule, zealous, competent, and under discouraging circumstances have labored hard and laid a foundation on which in time there will be developed a very superior guard.

Statistics issued by the War Department show that the proportion of national guardsmen to the total population is greater in Arizona than in any other State or Territory. In the United States the proportion is 1½ per 1,000, while that of Arizona is about 5 guardsmen to 1,000 of population.

During the past year there has been organized by special detail a hospital corps, which has been placed under the command of the surgeon-general, and a signal section, placed under the command of First Lieut. O. A. Turney, who has been especially detailed as signal officer.

Present strength of the National Guard of Arizona.

Governor's staff:		First Regiment Infantry—Cont'd:	
Brigadier-general	1	Commissary of subsistence	1
Colonels	3	Chaplain	1
Lieutenant-colonels	4	Captains	10
Majors	2	First lieutenants	10
Chaplain	1	Second lieutenants	10
First lieutenant	1		
	12	Total commissioned	43
First Regiment Infantry:		Noncommissioned officers	74
Colonel	1	Musicians	41
Lieutenant-colonel	1	Privates	335
Majors	3		
Surgeon	1	Total enrolled	450
Assistant surgeons	2	Aggregate First Infantry	493
Adjutants	2	Aggregate National Guard of	
Quartermaster	1	Arizona	505

UNDEVELOPED RESOURCES.

The undeveloped resources of Arizona in precious metals, agriculture, horticulture, grazing and timber, mineral springs, marble and building stone, onyx, coal, and nearly every natural product known to commerce, make the Territory one of the wealthiest subdivisions of the Union and insure its future as a great and prosperous State.

THE ARID LANDS AND WATER STORAGE.

The agricultural development of Arizona has been carried to a point beyond which much further progress in the line of enlarging the cultivated area can not be achieved without an increased water supply. The advantages offered by nature—a mild and almost superlatively healthful climate and a soil unexcelled in fertility and lying in level reaches in broad valleys unencumbered by wild vegetation and therefore ready for the plow, together with a ready market for all ranch and orchard products—have stimulated settlers in the work of reclaiming the desert, until the ultimate unit of the normal flow of the streams (except the Colorado River) has been diverted into irrigating canals. And in many cases the zeal of the pioneer has led him to construct ditches for the diversion of more water than the average flow of the stream justifies, thus bringing on a conflict with the prior appropriators over the ownership of the available supply. Yet the relation which the land so far reclaimed bears to the irrigable area is fractionally small. There are hundreds of thousands of acres of rich and level public land lying in the valleys of the Salt and Gila rivers which would be brought under irrigation from those streams were their flow adequately increased; and in other valleys of the Territory there are vast bodies of land which, if irrigated, would support a large population.

The further development of the water supply is, therefore, one of the most absorbing problems with which the people of this Territory have to deal. Confining the consideration of the question to the solution of the difficulties which confront only the people already here, it is extremely important. For, magnificent as is the showing made by the agriculturists and horticulturists and by the cities and towns of our prosperous valleys, the great wealth already created and the handsome profits yearly reaped are far short of what the land actually irrigated is capable of producing. Contending frequently with an insufficiency of water, the irrigators are often compelled to resort to a prorating of the diminished flow during the dry season and are forced to be content with a yield which, however profitable in itself, is short of the great capabilities of the soil.

It is conceded that Arizona has natural resources which would, if properly developed, make the Territory one of the most important agricultural States in the Union in point of population and productive power.

The question is also of great importance considered from the standpoint of national interest in respect to the use of the arable public domain. The eagerness with which settlers sought homes in Oklahoma when it was thrown open for settlement, crowding in until they

had created a new commonwealth in a day, the quick occupancy of the various Indian reservations of the semihumid States as they were thrown open to settlement in recent years, and the thousands of homes carved out of the desert amid the most discouraging difficulties, furnish convincing proof of the importance of this subject to the economy of the nation.

From the beginning of our National Government no question has been more continuously interesting than that of the proper utilization of the public domain. Solved for a time by the homestead law, the question reappears and presses for consideration more urgently now than at any stage of our history. Its urgent consideration is necessary because we have reached a development where the homestead law no longer meets the requirements of the situation. The arid lands present new problems which must be solved. In the Eastern and Middle States the growth of population has wrought such changes in economic conditions that the competition in all lines of business was never so keen and the national tendency to "expand" and establish new communities never had greater reason for existence. But, having taken up practically all the public land whereon it is possible to farm without irrigating the soil, the tide of Western emigration encounters in the so-called arid region an insuperable barrier to the creation of farm homes under existing conditions.

The land still vacant and open to settlement within the boundaries of the United States (excluding Alaska) comprises an area of nearly 600,000,000 acres, or almost one-third of the total extent of the country. Most of this is included in what is known as the arid region. Much of it is wholly unfit for agriculture under any circumstances, and there is no reliable data as to the exact quantity of irrigable land for which it is possible to develop a constant water supply. But the best information already gathered by the Government warrants the assertion that in the arid States and Territories enough water can be stored to support on irrigated lands enough people in new agricultural communities to more than equal the present population. Leaving out of consideration the settlement of Oklahoma, which was almost immediate, statistics show that since 1890 the public lands have been disposed of at a rate of hardly more than 1 per cent per annum, and the fact illustrates the conditions which the Government must meet hereafter. Wise statesmanship urges the development of our national resources, and the bringing into use of all dormant assets. In no part of our country has permanent wealth been created more rapidly than in the sections which have been brought under irrigation. Under the system of farming naturally followed in the irrigated regions, of which Arizona is typical, small farms are found to be the rule. A few acres suffice for the comfortable maintenance of a family, and with irrigation all the conditions are conducive to a full settlement of the country. Therefore statistics as to the reclaimable area do not carry an adequate conception of the advantages to the home-seeking population of the country, following a large increase of the water supply.

The following table prepared by the Geological Survey (Public Lands and Their Water Supply, by F. H. Newell) in 1895 is an interesting presentation of the status of the public lands as it was at that

date, and there has been no material change since that time, save in the fuller data concerning the water supply :

Vacant lands in the Western public land States.

States and Territories.	Vacant.		Millions of acres.				
	Square miles.	Acres.	Grazing.	Wood.	Forest.	Desert.	Water supply.
Arizona.....	85,908	54,981,120	30	3	7	15	2
California.....	90,215	57,737,600	27	5	6	19	17
Colorado.....	66,934	42,837,760	30	7	.....	.....	8
Idaho.....	75,069	48,063,360	19	20	8	.....	7
Montana.....	114,057	72,996,480	50	13	10	.....	11
Nebraska.....	17,186	10,999,040	11	.....	.....	.....	1.5
Nevada.....	104,571	66,925,440	42	5	.....	20	2
New Mexico.....	85,302	54,953,280	45	8	2	.....	4
North Dakota.....	33,090	21,177,600	21	.....	.....	.....	0.5
Oklahoma.....	15,213	99,736,320	9	.....	.....	.....	1
Oregon.....	55,887	35,767,680	17	11	9	.....	3
South Dakota.....	25,204	16,130,560	15	.....	1	.....	1
Utah.....	67,808	43,077,120	16	11	6	10	4
Washington.....	32,757	20,964,480	6	5	10	.....	3
Wyoming.....	83,644	53,532,160	36	8	5	5	9
Total.....	952,375	609,520,000	374	96	70	69	74

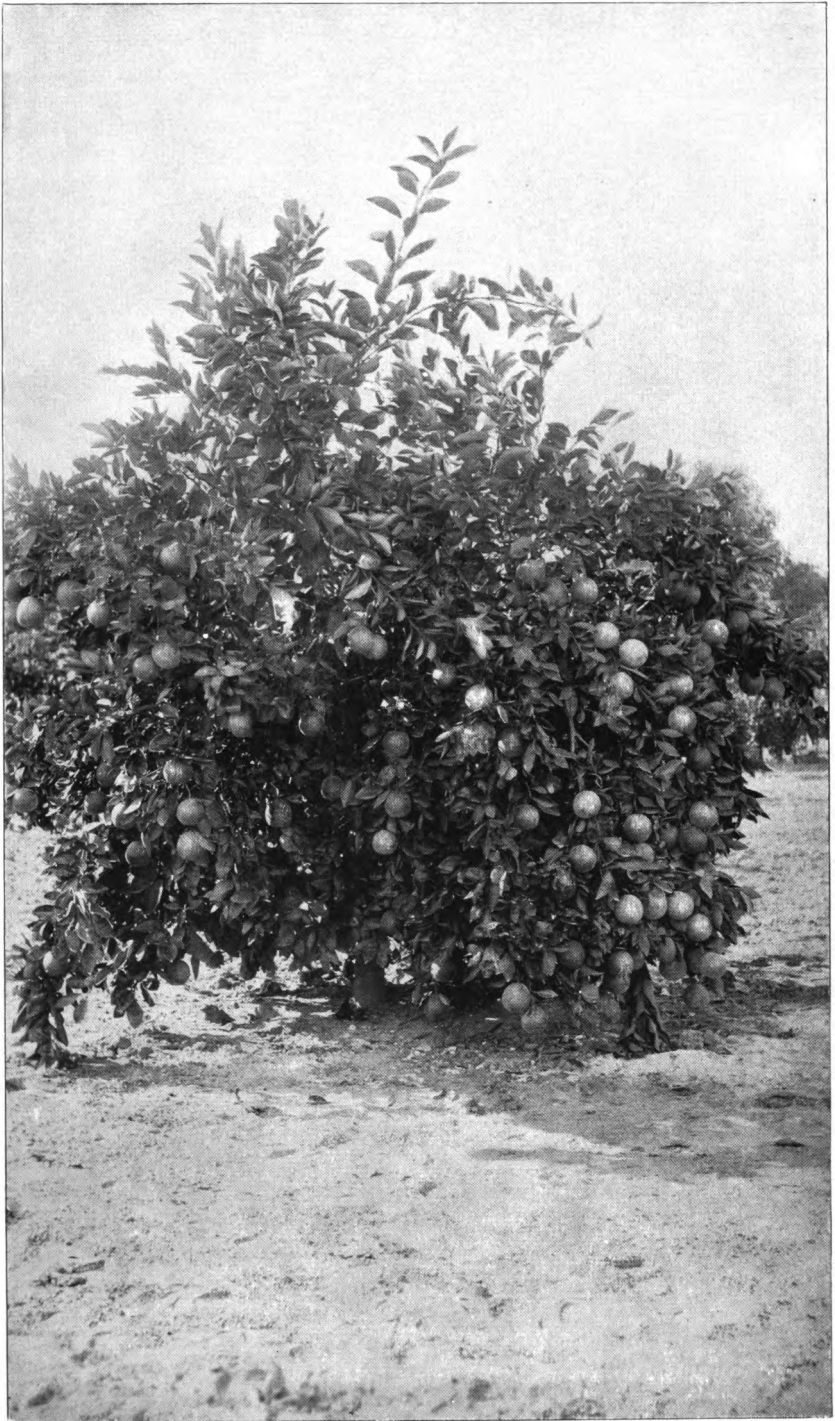
TOPOGRAPHICAL FEATURES OF ARIZONA.¹

The Territory of Arizona covers approximately 118,000 square miles, of which about 39,000 lie below the altitude of 3,000 feet, about 27,000 lie between the contours of 3,000 and 5,000 feet, and about 47,000 lie above the elevation of 5,000 feet. The highest point in the Territory is San Francisco Mountain, in the northern part, which reaches an altitude of nearly 13,000 feet. The Territory is sharply divided into two characteristic portions by the trend across it of the main axis of the great Colorado Plateau, from the northwestern corner of the Territory, in a nearly southeasterly direction. The plateau slopes gently to the northward, but on the southwestern side breaks off suddenly throughout most of its course, and its steep slope is deeply carved by lines of erosion. Almost the whole of that portion of the Territory which is below an elevation of 3,000 feet lies to the southward of this escarpment.

To the north of the escarpment the temperature ranges from that of the temperate zone to that where snow is nearly perpetual, on the summits of the San Francisco and White Mountains. The southern portion of the Territory is characterized by temperatures which may be designated as ranging from temperate, along the foothills of the Colorado Plateau, to semitropic, in the lower valley of the Gila and Colorado. The southern portion of the Territory may be again subdivided into two portions, that draining directly into the Colorado and lying to the westward of Prescott, and the greater portion to the south and east, which forms the great Gila River system. The Colorado Plateau is partly of igneous origin, and a great portion of it is somewhat pervious to water. Its northern slope for a considerable distance from the summits is very gentle, and though the precipitation is greater than in most portions of the Territory, it is very meagerly marked by drainage lines and almost destitute of water. Sharply contrasted with these facts are the conditions on the southern slope. Here, through most of its course, the plateau drops off with a very deep slope, which is deeply cut with drainage lines, in which are living creeks and rivulets of clear, beautiful water, such as San Francisco River, Black Creek, Bonito Creek, White River, Charizo Creek, Wild Rye Creek, East Verde River, Cibicu Creek, Box Creek, Cherry Creek, Tonto Creek, Pine Creek, Fossil Creek, Clear Creek, Beaver Creek, etc.

The region of high altitude, as before remarked, lies largely north of the divide, while the great bulk of the water flowing from the plateau, as proved both by erosion and drainage lines and by the volume of permanent streams, flows away to the south. The explanation of this is partly the porosity of the strata composing the plateau, which allows the water to sink instead of flowing off the surface. Once underground its egress to the south is favored by the shorter distance which it must percolate on a given grade before reaching the surface, due to the more abrupt slope,

¹ "Water Supply and Irrigation Papers," No. 2, Geological Survey.



ORANGES, SALT RIVER VALLEY.

Another partial explanation is found in the meteorological condition. The moisture of this region is brought from the Pacific Ocean and the Gulf of California by the prevailing southwest wind. As this wind ascends the elevations toward the Colorado Plateau its temperature is lowered, which reduces its capacity for holding moisture and increases its relative humidity. When this quantity reaches 100 per cent in any part precipitation occurs. This influence continues until the wind passes the summit, where the process is reversed.

As might be expected, therefore, the hydrographic resources of the country immediately southwest of the Colorado Plateau are disproportionately great when compared with those to the northward. For instance, the precipitation at Fort Apache, as shown by the mean of twenty years' observations, is 19.75 inches; the elevation being 5,050 feet, while the precipitation at Holbrook, at an elevation of 5,047 feet on the northern slope is 8.47 inches, as indicated by the mean of ten years' observations. This is an important fact, especially when taken in connection with the fact that the great areas of valley land with a semitropic climate lie in the southwestern portion of the Territory, and are easily covered by the streams which are formed by the conditions above described, and which constitute the main features of the great Gila River system.

The drainage area of Gila River, including a number of small lost basins which are topographically tributary, but which seldom or never furnish any run-off to the main stream, is about 72,000 square miles, of which nearly 57,000 lie in the Territory of Arizona, about 14,000 in New Mexico, and something over 1,000 in Mexico. The areas in the United States are distributed, with respect to elevation, approximately as follows:

Elevation.	Area of basin.	Area.
	Per cent.	Sq. miles.
Under 1,000 feet.....	9	6,400
Between 1,000 and 2,000 feet.....	19	13,500
Between 2,000 and 3,000 feet.....	16	11,400
Between 3,000 and 4,000 feet.....	14	10,000
Between 4,000 and 5,000 feet.....	15	10,700
Between 5,000 and 6,000 feet.....	12	8,500
Between 6,000 and 7,000 feet.....	8	5,600
Over 7,000 feet.....	7	4,900
Total.....	100	71,000

Gila Basin is conveniently divided into four parts. Of these, the most northerly is Salt River Basin, which includes all the territory tributary to Salt River. This again is sharply divided into its valley and mountain portions. Salt River Valley may be taken as including all the territory adjacent to Salt River from its mouth up to the junction of the Rio Verde. Above that point the greater portion of the basin is mountainous, with small valleys on the Rio Verde and in Tonto Basin, and at a few points on Salt River and other tributaries. The Lower Gila district may be taken as the portion lying below the mouth of Salt River to the Buttes above Florence, and including the Pima (Gila River) Reservation and the great Casa Grande Valley. The Upper Gila district includes the valley in the region of Camp Thomas and Solomonville and the tributary mountainous districts. In addition to these main divisions of the trunk streams may be taken the subordinate divisions of tributaries, such as San Pedro, Santa Cruz, Hassayampa, and Agua Fria creeks.

The tables of temperature for the Gila and Salt River valleys show that the climate is very warm. But care should be taken not to exaggerate this feature, for the actual conditions in their relation to human life and comfort are by no means as unfavorable as they might appear to persons comparing these tables of temperature with those of some eastern localities. For about eight months in the year the temperature of this valley is delightful. Cool nights, bracing mornings, and bright, pleasant days are the rule, except in the months of June, July, August, and September. In these months the heat becomes intense, and though there is of course some variation, the temperature remains continually high throughout the greater part of this period.

The physiological effect of this heat is markedly modified by the aridity of the climate. The human economy provides that when the temperature of the healthy body rises above the normal the perspiration glands begin to act and furnish the skin with moisture, the evaporation of which lowers the temperature of the body.

An essential condition of this natural safeguard against excessive heat depends upon the ready evaporation of the moisture furnished by nature. In a very

humid climate this evaporation can not occur; and in those portions of the country where the humidity is comparatively high such evaporation must be proportionately tardy and sluggish, so that any considerable temperature above normal blood heat produces great suffering and exhaustion, and even prostration. In an arid region on the contrary, the low percentage of humidity causes prompt and quick evaporation of the moisture and the consequent success of nature in its attempt to prevent uncomfortable and injurious bodily temperature.

In southern Arizona these favorable conditions for resistance to heat are at their maximum. Though the temperature is high, the relative humidity is very low, and every particle of moisture which reaches the surface of the skin is promptly evaporated—so promptly that its presence is not perceived—and while the body is thus kept at its normal temperature the unpleasant effects of excessive moisture are not experienced; and the sultry, sticky days so common in the east are unknown in Arizona. Farm labor, the construction of canals, the rounding up and branding of cattle, and other active hard labor are performed at any time in the summer—with less comfort of course—but with no worse effects, than at any other time of the year, and without actual suffering, the only requisite being plenty of drinking water.

A fair comparison of the sensible temperatures of two places may be obtained by a comparison of the readings of wet bulb thermometers. The difference between the readings of wet and dry bulb thermometers here often exceeds 30°.

The summer is, therefore, far from being as uncomfortable as might be supposed, and the delightful autumn, winter, and spring fully compensate for the discomforts of the summer months; and the climate, taken as a whole, with its extreme aridity, its mildness, and its large proportion of sunshine, is exceptionally healthy and especially beneficial to those suffering from bronchial or pulmonary troubles.

RAINFALL AND FLOODS.

Water being one of the most valuable of Arizona's resources, its proper conservation and economical use are of prime importance. There are periods of the winter season when but comparatively little irrigation is necessary, during which the greater part of the entire flow of the streams could, with reservoirs, be held back and stored for use in the spring and summer, thus greatly enhancing its value for the crops during their season of most rapid growth. Reservoirs, therefore, would be very useful even were there no floods to be considered. A storage system would put an end to the lavish use of water in winter, a practice to which irrigators now resort because the water is at hand and going to waste.

But it is in the extent to which the floods can be utilized in the reclamation of the vacant lands that public interest chiefly centers. Much of the rainfall is so torrential in character that a high percentage of the run-off is carried by the streams in flood. Sudden floods are caused also by warm winds and rains attacking the snow in the mountains in the latter end of winter. From long observations of these floods the older residents of the Territory are convinced that the land already under irrigation is but a tithe of that which could be reclaimed were the water stored which runs to waste to the sea. No one doubts that the area reclaimable under the water supply available for storage is many times greater than the area already irrigated. These general statements must suffice, because of the absence of exact data as to the quantity of rainfall and the average yearly volume of water carried in flood. In no other section of the country, probably, are the streams so capricious and fluctuating in volume. Storms of a cloudburst nature in the mountains often add in a few hours many thousands of cubic feet to the flow of the rivers.

The difficulty of making accurate measurements under such conditions is obvious. Records of the rainfall are not as complete as is desirable, but the measurements taken through a long series of years

and at points fairly representative of the whole Territory yield data from which very close calculations can be made as to the annual precipitation.

Observations were begun at Forts Whipple, McDowell, and Bowie as early as 1866-67 and carried forward to a recent period. Other stations were established later, so that for the last twenty years the records of a score of stations are obtainable. It is thus demonstrated that while the mean precipitation in the lower valleys is very slight—ranging from 3.16 inches at Yuma and 5.34 inches at Casa Grande to 7.60 inches at Phoenix—in the drainage acres proper—i. e., in the region of great run-off—it is much heavier. For illustration, Fort Apache shows a mean precipitation of 19.75 inches; Fort Whipple, 16.06 inches; Fort Verde, 13.24 inches; Fort Grant, 15.45 inches; San Carlos, 13.03 inches; Pinal Ranch, 20.46 inches. But the sections of the drainage area from which the least official information has been gathered are the sections over which the greatest precipitation occurs, as they are the sections of highest altitude, least accessibility, and of sparse settlement, and the observatory stations have been usually located at military posts or in the towns of the lower altitude.

When consideration is given to the wide extent of the drainage areas tributary to the irrigable valleys; to the precipitous, rocky, and barren condition of the mountains, so conducive to a maximum of run-off with a minimum loss from seepage, and to the character of the rainfall, the conclusion is inevitable that in Arizona the water supply can be increased enormously if the larger portion of the floods is stored. And if the Geological Survey's eminently conservative estimate of 2,000,000 acres be accepted as the maximum quantity of land in this Territory for which sufficient water can be developed, I regard it as well within the probabilities to estimate that that amount of land will, when properly irrigated, directly support 1,000,000 people.

In order that there may be an intelligent understanding of the question, in so far as it affects Arizona, it is necessary to review, in some detail, the situation of the irrigation industry as we find it to-day.

It is less than twenty years since the large investment of capital in irrigation enterprises in the West was begun, and hundreds of millions of wealth have been created by the new industry. Individuals and corporations have constructed in the agricultural sections ditches carrying all the normal flow of the streams, and a number of costly reservoirs have been constructed in different parts of the arid West, which impound a great additional quantity of flood waters. Influenced by the phenomenal development of the country under irrigation and by the profits derived from less costly irrigation enterprises, capital was led by too sanguine promoters to investment on a larger scale, which, for years, proved disastrous in many cases. The business of impounding water was new, and it was but natural that many mistakes were made. In some instances due investigation had not been made as to the average run-off of the streams. Incorrect deductions were made from exceptional floods, and after costly dams were constructed it was found that the drainage area and rainfall had not been accurately calculated, and in some years the reservoirs were practically dry. But more frequently, oversanguine calculations had been made as to the beginning of revenue.

Investors found that they had not taken sufficient account of the time which must elapse before these lands could be settled and cultivated sufficiently to be made productive of revenue.

Often there was litigation over the ownership of the water which prevented the revenues earned from reaching the pockets of security holders, and lands owned by the water companies were held at an exorbitant market price. Meanwhile, interest charges accumulated and stockholders and bondholders became discouraged. These things, added to extravagant and unnecessary cost of construction, over-capitalization, etc., served to give irrigation investments a bad reputation. Yet the fact remains that the storage enterprises which were carried to completion are at last, under intelligent and economic management, beginning to pay. With the experience gained from the past, and in possession of the extremely valuable data gathered in the past few years by the industrious engineers of the Geological Survey; with reliable information at hand as to the capacity of reservoir sites, the drainage area tributary to them, and the average precipitation which may be expected; with the cheapened cost of constructing dams and the knowledge which engineers have gained as to the proper mode of construction, the builders of storage dams, operating on conservative and business-like lines, hereafter should not fail to make any ordinary storage enterprise a profitable one for investors as well as for the country which they supply.

SOME RESERVOIR SITES AND STORAGE PROJECTS.

There are numerous reservoir sites in the Territory. On all the interior streams carrying volumes of consequence nature has provided storage sites, and reference will be made only to those of largest capacity.

Perhaps the most attention has been paid to the sites on the Gila by the engineers of the Government, because of the pressing necessity of providing the Gila River Indian Reservation with water for irrigation. The 4,000 Indians on that reservation were formerly self-supporting, but the waters of the Gila having been diverted by the farmers in Pinal and Graham counties, the occupants of the reservation are no longer able to raise crops sufficient for their sustenance, and under existing conditions they are certain to become absolute wards of the Government at a heavy expense each year for their maintenance. The fact that they are peaceable and fairly industrious long since bespoke for them a careful consideration of the problem of supplying them with water through some system of storage.

Investigations made by the hydrographers of the Geological Survey have yielded valuable data concerning the most prominent sites on the Gila. At The Buttes, 14 miles above Florence, the first reconnaissance was made some four years ago, and since then measurements of the flow of the river have supplemented the information gained in the first investigation. Last winter Congress made an additional appropriation for the purpose of ascertaining the location of bed rock at the dam sites theretofore examined, and during the present year much additional information has been gathered.

It is now definitely known that at The Buttes a dam 150 feet high will store enough water to cover 174,000 acres to a depth of 1 foot, or as it is technically stated, will impound 174,000 acre-feet. The dam would be 300 feet long at the bed of the stream, and 800 feet at the top. The original round-figure estimate of cost was \$2,000,000, but that estimate was based on the belief that bed rock is nearer the surface than this year's investigations have shown it to be. But within a recent period the cost of handling rock has been cheapened by

improvements in methods resulting from the experience gained in the construction of the Chicago Drainage Canal and other works of recent date, and as it is known that the estimate of \$2,000,000 was a liberal one, it is thought that the cost of building The Buttes dam will not exceed that estimate, notwithstanding the disappointing distance to bed rock.

At Riverside there is another valuable site for a reservoir dam, and at that point a dam 350 feet long at the base and 800 feet at the crest would create a reservoir still greater than the one proposed for The Buttes. At Riverside the bed rock has been found much nearer the surface than at The Buttes, but at this writing the estimate of construction cost has not been made public.

At San Carlos, on the Apache Reservation, there is another site, to which much attention has been directed during this year's series of investigations. The conditions there are exceptionally favorable for economical construction. The river passes through a narrow gorge, and a dam 150 feet high would be but 200 feet long at the crest, and would create a reservoir of 361,000 acre-feet capacity.

Each of the reservoir sites above referred to is still within the control of the Government, and the building of a dam at either point would furnish not only an abundant supply of water for the Indians on the Gila River Reservation, but would afford a splendid surplus for the settlers of the middle Gila Valley. The actual importance of the storage capacity of the sites mentioned is better understood if considered in connection with the "duty of water."

The duty of water, or the quantity of water necessary to adequate irrigation of an acre of ground in the Gila, Salt River, and other valleys of this Territory, has not been fixed with the definiteness which has been ascertained in other irrigated communities of the West where the flow in the canals is closely regulated and therefore freer from complications in calculation. And while there are substantial differences of opinion, due to the variable and capricious supply, and the custom already alluded to, of lavish and wasteful use of the water in seasons of plenty, it appears to be fairly settled that the actual requirements of an acre of ground cultivated to growing crops throughout the year and irrigated at regular periods—as in the case of alfalfa, for instance—can not be filled with less than 2 acre-feet. But by no means is all the ground cultivated during the year. After producing its particular crop a tract may lie fallow for months. Also, a good percentage of the acreage is taken up by roads, buildings, and corrals, and bearing in mind that usually only the flood waters would be impounded, supplemental to which would be the normal flow, it would seem safe to accept the prevalent conclusion that the storage capacity of a reservoir will represent, acre for acre, its irrigating capacity.

The Gila River Reservation embraces 357,120 acres and at least 200,000 acres can be covered by irrigating canals. Under a storage system this reservation could be made to support all the civilized Indians in the territory, and still afford a large surplus of land for white settlers. It being an Executive order reservation, the land controlled by the Indians could be curtailed to the area actually required for their support, and the remainder thrown open to public settlement, simply by the order of the President.

It would seem that here is an exceptional situation which warrants Congress in making the necessary appropriation for the construction of a reservoir, quite independently of the broad question as to the advisability of the Government adopting a general policy of reservoir

construction. The wisdom of enabling the Indians to become self-supporting is universally admitted. When, as in this case, that policy can be carried out on lines financially profitable as well, there can be no objection urged on any valid ground. Not only would the Indians gladly pay for water, but the farmers in the valley between any reservoir and the reservation would be good customers for any surplus. It is entirely safe to predict that the irrigators would readily pay \$2 per acre per annum for stored water. Prominent and responsible ranchmen in the Salt River Valley have said that they would cheerfully pay \$3 per acre per year for a properly regulated and adequate supply, such as would be furnished by a reservoir.

On the Upper Gila, at the extreme eastern side of the Territory, there are one or more reservoir sites which could be utilized for a storage supply to the already prosperous farming regions of Graham County.

On the Lower Gila, as the valley below the junction of the Salt and Gila rivers is called, there are also sites where the construction of substantial dams would impound large quantities of water.

Another important site which has received much attention from the engineers of the Government is that on Queen Creek, in Pinal County, some 40 miles east of Phoenix. From a reservoir at this point some water could undoubtedly be furnished to the Gila River Reservation. It was estimated by the hydrographer who made the original reconnoissance (Mr. Arthur P. Davis) that a supply of about 10,000 acre-feet per annum could be depended upon from this project at a construction cost of \$200,000.

Storage is likewise feasible in the Santa Cruz Valley, Pima County, where irrigation has been carried on without cessation since the first settlement, more than fifty years ago, and also in Santa Cruz County.

In Navajo, Apache, and other counties containing smaller valleys, storage is equally practicable, as will be seen by referring to the detailed reports from counties.

ENTERPRISES PROJECTED FOR THE SALT RIVER VALLEY.

The most extensive irrigation developments in the Territory has been made in the Salt River Valley, in the country surrounding Phoenix, and comprising the largest contiguous acreage under irrigation in the United States. The valley proper may be said to embrace the lands adjacent to Salt River, between the mouth of the Rio Verde and the confluence of the Salt and Gila, a distance in a direct line of about 40 miles, and extending 15 miles or more on each side of the river for two-thirds of the distance below the Verde. However, the plains extending to the north and west and more or less separated from the valley by broken ranges or hills are commonly classed as part of the Salt River Valley. In this valley the pioneer settlements were made more than thirty years ago and a system of canals leading from Salt River gradually developed, until the entrance of the first railroad into the valley, less than fifteen years ago, when capital in large amounts was quickly absorbed in canal building. More than 300,000 acres were included in the general system which contains more than 600 miles of lateral ditches. It was soon thereafter ascertained that the canal system had been overdeveloped and that all of the 250,000 acres for which irrigation had been attempted could not be supplied with water each year. It has been from the standpoint of the needs of the Salt River Valley, therefore, that the investiga-

tion of the storage problem has been made most systematically by the irrigation interests of the Territory.

All collateral questions have been answered in every essential particular. The rich soil, more than 30 feet deep in many places, has been tested most thoroughly and has proved its adaptability to all the diversified crops of the temperate zone. The taxable wealth of Maricopa County, as fixed by the assessment of this year—\$9,312,482.50—represents an actual wealth of at least thirty millions, and as this is nearly altogether the outgrowth of the irrigation development of the valley, it speaks eloquently of the conditions under which farming has been conducted despite the insufficiency of the water supply. It is little wonder that the results achieved have been a decided incentive to sustained effort toward obtaining reservoirs for the valley.

Very fortunately some of the most favorably situated reservoir sites in the whole country are located on the streams supplying the valley.

THE RIO VERDE PROJECT.

This enterprise contemplates the storage of water on the Rio Verde, at a site known as the Horseshoe Reservoir. The dam will be 386 feet long at the bottom and 1,250 feet along the crest and 150 feet high above the low-water line. The reservoir thus created will have a capacity of 204,935 acre-feet. The drainage area tributary covers 6,000 square miles. The estimated cost for the Horseshoe Reservoir is \$600,000. It is designed to irrigate a tract of public land in what is known as Paradise Valley, comprising about 50,000 acres. Thence it is proposed to extend the canal across the Agua Fria to the Hassayampa River. It is estimated that between the head gates and the Agua Fria 125,000 acres can be irrigated, and the estimated cost of the canal from the reservoir to the Hassayampa River is \$1,200,000. Westward of the Agua Fria, and between that river and the Hassayampa, there is an additional tract of 125,000 acres of level and almost unbroken, sandy loam. Two other and smaller reservoirs for the same system are projected for ultimate construction—one at the crossing of New River, 59 miles by canal length from the Horseshoe Reservoir, partly to store the storm waters of New River, which is usually dry, and partly to receive the waste waters from the canal. A dam at this point 150 feet high and 1,800 feet long at the crest would, it is said, impound 100,000 acre-feet of water. The third reservoir contemplated is also subsidiary, and is located west of the Hassayampa. It is to be filled by a lateral from the main canal.

A considerable amount of work has been done on this project by the Rio Verde Canal Company, the completed work including a tunnel 900 feet long. All work has been suspended for some time, the magnitude of the project making it necessary to raise additional capital. The company claims to have sold water rights for about 100,000 acres of land, at prices ranging from \$10 to \$18 per acre, at the rate of \$1 down and the balance in yearly payments, but payment on water rights were, of course, suspended when construction ceased.

THE M'DOWELL SITE.

There is said to be another eligible reservoir site on the Verde River, between the mouth of that stream and old Fort McDowell, which could be utilized for storing the flood waters of the Verde not

impounded by the Rio Verde Canal Company's reservoir, but there is no reliable information at hand from which accurate statements of cost and capacity can be made. This reservoir, if constructed, would be tributary to the lands irrigated from the Salt River.

THE AGUA FRIA PROJECT.

This project comprises two reservoir dams and one diversion dam on the Agua Fria River. The diversion dam, a substantial structure of masonry, has been almost completed by the Agua Fria Land and Water Company. Some canal work has been done and a considerable amount of stone excavated for one of the reservoir dams. Work is suspended pending attempts to raise capital to complete the project. A glance at the map would seem to show that there may be a conflict of interest between this enterprise and that of the Rio Verde Canal Company, but there is little or no basis for that conclusion, as the vast tracts of land available for reclamation under the two systems could utilize all the water that they can both furnish.

The diversion dam, almost completed, is about 80 feet high above bed rock, and 40 feet above the stream bed, and is 650 feet long on top. The canal begins at the east end of the dam, in a 16-foot cut in solid rock, and has been constructed for a distance of 4 miles, whence it is proposed to carry the water across the river in a flume 700 feet long, and thence by canal in a southwesterly direction.

The first reservoir proposed to be constructed lies adjacent to the diversion dam, the distance from the latter to the reservoir dam being only $1\frac{1}{4}$ miles, and it is claimed that it will have a capacity of 50,000 acre-feet with a dam 100 feet high. Eight miles above the first reservoir site there is another dam site, 262 feet wide at the bottom, and but 500 feet wide at a height of 200 feet. It is claimed that the basin lying above this dam would hold 150,000 acre-feet of water, with a dam 150 feet high. This storage system when completed will reclaim 150,000 acres of magnificent land.

THE TONTO BASIN PROJECT.

This enterprise now under promotion by the Hudson Reservoir and Canal Company, and designed to regulate the supply and overcome the periodical shortage of water in the Salt River Valley, is the most comprehensive storage project yet brought to public attention. As an irrigation scheme it is the most ambitious in scope, and in its results will undoubtedly be one of the most far-reaching of all the industrial enterprises projected for the western country. Under existing conditions no other project can have such an intimate bearing on the further development and future welfare of the Salt River Valley. Among all the irrigation systems with which I am acquainted, it is unique, in that its main purpose is to supply a country already settled and ready for its service.

Recently the reservoir company has completed contracts with the leading canal companies operating in the valley, agreeing to supply them yearly with impounded water sufficient in quantity, when used with the normal flow of the river, to irrigate all the lands under the canals, estimated at 300,000 acres. It is understood that the canal companies are to pay the reservoir company \$1 per acre per annum. I consider that the making of these contracts marks one of the most important steps possible to be taken toward the solution of the water



HUDSON RESERVOIR AND CANAL COMPANY'S DAM SITE IN THE DISTANCE.

problem so far as it affects the Salt River Valley, and assures the permanent and unretarded prosperity of the valley from the time the reservoir is finished. By this means an abundant supply of irrigation water to the valley is assured, since the lands already under irrigation are to be supplied before the reservoir company undertakes the reclamation of lands under canals of its own.

The dam site is on the Salt River, in the mountains, some 60 miles northeast of Phoenix, at the point where the river, leaving the Tonto Basin, enters a deep, narrow gorge in the solid rock, known as the Box Canyon. The gorge is but 200 feet wide at the level of the stream, and for the first hundred feet upward the walls are perpendicular. In the preliminary reconnaissance bed rock was located at an average depth of 25 feet below the stream bed. It is proposed to build a masonry dam which will be 200 feet high above low water, and allowing for waste ways 20 feet deep, will create a reservoir 180 feet deep. The dam will be 650 feet long on top. The waste ways on each side of the dam are calculated to pass, without overtopping the dam, the greatest known flood, that of 1891, when the discharge during part of one day was equal to one-half of that running over Niagara Falls.

The reservoir site, covering over 18 square miles, is likewise ideally located by nature. Into this basin is carried the run-off from a drainage area of nearly 6,000 square miles, most of which is within the region of the greatest precipitation in the Territory. The greater portion of this watershed has a rainfall of 15 to 20 inches and upward, annually. It requires but $3\frac{1}{2}$ inches depth of run-off from this shed, or 20 per cent of 16 inches of rainfall, to produce 1,000,000 acre-feet. The storage capacity of the reservoir is limited only by the height of dam which it is practicable to build, and the capacity of the reservoir which will be created by the dam projected will be stupendous—no less than 757,000 acre-feet, or 32,670 million cubic feet of water. It is conservatively estimated that the 757,000 acre-feet thus stored will be ample for the irrigation of 500,000 acres of land. That the company is fully warranted by the water supply in constructing a reservoir of this enormous capacity can not be doubted. Measurements of the flow of Salt River during a period of years show the run-off to have been as follows:

	Acre-feet,
1889	1,134,780
1890	1,659,500
1891	2,000,000
1892	663,000
1893	1,000,000
1894	277,700
1895	1,124,000
First half of 1896	226,248

With a dam storing 757,000 acre-feet, the reservoir would have passed through this cycle of dry and wet years and supplied 750,000 acre-feet in every year but 1894 (said to be the driest year on record), when it would have yielded, with the water carried over from the previous year, nearly the quantity without emptying the reservoir.

Under the land act of March 3, 1891, the Government has granted the site to the reservoir company. From the dam site to the irrigated region of the valley, a distance of about 30 miles, the river flows through a canyon, and the company has appropriated, under the Territorial laws, this channel as its canal for conveying the impounded water.

It appears to be a very reasonable estimate that after meeting the requirements of the existing canal systems the reservoir will have a surplus of water sufficient for the irrigation of 200,000 acres of public land, thus making the total acreage served by it fully 500,000.

In the 200,000 acres of vacant land, for which this reservoir will be available, the Gila River Indian Reservation may be included to the extent necessary to supply the Indians with water, as Congress has granted to the Hudson Reservoir and Canal Company a right of way for its canal across that reservation, conditioned on the company supplying the Indians with water "on such fair and reasonable terms as may be prescribed by the Secretary of the Interior." To supply the Indians it would be necessary for the reservoir company merely to build a canal from the terminus of the Consolidated Canal, which is near the northern line of the reservation.

The estimated cost of the Tonto Basin dam, complete, is \$2,500,000. The plans are so drawn, however, as to permit of building the dam in two sections, so that in case of difficulty in procuring funds sufficient to build the dam to the ultimate height projected, the first section may be built to a height which will impound 300,000 acre-feet of water, the second section to be completed thereafter as convenient. But the indisputable merit of this enterprise should make it no difficult undertaking to obtain in the beginning all the capital necessary for construction.

Vitally important as this project is to the irrigation and all other vested interests in the Salt River Valley, the Globe copper mining district and the mining region between Globe and the dam are little less interested. To the mines and smelters of that locality the high cost of fuel is a serious hindrance to development and profit. Wood appears to be an exhausted quantity, practically, and coal costs \$12 per ton. The estimated average cost of producing a horse power for one year is \$187.50 for fuel alone.

Cheap electrical power would wonderfully stimulate the mining industry in that locality, and the reservoir company claims that it will develop a water power which will produce 10,240 horsepower, of which 6,768 horsepower can be transmitted electrically to Globe, 35 miles distant. I have received no estimate from the company of the cost of installing their electric power and transmission plant, but that it can be done at a cost not prohibitive of profitable operation I have no doubt.

THE DUTY OF THE GOVERNMENT.

In my opinion, the Government can and should come to the aid of the arid regions in a most effective way. It can be shown that, without expense to the National Treasury, an outlet can be provided for the surplus and home-seeking population of the East by making the desert lands habitable and productive; it can be shown that by exercising a wise policy at this time respecting the arid lands, the growth of the West—phenomenal as it has been through three decades—can be maintained indefinitely; it can be shown that these lands can be converted into a field for the enterprising young men of crowded communities equal or superior to that afforded by the Middle West during the years following the civil war. The question is a most important one for the consideration of Congress.

In this Territory it is possible to store the flood waters of the streams and thereby increase many fold the volume of water for irrigation. It is possible for the Government, without expense to itself,

to aid effectually the rapid reclamation of the irrigable lands within this Territory.

It is my belief that this great problem would be best solved by the cession of the public lands to the Territory. Once placed in control of these lands, our people, acting through their legislature, would be in a position to raise the necessary capital wherewith to construct the needed reservoirs.

Without water the lands can never have a value. They are absolutely worthless. As a rule the desert lands in the valleys are wholly unfit for even the most meager grazing. The Government derives no revenue from them, and never will, because practically all of the area which can be reclaimed through ordinary methods has been filed upon. That remaining vacant will, for all time, be in the hands of the Government—a worthless asset. Treating this subject briefly in my report for 1898, I said:

If it were possible to secure sufficient financial help from the General Government, to be expended under suitable regulations, to build canals and reservoirs for the reclamation of the arid lands of the West and thereby rapidly develop and populate the now unoccupied and unproductive sections, I would earnestly favor such a plan; but experience has taught us that Congress will not appropriate large sums of money for such a purpose, and the constituents of the members of Congress from the East and Middle West do not want their Representatives to appropriate money for which they will be taxed to bring into competition with them large areas of new farm lands; besides, any system which could with propriety be adopted under the usual governmental restrictions would be cumbersome and difficult of operation. I am therefore firmly of the opinion that the quickest, best, and most satisfactory way to secure the reclamation and occupancy of the arid portions of the country is to cede the lands to the States and Territories in which they lie, so that the question of disposition and development may be one for local legislation.

And the conclusion then stated has been fully supported by the proceedings of Congress during the last session. I regard it as hopeless to expect that the Government will embark upon a general policy of reservoir construction; and however equitable the premises upon which the request for that form of governmental assistance may be, it does not appear that any solution of the question can be hoped for in that direction.

It is true that one or more of the storage enterprises heretofore projected for this Territory appear to be on the eve of success, owing to the peculiar individual merit with which nature has endowed them and on account of the patient and persistent manner in which the effort has been carried forward to promote them, but their success will not satisfy all the needs of the Territory, and will leave the broader problem still unsolved. While the objections raised by the farmers of the East and Middle West to the appropriation of money for the purpose of promoting irrigation and developing competitive farm lands are unworthy and not deserving of consideration, yet they have considerable effect east of the Mississippi. No one can deny the great importance to the entire nation of the reclamation of the arid public lands, and few questions deserve more careful and effective consideration by Congress. There is no division of opinion in the West upon the question of Government help in reclaiming the arid lands, except as to the method. The people are unanimous in requesting Federal aid, but they are divided in opinion in some localities as to how that aid can be best extended. Some argue that a department or bureau of irrigation should be established by the Government to be conducted under the direction of the Geological Survey, and that the feasible reservoir and canal sites should be surveyed and located

by the officers of the department or bureau, and the lands under them reserved from entry pending construction, the money for construction to be obtained in continuous appropriations by Congress. This is the same old plan which was inaugurated in 1888 and now, as then, has a powerful lobby behind it, presumably working in the interests of parties who expect to be beneficiaries of the legislation if secured. The original plan was a failure, and Congress repealed the partial legislation which had been secured in its behalf. A careful analysis of the question ought to convince any reasoning mind of the utter impracticability of the system proposed.

In the first place, it is contended—and properly, I think—that the Government will never go into the business of reservoir and canal building and the distribution of water, except in specific cases of extraordinary merit and where the Government has collateral interests involved, such as the furnishing of water to Indian reservations. If the policy of building and operating canals and reservoirs were to be adopted by the Government on a sufficiently comprehensive scale to cover the entire arid West, it would involve the appropriation of hundreds of millions of dollars and require continuous appropriations for a long period of years, while the holding back of the settlement of the lands during the construction of water-storage systems, under the usually slow procedure of the Government, would retard instead of hasten the growth of the country. Not only that, but complications would certainly develop over questions of jurisdiction between the State and General Government and the interests of farming communities where crops are raised by natural rainfall and localities where the Government would be engaged in the business of irrigation. It would be as proper for the Government to engage in farming the lands reclaimed. It is not claimed that the Government will speedily construct the desired reservoirs and canals and turn them over without cost to the State or communities served. A large force of employees would be necessary, an embarrassing responsibility would be assumed, and an entirely new policy be required on the part of the Government. The foregoing are a few of the reasons why it is believed by many that aid upon the plan outlined can not be expected. It has been argued that the Fifty-fifth Congress very nearly appropriated \$300,000 for water-storage enterprises. I regret very much that the appropriations were not made, as they were proposed for specific enterprises of accepted merit, principally in Wyoming (there are equally meritorious propositions in Arizona), and I believe it to be the duty of Congress to aid in such cases; but if \$300,000 were to be distributed all over the arid West (and probably one State has as much right to recognition as another) that amount would not be sufficient for preliminary surveying. I am very much in favor of "Federal aid," but I wish the aid to be so effectively extended as to insure the maximum benefits. I advocate most earnestly the cession by Congress of the arid public lands to the States and Territories in which they lie, subject to suitable restrictions, similar to the provisions of the homestead law, or such other safeguards in the interests of actual settlers as Congress in its wisdom may see fit to impose. And after the lands have been ceded, the arid lands, States, and Territories should be aided further by Congress in the construction of specific and meritorious water-storage and irrigation systems in different localities with as much reason and justice as rivers and harbors are improved throughout the nation.

It is urged by the opponents of cession that the Carey Act, erroneously supposed by many to cede 1,000,000 acres of land to the State of Wyoming, was a failure, and did not result in the reclamation of any considerable amount of land. To correct the misinformed, it is proper to state the cession of the million acres under the provision of the Carey Act was conditioned upon reclamation, and title could not pass until after the land had been reclaimed. The State of Wyoming did not wish to go into the business of reclaiming lands as a State any more than the United States wants to engage in that occupation as a Government business.

Had the million acres been actually ceded, no doubt the State of Wyoming through its legislature could have adopted such a policy as would have insured the reclamation and occupancy of the lands.

LOCAL AID AND ENCOURAGEMENT TO STORAGE.

The energetic, resourceful, and self-reliant spirit which characterizes the people of Arizona has led them to do all within their power to promote storage enterprises. Corporations and individuals have done a large amount of troublesome and expensive preliminary work. The numerous reservoir sites have been closely explored and many of them have passed under the searching scrutiny of eminent engineers, and the feasibility of proposed reservoirs has been fully verified. In a few cases construction of some magnitude has been accomplished, but the work has been suspended while efforts are made to enlist additional capital.

Liberal laws have been enacted governing the appropriation of the flood waters and their conveyance through natural channels of the streams to the points of diversion. The work of educating the investing public as to the merits of storage enterprises has been carried on with patience and vigor, and with the return of prosperity to the whole country there have been encouraging indications within the past few months that Eastern capital is at last awakening to the value of Arizona reservoir securities. I have no doubt that final arrangements for the necessary capital for some of the best-known projects will be completed before another year.

Acting in accord with strongly pronounced public sentiment, in February of this year I addressed a special message to the legislative assembly recommending that an act be passed exempting from taxation for a period of years the reservoirs and canals which may be constructed within the next few years. It was pointed out that when reservoirs are constructed they can not fail to increase the taxable wealth and population of the Territory in a very large degree; that the enlargement of the water and irrigation systems of Arizona is an imperative necessity, and that exemption from taxation would encourage capital to come into the Territory and accomplish the necessary work. The legislature was of the same opinion, and passed an act exempting from taxation for the period of fifteen years the reservoirs and canals constructed within a certain time, and the act became a law in April.

Under the various forms of encouragement thus held out the people of the Territory have proved that they are ready to extend a ready and hearty welcome to investors in storage enterprises; and if Congress will add to those local efforts the impetus of national aid, by ceding the vacant lands, the Territory will be in a position to assure

the early construction of a complete and thorough water storage and irrigation system. Moreover, the intelligence, patriotism, and public spirit of the people provide an unquestionable guaranty that the lands would be controlled and disposed of as a sacred public trust and in a manner thoroughly protective of all public and private interests.

STATEHOOD.

The arguments heretofore urged in favor of the admission of Arizona as a State apply this year with added strength. The progress of the Territory in population, wealth, and the development of material resources has been remarkable. The rapidity with which Arizona has developed from a primitive frontier region into one of the most progressive, enlightened, and law-abiding communities of the Union is neither understood nor appreciated by Eastern representatives, otherwise the boon of self-government, for which we all pray, would not now be denied us.

The spirit of fairness, so prominent in our national character, would not longer permit Arizona to suffer the wrongs of Territorial vassalage, if the Territory and its people were properly understood east of the Mississippi.

Arizona has 100,000 people and one hundred millions of taxable wealth if it were all assessed.

Every argument and principle which should in justice and right be considered in connection with the admission of the Territories rests simply upon their ability to maintain themselves as States, and the desire of a majority of their people for self-government. No law, precedent, nor construction of law can be found to the contrary, and while no specific regulations exist for the guidance of Congress in the admission of States, the law as recognized by custom and precedent has become a fundamental part of our national policy, that whenever the people of a Territory of this Union express the desire for self-government and can furnish satisfactory proof of their competency in population and wealth, it is not only their right to be admitted to Statehood, but it is clearly the duty of Congress to admit them. This is conceded by all of the authorities on constitutional law and precedent, and any other view is repugnant to the very inspiration and patriotism of the Republic.

The Territory has greater wealth and population than had a large majority of the States when they were admitted, its undeveloped resources are almost incalculable, and the people unanimously demand recognition of the rights to which they are entitled under the Constitution. The Territorial form of government has existed in Arizona for thirty-five years. The fifteenth legislature of Arizona ten years ago authorized a constitutional convention and the election of delegates thereto, an election was had, a convention held, and a constitution framed, which at a subsequent election was ratified by the people.

These proceedings cost the Territory \$30,000, yet Congress would not recognize our just claims. Bills passed the House of Representatives for the admission of Arizona during the Fifty-second and Fifty-third Congresses and were favorably reported in the Senate, and both the Senate and House of Representatives of the Fifty-fourth Congress reported admission bills favorably, yet it has been impossible to obtain the just consideration to which we are entitled.

Statehood has been denied to Arizona because of sectional prejudice, ignorance, imaginary partisan policy, and pure selfishness. The latter

reason exists in the fact that our Eastern brethren are unwilling to divide legislative representation in Congress. They refuse to grant to their brother Americans of the West, who are their equals in every respect, the same privileges under the Constitution which they enjoy, and for which the founders of the Republic fought and bled.

Upon reflection, it is not so very surprising that ignorance and prejudice on this question exist in some of the older sections of the country. The great Webster, with all the power of his mighty eloquence, opposed the annexation of California, and declared the country west of the Rocky Mountains to be a great waste of shifting sands, bordered by 3,000 miles of bleak, uninviting seacoast; and another great New England senator—Winthrop—declared that the people he assumed to represent would be justified in secession if the "Louisiana purchase" were perfected. California is conceded to be one of the greatest and most valuable States of the Union, and within the "Louisiana purchase" there are now nine great States, besides the Indian Territory, Oklahoma, nearly all of Montana, Wyoming, and Colorado. Senator Winthrop opposed, with great vehemence, the annexation of Texas. Time does not seem to have made our New England brothers comparatively very much more expansive and liberal, nor much better informed as to the Western rights and conditions, unless the stirring events of the past year have opened their eyes.

Perhaps, on account of the annexation of Hawaii, and when our national policy is finally determined in regard to the government of territories acquired as the necessary results of an unforeseen and unpremeditated war, our Eastern friends will realize in some degree the importance and magnitude of this nation, and be more willing, "in order to form a perfect union, establish justice, insure domestic tranquillity, provide for the common defense, promote the general welfare, and secure the blessings of liberty," to recognize that other citizens of the United States are entitled to be as free as they are, and "hold these truths to be self-evident; that all men are created equal; that they are endowed by their Creator with certain inalienable rights; that among these are life, liberty, and the pursuit of happiness; that to secure these rights governments are instituted among men, deriving their just power from the consent of the governed."

RECOMMENDATIONS FOR CONGRESSIONAL LEGISLATION, AND ACTION OF THE INTERIOR DEPARTMENT.

- (1) That Arizona be admitted as a State.
- (2) That all the public lands within the Territory be ceded to the Territory or State.
- (3) That until the lands are ceded authority be granted to the Territory to lease the grazing lands.
- (4) That all the lands within the Territory be surveyed, especially the railroad-grant lands, so that they may be taxed.
- (5) That a Government assay office and branch mint be established within the Territory.
- (6) That the act of Congress of June 27, 1866, granting right of way to the Atlantic and Pacific Railroad Company, and exempting said right of way from taxation in Territories, be so amended as to permit the taxing of track and superstructures on the right of way.
- (7) That the salaries of the Federal judges of the Territory be increased.

SUPERINTENDENT TERRITORIAL PRISON.

Herbert Brown, Yuma.

SUPERINTENDENT TERRITORIAL INSANE ASYLUM.

Dr. J. Miller, Phoenix.

LIVE-STOCK SANITARY COMMISSION.

W. C. Barnes, Holbrook, chairman; A. C. McQueen, Mesa; W. F. Nichols, Willcox.

TERRITORIAL VETERINARIAN.

Dr. J. C. Norton, Phoenix.

FISH AND GAME COMMISSIONERS.

J. L. V. Thomas, Flagstaff; John McCarty, J. K. Day.

UNITED STATES DISTRICT ATTORNEY.

R. E. Morrison, Prescott; assistant U. S. attorney, Thomas D. Bennett, Phoenix.

UNITED STATES MARSHAL.

William M. Griffith, Tucson.

UNITED STATES INTERNAL REVENUE COLLECTOR FOR NEW MEXICO AND ARIZONA.

A. L. Morrison, Santa Fe, New Mexico; chief deputy, first division, S. M. Cullom, Phoenix.

UNITED STATES INTERNAL REVENUE COLLECTOR OF CUSTOMS.

H. K. Chenoweth, Nogales.

UNITED STATES LAND OFFICE, PRESCOTT.

F. A. Tritle, register; J. C. Martin receiver.

UNITED STATES LAND OFFICE, TUCSON.

M. W. Moore, register; J. H. Bauman, receiver.

UNITED STATES SURVEYOR-GENERAL.

George Christ, Tucson.

DELEGATE TO CONGRESS.

J. F. Wilson, Prescott.

BOARD OF REGISTRATION IN DENTISTRY.

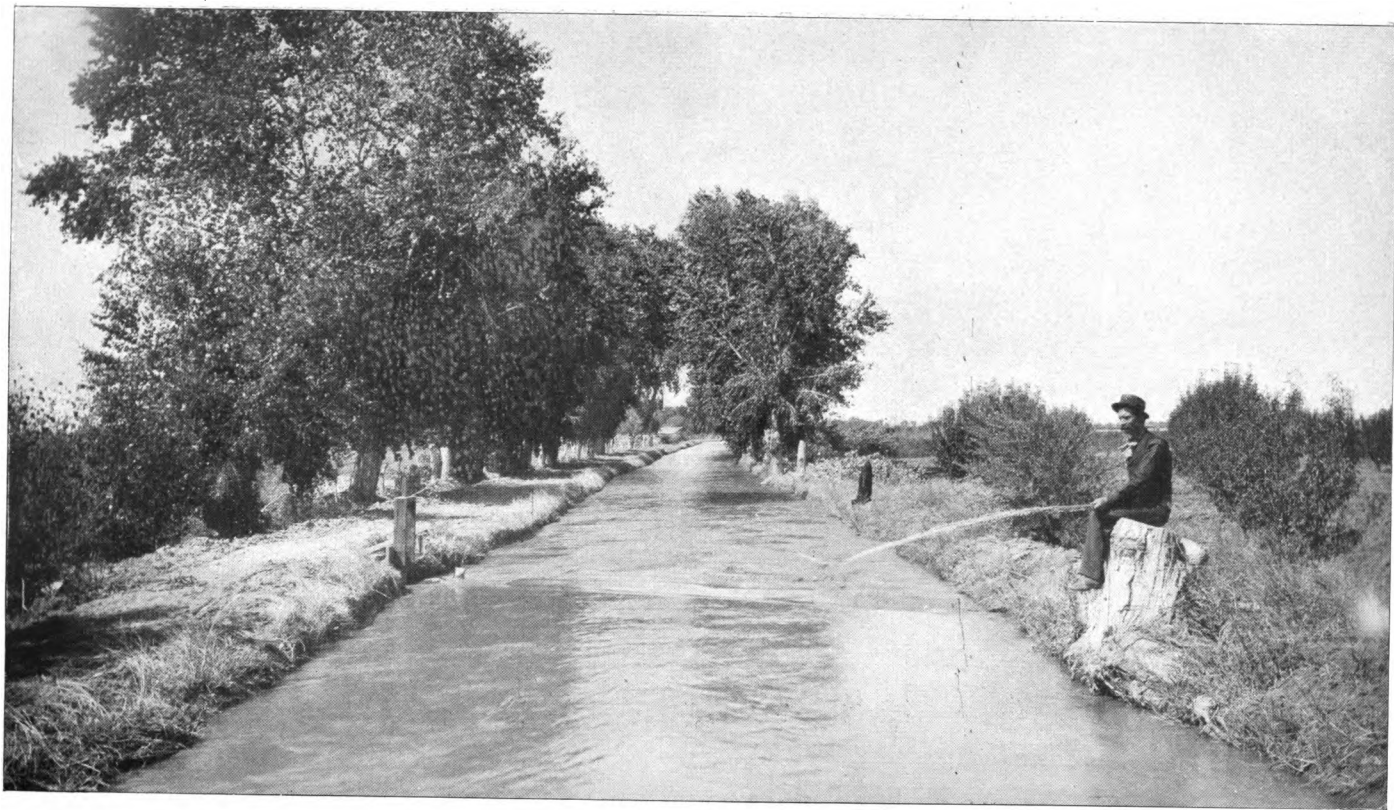
F. C. Devendorf, Tucson; A. A. Doherty, Nogales; E. C. Hyde, Phoenix; H. J. Jessop, Phoenix; A. P. Preston, Globe.

BOARD OF MEDICAL EXAMINERS.

Winfred Wylie (regular school), Phoenix; D. M. Purman (regular school), Phoenix; George Goodfellow (regular school), Tucson; W. L. Woodruff (homeopathic school), Phoenix; C. W. Woods (eclectic school), Jerome.

CAPITOL GROUNDS AND BUILDING COMMISSION.

E. B. Gage, Prescott; Walter Talbot, Phoenix; Frank H. Parker, Phoenix.



IRRIGATING CANAL, MARICOPA COUNTY.

APPENDIX B.

GENERAL CONDITION AND PROGRESS OF THE TERRITORY AS REPORTED BY COUNTIES.

MARICOPA COUNTY.

County seat, Phoenix.

County officers—Supervisors: J. T. Priest, J. A. Marshall, J. R. Norton; sheriff, D. L. Murray; treasurer, M. W. Messenger; recorder, F. W. Sheridan; district attorney, Thomas E. Flannigan; probate judge, N. A. Morford; county school superintendent, A. H. Fulton; assessor, L. W. Coggins; clerk board of supervisors, John Gray.

The county of Maricopa lies in the south central part of the Territory and was created in 1871 from a part of Yavapai County, but notwithstanding its age as a county Maricopa is really young as to development. Its settlement and growth as a modern community dates from the advent of the railroads. The county may be said to be less than two decades old. It embraces within its boundaries the great Salt River Valley, the fame of which has extended to all parts of the world. This county contains one of the largest tracts of irrigable land in the United States, estimated to be over 1,500,000 acres. The surface of this irrigable area is remarkably level, sloping by easy gradients to drainage streams with which the entire county is abundantly supplied. From the northeast to the southwest, through the valley, flows the Salt River (a misnomer, as far as its saline properties are concerned), to a distance of about 20 miles southwest of Phoenix, where it joins the Gila, which changes its course from west to southwest, crosses the western boundary line of the county, and enters the Colorado River at the town of Yuma.

The topographical features of the county are most pleasing. The northeast and east is one continuous range of mountains and foothills, while through the valley are many curiously formed peaks, all of which go to diversify and beautify what has been most truthfully designated as the most lovely valley on the American Continent.

SOIL AND CLIMATE.

The soil in the Salt River Valley is incomparable in its productive capacities. In fact, it is limited only in this respect by its water supply. The mesa land is gray sandy loam, while nearer the stream it changes into a dark rich soil, admirably adapted to the growth of alfalfa, wheat, barley, and all kinds of vegetables, sugar cane, watermelons, etc., while the lands of the mesas have demonstrated that for the growth of oranges, lemons, and all citrus and deciduous fruits they have no equal in this or any other country. The soil when irrigated is a rich alluvium, and is of marvelous depth, and the waters which give life to the plants and trees in this garden of the New World, not unlike that of the Nile, carries a large percentage of sediment which is incomparable as a fertilizer and continually enriches the soil cultivated.

The Senate of the United States appointed a special committee to examine into the possibilities of irrigation, and they passed several days in the intelligent examination of the soil, climate, and agricultural conditions of the Salt River Valley. In their report we find on page 60 the following testimony: "A careful analysis of this soil shows its fertile qualities to be superior to the Nile earth." When we think of the early history of civilization, its marvelous growth and development, and then realize that civilization and ancient greatness had its high tide along the course of the Nile, we marvel at the future of this new Eden of the West. Most of this valley's soils are the accumulated washings from the surrounding hills, made up of the fine particles that have been, during countless centuries, disintegrated by frost or the elements. The water is also charged with new fertility.

One fact here may show the value of irrigation as a fertilizer. The Pima and Maricopa Indians along the river in this valley live by farming and stock feeding. The system of irrigation used by them for centuries is of the rudest nature, yet they have always been self-supporting, never having cost the Government a dollar. They have no tradition running back to the time when their ancestors did not cultivate these valleys, sowing from year to year the same variety of wheat, never changing the seed in all these years, and neither the grain nor the soil shows signs of exhaustion. No wheat of greater beauty nor of more excellent quality can be found.

SPECIAL ADVANTAGES.

The Salt River Valley has many advantages besides its climate, soil, and conditions. It is six weeks earlier in the market with apricots, grapes, oranges, and peaches, thus sure of securing a ready sale for its products. The early fruits always command the highest prices and most ready sale.

The extensive fields of alfalfa in this valley afford fine opportunities for the fattening of stock, of which the stockmen of the various counties have taken advantage, and this is a source of great profit to the farmer.

In this southern territory is the coming agricultural empire of the continent. Palmyra of old, Egypt in the days of the greater Rameses, and the plains of greater India must be brought to mind before the infinite possibilities of the region can be even dimly comprehended. Along a single Arizona river is a greater arable area than in all the lately acquired Hawaiian Isles. In the single valley of the Salt, where 250,000 acres partially cultivated maintain a population of 30,000, are yet untouched a million acres, susceptible of irrigation and as well fitted by nature for agricultural production as are any of the acres already sown. This development to the extent of the arable land will come with the conservation of the flood waters of the Salt, as a similar and no less phenomenal change will come through the same means to the upper and lower valleys of the Gila River.

The soil of the great undeveloped plains or deserts is almost uniform. Near the stream channels are to be found strips of clay-like black adobe, with occasional streaks of alkali, containing varying proportions of mineral salts. The upper-lying land is lighter, though it is not to be classed as less rich. It abounds in lime, particularly in lime sulphate (gypsum). It is lacking in two elements, vegetable humus and iron. Both are readily secured by cropping for several years to alfalfa. Thus prepared, through the planting and plowing under of alfalfa, the land is at its best.

Alfalfa is king in the southland. Of this there can be no dispute. Around about Phoenix 60,000 acres are planted to it, and rich is the owner of a farm thereof. The past season was a mortgage lifter with the alfalfa raisers of the Salt River Valley. Crops were good; those of California were poor. The local granger, till rain came to the Golden State, loftily declined tenders of less than \$12 a ton for his baled hay, delivered on the cars. It had cost him about \$1 a ton to cut and stack and little more than that to bale. This condition, however, was rough on the Arizona cattlemen, who annually drive their feeders to Phoenix. Fewer cattle, by far, were brought to the valley, for pasturage rates rose, and cut alfalfa is rather dear fattening material at a dozen dollars a ton.

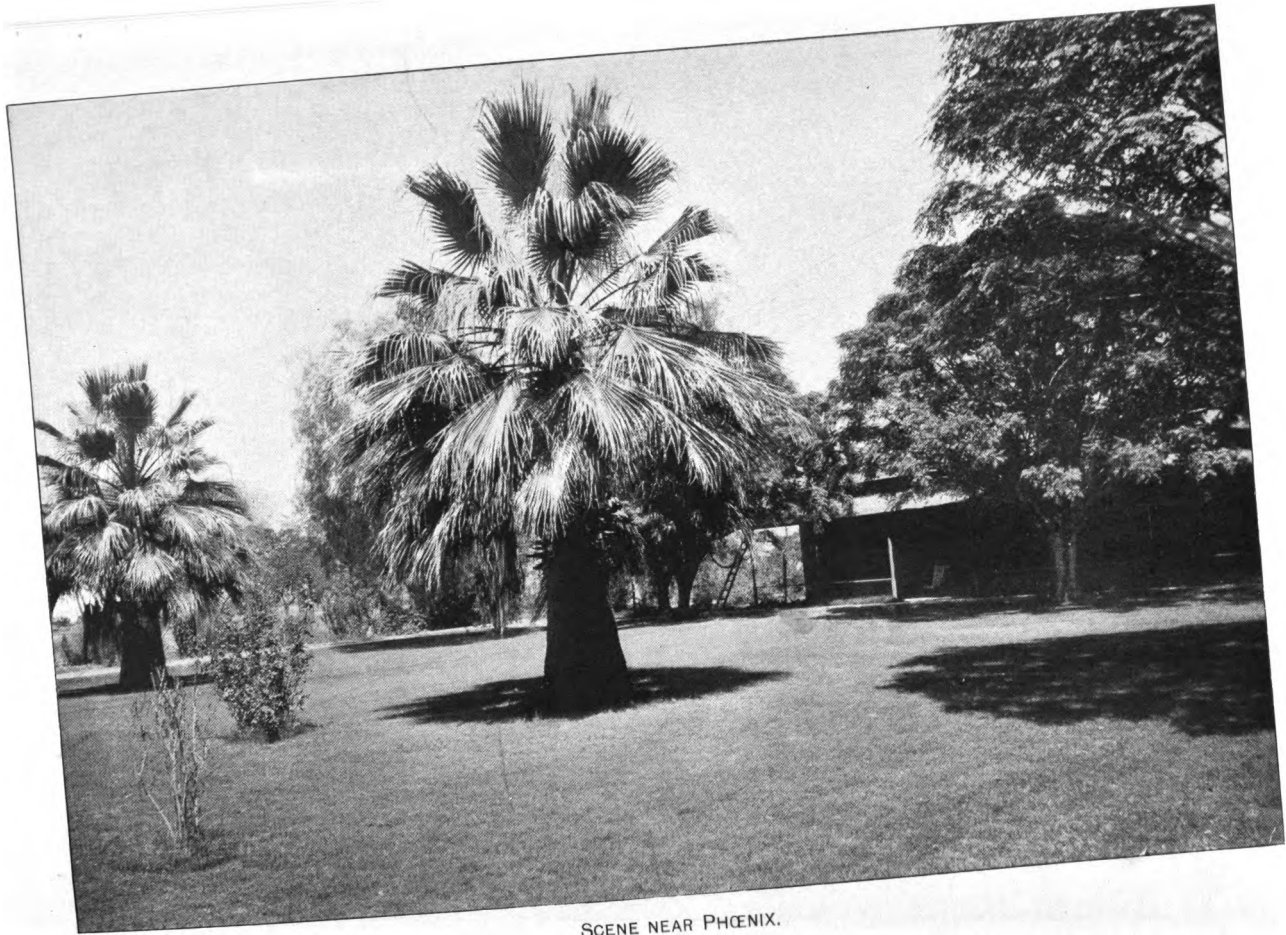
A farmer can and does, in average seasons, clear from \$10 to \$25 an acre from his easily attended alfalfa field. Better than that few farmers do anywhere. The newcomer will hear tales of single cuttings of 5 tons of alfalfa to the acre, and again of five cuttings per annum. The tales are true, though such records are rare. A common crop is 6 tons to the acre, and three cuttings. Compute this at \$5 a ton in the stack, and you figure up a very decent income for a man with a 160-acre ranch. The labor bill is a light one. The farmer and one hired hand, with a couple of extra men and a hayrake boy in summer, do all the business. If he wants more income and more work, he buys a hundred head of lean mountain cattle and feeds them to fatness. As a rule, the farmer who does this doubles his investment, marketing his crop on its own feet, instead of by weary wagon haul.

All over the Salt River Valley is to be found the prosperous man who owes his plenty to alfalfa. South of Tempe there lives a farmer who fifteen years ago worked for \$26 a month when he was fortunate enough to get work. To-day M. Ellingsen, in lands, water shares, and town property, is worth more than \$100,000. Every dollar was made out of the Chilean clover, planted on two quarter sections of good land. A dozen similar instances might be cited. And the same can be done to-day and to-morrow. The demand for alfalfa must last as long as humanity eats beef.

If ever there was a lazy man's crop it is alfalfa. In the summer it pushes the granger hard, but the rest of the year he needs do little save attend to his fences,



APRICOT ORCHARD.



SCENE NEAR PHOENIX.

watch the fattening of his kine, and market the butter his good wife makes. He will irrigate about as often as the Zanjero will let him.

Yet there are farmers in Arizona's southern valleys who get along with only enough alfalfa to properly keep two horses, a cow, and a run of chickens. Wheat and barley are usually profitable, and when properly sown and intelligently irrigated, produce from 1,500 to 2,800 pounds to the acre. Both of the cereals, to secure the best results, should be sown before the Arizona winter sets in, and return the heaviest yield when sown in ground that has been irrigated and then plowed. The plowing is advisable in all cases, even when the land is new and as light as an ash heap. If irrigated after sowing the silt of the water and the lime of the soil form a crust through which the shoots find difficult egress. Barley is raised in the southwest for horse feed, taking the place of oats. Oats, save under exceptional circumstances and with northern-grown seed, fail to mature their grain, though the wild oats grow luxuriantly and is esteemed for hay.

Corn of whatever variety does best when planted in the middle of summer after the grain crop is off, yet is rarely a complete success. The main trouble lies in the lack of vegetable matter (nitrogen) in the soil. This was well demonstrated two years ago, when E. G. Frankenburg, a south-side farmer, raised 80 bushels of corn to the acre on an old alfalfa field he had plowed up for reseeded.

Almost to infinity is the list of special field crops that may be raised in the irrigated valleys. Perhaps in days to come sugar beets will occupy in acreage the place next below alfalfa. Thus far it is believed the best methods of sugar-beet cultivation have not been discovered, though one variety of beet, the Klein-Wanzlebener, has been fixed upon by the American agricultural experiment stations as best adapted to local conditions. In saccharine strength and purity the best Arizona beets have thus far come from localities with altitudes above 2,000 feet. Sugar cane thrives in all luxuriance, as does sorghum. Both have been utilized in the manufacture of molasses. Sorghum is one of the most profitable crops when grown for fattening cattle. The feeder secures the quickest and most economical results who combines sorghum with alfalfa hay.

DAIRYING.

Statistics show that among the many great industries of the United States the dairy interest is one of the most important. Nine hundred millions of dollars of annual production, distributed among thousands of producers, creamery men, cheese makers, dealers, and laborers in every department of the work, must indeed prove a material factor of general prosperity. It is also a known fact that no class of people are more uniformly successful than the dairymen, and no sections of our country present so many visible signs of permanent prosperity as those sections devoted to dairying.

If accurate means were at hand to secure perfect statistics, the value of the milk product of this country would probably prove to be close upon \$1,000,000,000 annually—more than twice the value of the wheat crop of the entire country.

But what part have we of this valley in this great industry? It does not take a very old resident to remember when milk from a few range cows, set in tin pans, skimmed with a tin skimmer, churned in a dash churn, the product misnamed butter, taken to market in tin fruit cans, constituted the dairy output of Maricopa County. The misnamed product was bartered to the local grocerymen, for, I will not say a small price, although it could not be sold to-day at any price. It brought a good price then because it was all there was to be had.

But the dairy industry has grown from nothing until to-day it is one of our leading sources of income, bringing into the valley not less than \$100,000 annually, and contributing an annual product of no less than \$125,000. In fact, some conservative men place it much higher. But this much at least is known from figures based upon actual weights.

Naturally it is asked what are some of the factors which have contributed to the building up of this industry?

First, the mild and equable climate of our valley has proven the natural home for the dairy cow. Freed from the excessive cold and severe storms of other sections, she will produce larger returns and give in milk more continuously. Then, again, our luxuriant alfalfa comes as near being a balanced ration as anything known—that is, as one thing. That being true, naturally our cows need never be hungry. This feed, combined with sorghum for a part of the year and the fresh green grainfields for the winter months, with plenty of hay at all seasons, leaves little to be desired for the highest productiveness at the least cost. Then, to give impetus to the business, comes the fact that we are surrounded in our own Territory with a market which as yet we are in no wise able to supply.

Realizing these many advantages, a few of our most progressive farmers on either side of the river have combined to profit by these conditions. For some five years the Tempe-Mesa Produce Company has been in successful operation.

Less than three years ago was organized the Maricopa Creamery Company, which has been in successful operation for the past two years. It is organized upon a cooperative basis, the stock in the main being held among the farmers and dairymen. By hard work and careful management the beginning of a great industry in our valley has been put upon a solid business basis. The milk producers have been treated fairly, and at the same time the stockholder has realized a small per cent for the use of his money. In the meantime a trade has been secured which far exceeds the productive capacity of the present herds to supply. There is no question but that the man who goes into the dairy business and handles it with business sense, such as is necessary for success in anything, will realize handsomely upon his investment, whether that investment be brains and specialized skill, careful, conscientious labor for another, or the capital of the investor seeking a fair interest upon his money in a perfectly safe business.

HORTICULTURE.

Ever since the first irrigating canal was taken out of the Salt River in 1868 fruits have been raised here for family use; but as the valley had no connection by rail with the outside world, there was no incentive to plant orchards and expect a commercial return. The completion of the Maricopa and Phoenix and the Santa Fe, Prescott and Phoenix railways, however, gave the valley markets both east and west, since which time the acreage of all kinds of fruits has been constantly increasing, and fruits raised in this valley have been marketed from Augusta, Me., to Los Angeles. Fresh apricots, grapes, oranges, pears, almonds, peaches, watermelons, dried fruits, and pickled olives have been shipped in car-load lots for the past three years. This valley also supplies all points in Arizona by shipments with all varieties of fruits, and has shipped early apricots and watermelons even to California. There are about 800 acres in the valley planted to apricots. The principal varieties are the Royal, the Moorpark, and the Newcastle. Apricots here are regular bearers, and every year the trees bear more fruit than should be permitted to mature. This is one thing that the orchardists here, as elsewhere, are slow to learn. If the fruits on the trees were thinned soon after it formed, not only would the remaining fruit be much larger in size, but the quality would be finer. Several new varieties of apricots, of larger size and better flavor than the standard varieties, have been introduced in the valley. The fruit of the Elvey seedling, first grown by Mr. T. K. Elvey, of this valley, is large and of fine flavor and the trees bear regularly. There are also a few trees of a variety something similar to the old peach-apricot, but the fruit is of much finer quality and larger in size and is probably similar to the Routier apricot, recently introduced into California.

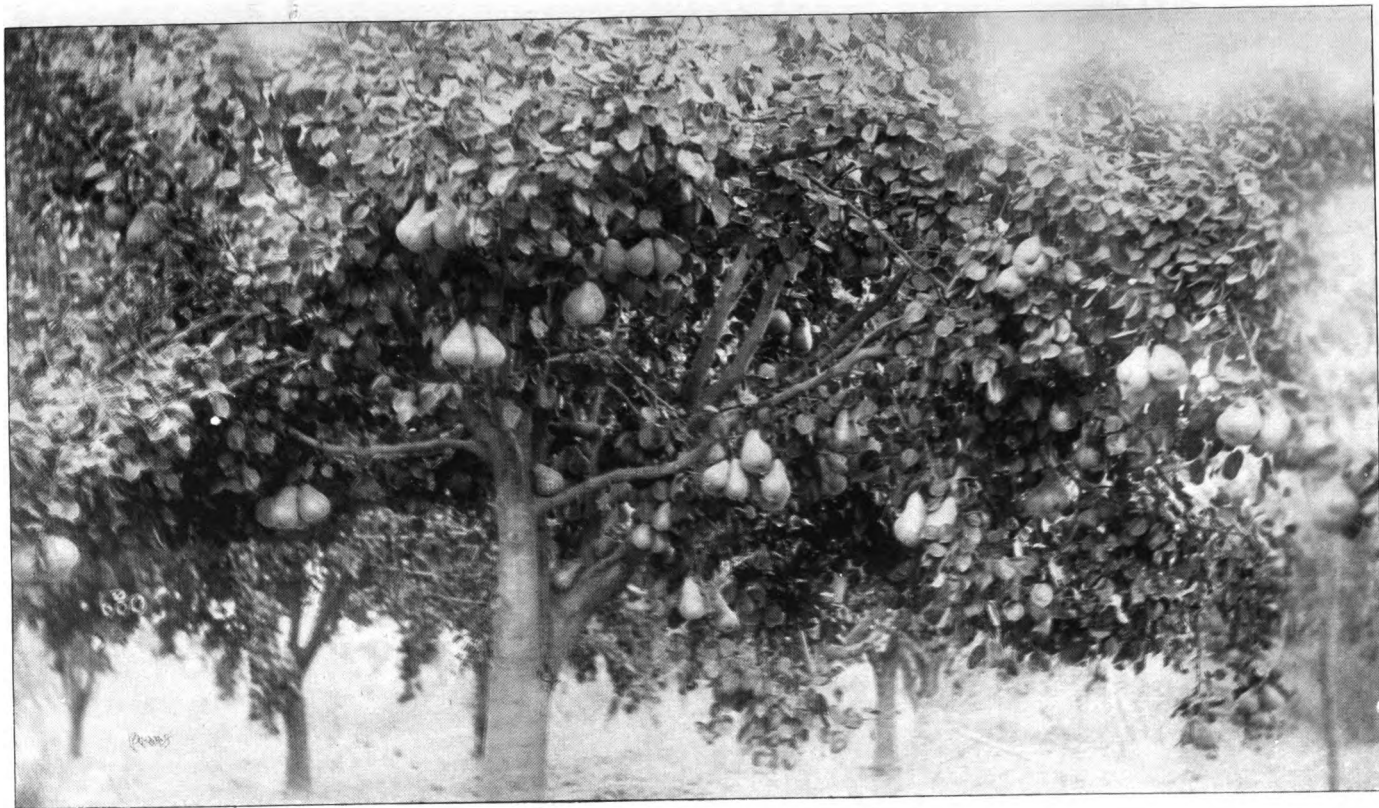
Apricots ripen here early in May, which is some three weeks earlier than the California apricot matures.

Apricot trees are set 109 to the acre, and when in full bearing ought to average over 200 pounds per tree. Three hundred to 350 pounds is nothing uncommon for a full-grown tree. Several carloads of apricots have been shipped East in refrigerator cars. Owing to the perishable nature of the fruit, however, it is considered more satisfactory by many horticulturists to dry the fruit and dispose of the crop in that way. Rain is almost unheard of during the time when apricots mature, which gives the growers here an opportunity to dry their fruit under ideal conditions. Four or 5 pounds of green fruit will make 1 pound of dried fruit, which sells for about 8 cents per pound.

The better variety of peaches here bear regularly. The Salway is one of the most satisfactory varieties. It grows very large, has a fine flavor, and is suitable for canning or drying. The Strawberry peach and the Orange and Lemon Clings are all fine-flavored fruit of beautiful appearance, and do well here.

The principal varieties of pears raised are the Bartlett and Winter Nellis. Both bear regularly and abundantly and are readily marketed, both green and dried. The Winter Nellis pear is very hardy and will stand very rough handling. After picking they can be packed into barrels, and if necessary shipped to Liverpool.

Almond trees grow rapidly, commence to bear at 3 years old and are in full bearing at 8 years of age. The best varieties are Ne Plus Ultra, I X L, Nonpareil, Paper Shell, and Smith Seedling. This latter variety was discovered and introduced by Mr. A. H. Smith, of this valley, who claims that it blossoms later than other varieties and for that reason is less liable to frosts in exposed places in the valley. Full-grown trees will bear 60 pounds of almonds and over to the tree.



PEARS, SALT RIVER VALLEY.

Last year growers received 10 cents per pound in Phoenix. The largest and most profitable almond orchard in the West is owned by Mr. E. J. Trippel, of Mesa, Ariz.

The Salt River Valley is undoubtedly the ideal home of the grape. Among the varieties suited to this climate are the Muscat, Malaga, Thompson Seedless, Rose of Peru, Mission, and Sultana. They bear abundantly every year. A failure in the grape crop is absolutely unknown. To a person unfamiliar with conditions in a country like this the average yield seems phenomenal. A full-grown Thompson Seedless vine will bear in weight half as much fruit as an apricot tree, and when it is remembered that the vines are set about 500 to the acre it will be readily understood that a man with 10 acres of grapes will have something of a crop to harvest. The seedless Sultana when dried makes the commercial California currant. The Muscat is a raisin grape and needs no introduction to our readers, as that has been the standard raisin grape of Italy and France, as well as California, for many years. The long warm summer of Arizona, which gives our oranges their exquisite flavor, also puts sugar in the grapes, which is one of the requisites for first-class raisins. For the same reason here grapes are too sweet to make good dry wines, but are well adapted for making the sweeter wines and brandies.

Arizona strawberries have more than a local reputation. Express shipments are made from Phoenix from spring to fall of a quality of berry which equals, if not surpasses, berries from any other locality in the world. The Arizona ever-bearing strawberry, which was first propagated in this valley, is now on every nursery list in California.

In California, Italy, and France olive trees come into bearing when about 10 years old. The oldest olive trees in the Salt River Valley are only 6 years old, and last year bore abundantly, which was all the more notable as the California crop in that year was a complete failure. The olive is a comparatively hardy tree and seems to thrive well on sandy, rocky soil, but responds in yield to richer soil. The principal varieties so far planted here are Manzanillo, Navadillo, Mission, and Columella. The Manzanillo and Navadillo are the heaviest bearers, the Manzanillo being the best pickling olive, and the Navadillo is the best adapted to oil. These two varieties begin to ripen the latter part of August, which is about two months earlier than the same varieties mature in California. Both pickling and crushing for oil are comparatively simple processes, and there is no reason why Arizona should not produce as fine olive oil and pickles as are made in the world. Three carloads of olives were pickled in Phoenix last fall and shipped to Eastern markets.

While during the past three years Arizona has become well known in many sections of the country as producing very fine deciduous fruits, yet it is through her citrus fruits, and especially her oranges, that Arizona has gained special distinction outside of her own borders. Salt River Valley oranges are well known in the markets of New York, Boston, Chicago, Philadelphia, and other Eastern cities. A large commission house wrote to a dealer here last fall that the finest oranges received in that market during the season were from the Salt River Valley. At the California Midwinter Fair Salt River Valley Washington navel oranges received a first-premium gold medal for excellence, and this after being picked for two months and shipped a thousand miles. Not alone are the Washington navel oranges of the Salt River Valley as fine in quality as any grown, thin skinned, sweeter than those from California, as juicy as a Jamaica orange, and more highly colored than those from the Indian River country of Florida, but, what is more important than all to the grower, they are the earliest navel oranges to ripen in the United States. Orange picking commences in the valley early in November and lasts until after the holidays, the latest varieties ripening in January. California navel oranges ripen the latter part of December, January, and February. Last year the Ingleside Company had a carload of navel oranges in the Chicago market nearly a week before Thanksgiving.

Many varieties are raised here, including the Washington navel, St. Michael's, Jaffa, Heart's Tardiff, Mediterranean Sweets, and Parson Brown. The navel is of course the popular variety in the markets of the East, and are our largest and finest fruit. They do not, however, bear quite so heavily as some other varieties. Blood oranges, while much smaller than the navel, have a distinct and excellent quality, and have many friends. The little Japanese "Kid Glove" oranges, the Mandarin and the Tangerine, bear regularly and well here, and are quite profitable.

The orange is a very long-lived tree. In California and the countries surrounding the Mediterranean orange trees bear regularly up to one hundred years, and there seems to be no reason why they should be shorter lived here. Trees come

into bearing here at three years, after which time the yield will probably increase steadily up to twenty-five years.

The great freezes which for two successive seasons have devastated the entire State of Florida seem to demonstrate the fact that there is no citrus belt in this country outside of Arizona and California. During last winter, which was an unusually cold one, not a tree was damaged in the citrus belt of this valley.

There are 1,000 acres now planted to oranges. About 50 acres on the south side of Salt River and the balance along the foothills, commencing at a point about 6 miles due north of Phoenix and running east to the east end of Camel Back Mountain. The largest grove in the valley is owned by the Ingleside Company. It lies directly south of Camel Back Mountain and is under the Arizona Canal. This grove is the oldest in the valley, contains about 100 acres, and is planted almost entirely to Washington navel oranges.

The foreman of the Ingleside grove estimates that the yield on the oldest trees will average about 250 boxes per acre.

There is a very fine group of citrus groves about a mile and a half west of the Ingleside grove. This includes Mr. W. J. Murphy's grove of Washington navels and grape fruit, Dr. Hardy's grove of Jaffas and Mediterranean Sweets and Mr. Ward's grove. Mr. Ward, perhaps, cultivates more different varieties of citrus fruits than any other grower in the valley. His orchard includes grape fruit, tangerines, Jaffas, Mediterranean Sweets, and lemons.

The nearest groves to Phoenix are in the suburb of Orangewood, on Central avenue, about 6 miles north of Phoenix. There are at present 10 orchards in this attractive suburb and are planted almost exclusively to Washington navel oranges. Many of these groves are owned by retired business men, who expect to make their orange groves the site of ideal homes. The oldest of these groves belongs to Dr. Mulvane, a prominent physician of Chicago, who plans to make his future home in this valley. All of these groves are in a high state of cultivation and give promise of large returns when the trees come into full bearing.

There is a great future in this valley for the propagation of pomeloes or grape fruit. Grape fruit ripens here very early, and there are some varieties which can be put on the market fully matured at Thanksgiving. At that time last fall grape fruit was selling in New York and Chicago at \$8 per box. It needs no expert mathematician to compute profits at these figures. Grape fruit bears regularly and well here, and the varieties so far introduced seem really to improve under the conditions they find in this valley. Some of the growers here are experimenting with a seedless variety, which gives good promise of success.

Lemons have been propagated on a small scale for several years, and do very well. The profits in them, however, are smaller than in oranges and pomeloes, and for that reason they have not been extensively cultivated.

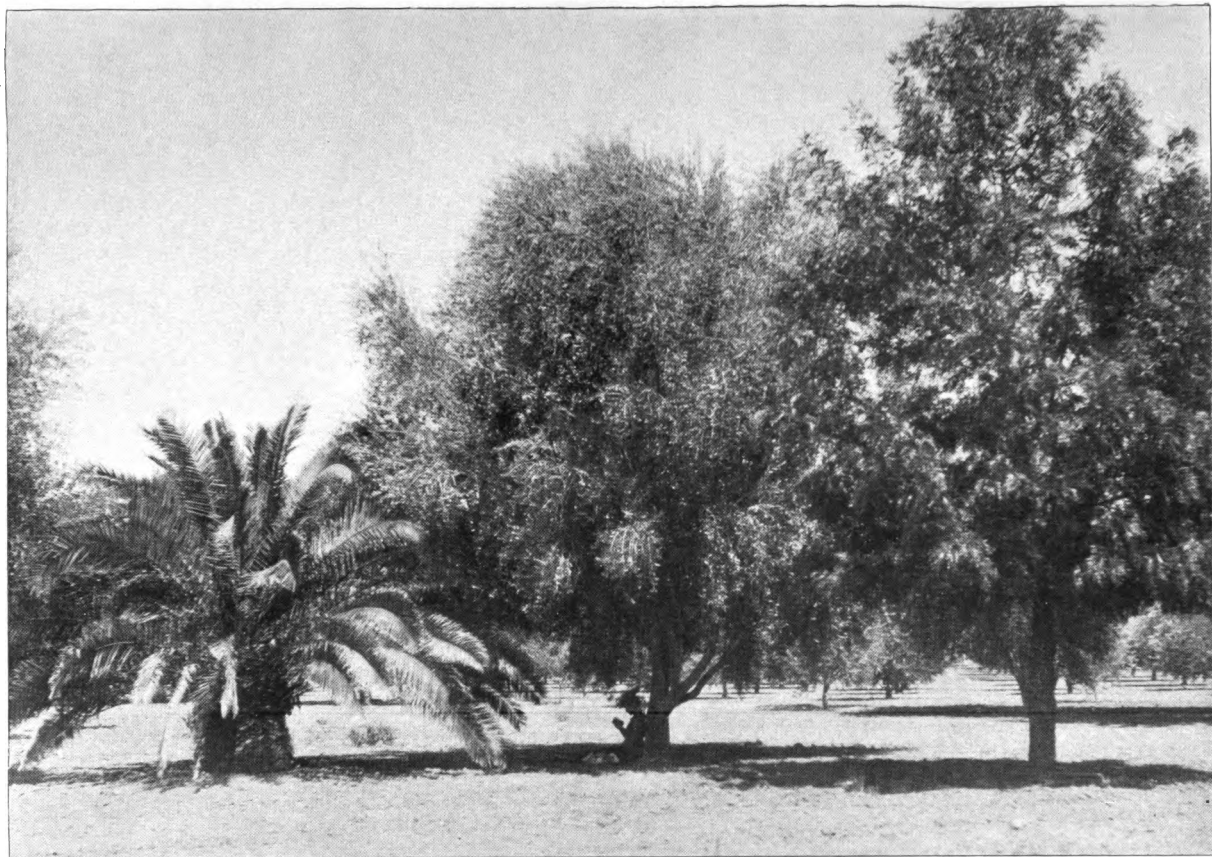
The Salt River Valley enjoys the distinction of being the only place in the United States where dates can be successfully raised. The date palm tree flourishes in southern California, but does not fruit. Only the female or pistillate tree bears, which has to be fertilized from the pollen of the blossom of the male or staminate tree. All the female trees over 6 years of age in the valley bear regularly when pollenized. Several bunches of dates were shipped in 1897 to the horticultural fair in Madison Square Garden. The quality of the dates was highly commented on, and they were one of the unique features of the fair.

In addition to the above named, many other varieties of fruit are grown in the valley, and while excellent in quality, are not so extensively raised as the kinds mentioned. Plums deserve special mention. All of the finer California varieties are grown and do well. The *Prunus Simona* is a delicious fruit, large, of a golden straw-color, changing to a deep crimson. The *Wickson* is a little smaller, being about the size of the *Kelsey Japan*, and is a delicious fruit, either eaten ripe or for canning purposes. The *Wickson* plum begins to bear at 2 years old, and is in full bearing at four or five years, when the average amounts to over 150 pounds per tree. The white or *Smyrna* fig of commerce is grown in the valley, but the trees bear irregularly, and there is but little profit in raising them. The black or purple fig bears abundantly and has two or three crops every year. It makes a fine table fruit and a jam par excellence.

Loquates, guavas, Japanese persimmons, and other kinds of what might be termed fancy varieties of fruits have been grown to a limited extent.

ALMOND CULTURE.

It has been demonstrated beyond a doubt that the culture of the almond is destined to be one of the leading industries of this valley. It is well to assert the fact that whoever enters into this line of horticulture and hopes for success must bring to bear upon his work the same keen perception that he applies to any other



DATE PALM, OLIVE, AND FIG TREE, SALT RIVER VALLEY.



OSTRICHES, SALT RIVER VALLEY.

business venture. Simply planting a tree and putting in time figuring out results wont produce almonds. He must be as familiar with his trees as the turfman with his horses. Constant study and observation is the only road to success. By the authority of expert testimony this valley claims superiority over the California product in the following points: Color, and plumpness of kernel and flavor. The tree under proper care is a rapid grower and is a bearer at three years. The leading varieties are the Ne Plus Ultra (paper shell) I. X. L. (soft shell), and Arizona Prolific (hard shell). So far the I. X. L. stands at the head of the list.

There are no insect pests to affect the growth or bearing. The only drawbacks are crown-knot and March frosts. Both are under control of the orchardist. The former is more or less the result of the haphazard methods so common throughout the valley. Ignorance has left footprints all about us, and would stamp out horticulture enterprise if left to its management. It has been practically proven that the effects of March frosts can be counteracted by the use of smudge fires, insuring each year a crop.

Our trees are still young, yet several carloads have gone into the Eastern market, and their superior quality has created a demand that will readily take all that will be grown, at the highest market price. In many sections of the valley the soil is perfectly adapted to the almond. Porosity of soil is the first requisite, which is also true of all the fruits. In the cultivation no mathematical rule can be laid down. There are certain elementary principles that are essentials in all plant growth. These principles form the foundation—intelligence does the rest. Because a man can gee and haw through a corn field does not make him an orchardist. The best results in California have been achieved by men from the professions and the counting rooms. There is an open field for this class with everything in favor of successful results. Whenever this class takes hold the dawn of a new era is upon us and horticulture will take the lead.

In summing up the care of an orchard, bear in mind that by cultivation and irrigation you supply the tree with food. Any system that you may devise to accomplish this is good. Let every move made be a logical one—made for certain results. Four words cover the whole ground—read, study, observe, and work. There is an advantage we have over California, as our crop ripens earlier than theirs. This assures the very best prices. Last year the I. X. L.'s brought \$200 per ton f. o. b., and prospects are better this year. The crop ripens in July. The cost of gathering from the tree to the sack is about 1½ cents per pound.

In conclusion, from practical experience it can be safely asserted that no better opening presents itself to the lover of horticulture than that of almond culture. It is with us no longer a theory, but a fully proven fact. Success in this as well as in other lines has no royal road leading thereto, but a path graded and macadamized by persevering and intelligent study and labor. If by vigilance one man can save his orchard there can be no reason why others should not do so.

HONEY PRODUCTION.

Many years ago some of the early settlers of this fertile valley brought with them when they came here, or had shipped to them soon after, a few colonies of bees. They were men who had kept bees in their old homes, and they thought the conditions here were favorable for beekeeping. At that time there was but little alfalfa growing in the valley, and its value as a honey-producing plant was not fully known and appreciated, but the whole country was covered with a growth of mesquite, which yields honey in large quantities and of the very best quality. These men did well with their bees, and as fast as possible they increased the number of colonies. There was a splendid market, at good prices, for all honey produced, right here at home and in the surrounding mining camps. Other men saw that there was money to be made in the production of honey, so new apiaries were started and increased as fast as possible; and so it has continued until the few colonies brought across the deserts in early days have increased and multiplied until there are now in the valley probably not less than 8,000 colonies of bees.

The mesquite, which originally supplied most of the honey, has been gradually cleared off to make way for the farmer and rancher, until now the yield from that source is very small; but as mesquite has disappeared alfalfa has been sown, and so good a honey-producing plant has it proven to be that it far outranks the disappearing mesquite. When alfalfa is allowed to stand until it gets into full bloom it yields a large amount of honey, but unfortunately for the beekeeper the tendency among ranchers the past few years has been to cut the alfalfa before it gets into good bloom.

Bees get a little honey from wild-desert bloom, fruit bloom, and the blossoms of shrubs and bushes that grow along ditch banks and on the river bottom, but

the amount obtained from these sources is comparatively very small, so that I may say that practically all our surplus honey comes from alfalfa.

As already said, there was at first a good home demand for all honey produced here, but as the number of colonies increased, and with that the production of honey, the time came several years ago when the supply was in excess of the demand, and other markets had to be found. Being so far from the Eastern markets, it was apparent that it would be necessary to ship in carload lots, and in order to do this it was necessary for the honey producers to cooperate, hence the organization of an association of bee men. The first season there were but two carloads, of about 18,000 pounds net of honey in each, shipped.

Considerable trouble was experienced before this was all sold, partly because this kind of honey was not then known in the Eastern markets, and partly because it was not put up in the best shape, owing to our inexperience. At that time most of the extracted honey was put up in empty coal-oil cans which had been cleaned. Some producers did not get their cans thoroughly clean, with the result that the honey was tainted with a coal-oil taste, which naturally did not help in establishing the new market that we were seeking. It was promptly decided by the association that no more honey would be shipped in coal-oil cans, and arrangements were made to supply shippers with new cans at moderate cost by getting them in carload lots. Our honey is all shipped in 5-gallon cans, two cans in a case. The first year 1 car of 1,100 cases was more than enough for the season's crop. Now 4 to 5 carloads of 1,300 to 1,500 cases each are used in a season. This shows the increased production that has taken place. From the first year, when two cars were shipped, the production has gradually increased until in the season of 1896 29 carloads, containing 750,000 pounds of honey, left this valley for the large markets of the East—Chicago, New York, Pittsburg, Baltimore, Boston, etc. In the years of 1897 and 1898 the total product fell some short of the yield of 1896, being about 600,000 pounds each year. The lighter production of these two seasons was caused by the late frosts injuring alfalfa so that the first crop did not bloom, and by the early cutting of alfalfa by the farmers before it was out in bloom.

Although this industry is not very large compared with some others, still it is in many respects an ideal one, considered in the relation of its benefits to the country. It takes a natural product of the country, sends it to an outside market, and brings back the hard cash, which is distributed among quite a considerable number of men, no very large amount to any one, and these men in turn spend nearly all of it right away among our business men. In this way \$18,000 to \$25,000 are annually distributed here. Thus this industry is helping to turn the "balance of trade" in favor of this valley.

STOCK RAISING.

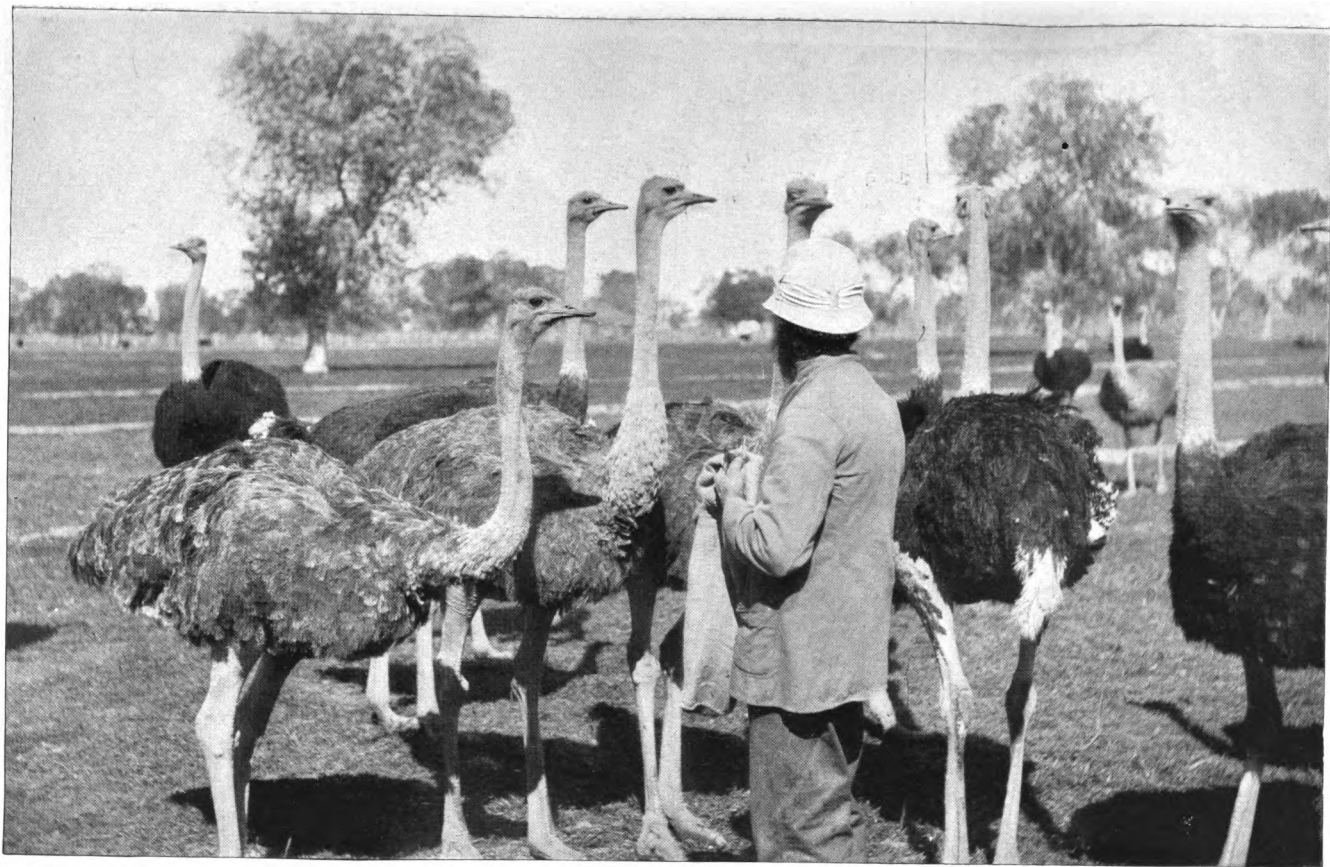
Of the 250,000 head of cattle shipped and to be shipped out of Arizona this year, Maricopa County furnishes nearly all that are ready for market. Beeves intended for the slaughterhouses of California, Denver, Kansas City, and Chicago have gone out of the valley by the train load, all of them fattened on Maricopa County alfalfa. The business of fattening cattle is one of remuneration to both farmer and stock raiser. The latter brings his herds from the ranges and turns them over to the alfalfa raiser, to receive them again when they are prepared for market.

The raising of hogs is a profitable business for the farmer, the valley being singularly free from the diseases which make hog raising a precarious industry in the East. Alfalfa is the staple food, and in the alfalfa field the hog remains from the beginning of his career as a pig until he is gathered to the slaughterhouse. Some breeders, however, prefer to feed barley for a few weeks before marketing, that grain giving a firmness to the flesh which alfalfa fails to produce. But there is never any difficulty as to variety of feed, since a failure of crops is unknown, and the yield of barley, wheat, and sorghum can be forecasted almost exactly from the time the seed is planted.

Horses do well, and those who are best qualified to judge say that the climate is an ideal one for horse raising. Blooded horses which would be a credit to Kentucky are becoming numerous in Phoenix and the county towns, and many farmers ride into Phoenix behind their fancy steppers.

OSTRICH FARMING.

This unique industry bids fair to become one of leading importance in the Salt River Valley. Experience has proven that the conditions existing here are ideal for the successful breeding and raising of African ostriches.



OSTRICH FARMING, MARICOPA COUNTY.



3. HARTWELL to
HAMAKA

FORD HOTEL.

The first experiment of raising ostriches in Arizona was commenced in 1891, when Mr. Josiah Harbert, with a single pair of birds, started breeding them. The experiment was a pronounced success from the start, the birds increasing rapidly in numbers until the flock was sold in the fall of 1898 to the Arizona Ostrich Company, when it numbered 104 birds, 38 being of breeding age, of which number 26 were paired. Mr. Harbert also realized a nice profit from the sale of feathers, barren eggs, and from admission fees paid by people coming to view the birds.

In the fall of 1898 the Arizona Ostrich Company was organized for the purpose of engaging in ostrich raising on a business basis. Forty acres of alfalfa land, about 3 miles north of Phoenix, were prepared for handling the new industry, and the birds taken there and placed in charge of a competent and experienced man in that class of work. Since that time the flock has increased rapidly, 47 chicks having been hatched. This company now has the largest and finest flock of African ostriches in the United States.

The success attained by the company during the past year is certainly proof that ostrich farming in the Salt River Valley offers a profitable and attractive field for the investment of small capital, backed by intelligence and industry. Through the courtesy of the management accurate figures have been obtained, giving the results of the business during the year, and these figures show that the company will realize a net profit of \$2,500 for the year, besides the increase in birds. Forty-seven birds have been hatched during the year, which, estimated at \$100 each, bring the total profits of the company for the year up to \$7,200. The valuation of the young birds is based on the value of their product, and as they will yield 1 pound of feathers each during their first year, worth at present prices about \$15, or 15 per cent per annum on \$100, it will be seen that that is a low valuation to place on them. The management is confident that next year will show even a greater relative profit.

When we take into consideration the fact that ostriches continue to yield feathers of a uniform quality for a longer time than the average human life, and that they are not subject to any contagious or other known disease, it would seem that an ostrich farm, properly started in this valley, should prove one of the safest forms of investment, and one of the surest dividend-paying enterprises known.

The man in charge of the farm here (Mr. R. J. Icke), who spent 15 years handling ostriches in South Africa, says the birds do just as well in this valley as in Africa, and that the climatic and other conditions surrounding them here seem as well adapted to their requirements as those existing in their native home; and the results thus far obtained would certainly seem to justify the claim, as but one bird has died during the year, and that a young chick, while all the rest of the flock are in perfect health.

After the birds attain the age of 4 weeks there is little danger of their dying from natural causes for many years. Mr. Icke says it is not known positively how long an ostrich will live under normal conditions; but he states there are birds on the South African farms which are believed to have reached or passed the century mark, many of them having been in captivity there over fifty years. He says they are very rarely known to die from natural causes.

A few words regarding the nature and habits of the ostrich and the methods employed in breeding and handling him in captivity may be of general interest in this connection.

Most people have the idea, obtained probably from their old geographies when they were children, that the female ostrich after laying her eggs in a nest scooped out of the desert sands covers them up with the sand and leaves them, trusting to the heat of the sun to hatch them. This is not the fact. The birds always pair off during the breeding season, the male bird making the nest by resting his breastbone on the sand and turning slowly round and round, scratching the sand away with his feet until a shallow hole is made, some 3 feet in diameter and about a foot deep. The female then lays, usually, 15 eggs, and the birds take turns setting on them, the female setting during the daytime and the male at night, except that the male allows the female about an hour in the middle of the day to feed, when he takes her place on the nest. As a female bird will lay three settings of eggs (or about 45) before she stops, about 30 are taken from her and hatched in the incubator, the birds being permitted to hatch the last 15 eggs laid. The eggs hatch in about forty-two days, the old birds helping the chicks to get out of the shell.

A chick 1 week old weighs about 5 pounds, at 6 weeks 50 pounds, and at maturity about 300 pounds. The chicks grow very rapidly, reaching a height of about 5 feet at 4 months of age. At 4 years, when full grown, they average nearly 8 feet in height.

The first few days after hatching the chicks must be carefully watched and cared for to keep them alive; when 4 weeks old they are considered safe, and require but little special care after that age. The young birds are fed a little grain, but the old birds obtain their entire living from the alfalfa on which they graze. During the breeding season each pair of birds is placed in a separate field about 50 by 200 feet in size; the other birds are turned into large pastures together. One acre of alfalfa will furnish feed for 4 full-grown birds throughout the year. They require but little water, and their keeper does not have to worry for fear he may miss a "run" of water and his birds have to go without any for a couple of weeks. Last winter these birds were given no water from September to April, yet they seemed just as well pleased; and Mr. Icke informed the writer that he had known birds to go three years in Southern Africa without a drop of water, and apparently without any ill effects.

The birds require but little care, one man being able to do all the work connected with the farm and its 150 ostriches, with the assistance of an additional man who is employed by the day occasionally, when picking or other extra work is necessary.

The birds are first plucked when 6 months old, yielding about 12 ounces of feathers each, of the market value of \$7.50 per pound. After that they are plucked every eight months, yielding an average of 1 pound of feathers each plucking, of the value of \$17.50 per pound at present prices. How long the birds will continue to yield feathers is not definitely known, although in South Africa they have been yielding feathers continuously for fifty years, with no signs of decreasing.

There are now 5 ostrich farms in the United States—2 in California, 1 in Texas, 1 in Florida, and 1 in Arizona. The fact that the farm here, although the youngest, is the largest and most flourishing in the country, proves conclusively that the Salt River Valley is better adapted to the successful breeding and handling of the African ostrich than any other section of the continent. No protection whatever is required here for them during the winter. They graze the entire year in the fields the same as horses and cattle, and are always healthy and thrifty.

During the last fiscal year \$1,700,000 worth of ostrich feathers were imported into the United States from Africa, and only about \$120,000 worth produced in this country, so there is little to be feared in the line of competition from overproduction at home. As the Government imposes a duty of 15 per cent ad valorem on imported feathers, the American farmer is amply protected from foreign competition.

The local farm is a very interesting and instructive place for tourists to visit, and hundreds of people avail themselves of the opportunity afforded them, when in this portion of the country, to behold the king of birds in his natural state, where he has the freedom and surroundings to properly show off his magnificent proportions and his wonderful powers of speed and endurance, and he shines forth in all the majesty and beauty of his native land. A small admission fee is charged, and as the farm is situated only 3 miles from Phoenix, on one of the finest drives in the country, there is a constant stream of people going to and from the place in the winter. The eggs that have proven barren (generally about 10 per cent of those laid) are also sold as souvenirs, and from these two sources alone the company derives sufficient revenue to pay all expenses of maintenance and operating the farm, leaving the increase in birds and the receipts from the sale of feathers practically clear profit.

The men interested in this industry here, who have carefully studied the subject, assert as their positive belief that when it becomes generally known that this valley is an ideal place for successfully breeding and handling ostriches, and when the safety and profitableness of this form of investment is fully appreciated, the Salt River Valley will become as important an ostrich-raising country as South Africa is to-day; and in view of the wonderful success attending the work thus far attempted, there would seem to be good grounds to expect this prophecy to be speedily fulfilled.

THE CITY OF PHOENIX.

It has been said that Western towns are either miniature cities or exaggerated villages. Her residents consider Phoenix included in the former class. She is essentially modern, founded though she be on the ruins of a pre-Columbian civilization. Here there is none of the languor of the South, no trace of the provincialism of the Middle West, and only enough of the Mexican and Indian to make picturesque the poorer quarters of the city. Hither have come the brightest of minds, professional and commercial, and the visitor soon acknowledges that here he finds push and intelligence not inferior to those qualities that mark the most favored communities of the Union.



COMMERCIAL HOTEL AND CENTER STREET. LOOKING NORTH.



RESIDENCE STREET, PHOENIX.

The inception of the city is within the memory of many of its present residents. It was in 1868 that a small number of pioneers banded together to form its nucleus. In 1870 it was platted. Among the original American residents were W. A. Hancock, John T. Dennis, Ben Block, Thomas Barnum, Jacob Starer, E. Irvine, C. H. Gray, J. D. Monnihon, and J. P. Osborne.

The valley had been occupied for several years, since Jack Swilling, noted for desperate deeds, had come from the Rich Hill diggings to cut a ditch from Salt River and to practice the arts of peace. Friendly Indians were to the south and wild Apaches on the north and east. John T. Dennis, who then lived near the present waterworks site, in the late sixties lost a number of cattle and horses through a raid of the Yavapai Apaches, and only proximity to the friendly Pima and Maricopa tribes saved the infant settlement from continued depredations. In 1871 a traveler wrote that Mrs. J. J. Gardiner was the only American woman in the village, there being at the time about 75 American men. In 1877 Hinton wrote that Phoenix was a town of about 500, half the population being Mexican.

September 5, 1872, the first public school was started. It was a long adobe building on what is now First avenue, about 50 feet south of Washington street, the same edifice serving as court-house. A few years later a little adobe one-roomed building was erected on what is known as the Central school block, on North Center street.

In 1871 the county was established, carved from the southern portion of the giant county of Yavapai. The first county record filed was a deed in which was transferred the ownership of the ground on which the Porter Block now stands. The price was \$100. The present value of the same ground is about \$20,000. In the spring of 1879 the Southern Pacific, building eastward, reached Maricopa, and through Phoenix flowed the entire commerce of northern and central Arizona, then rejoicing in the greatest degree of mining activity ever known to the region. Dusty freight teams, not infrequently with 20 mules to a team, were almost continuous on the road from the railroad north, bearing supplies to the mines. The freighter was the most important of beings, and lived in a freighter's gastronomical paradise on a diet of canned goods straight. Fast freight to Prescott had a tariff of 4 cents a pound, and fast freight meant making the 170 miles in two weeks. There was a strong Mexican flavor to the community, and a knowledge of Spanish was almost essential.

Occasionally on the streets would be seen numbers of squeaking 2-wheeled ox carts laden with fruit, mescal, and other products of Sonora, brought across the international line in serene carelessness of any such thing as tariff.

Phoenix has not been exempt from the usual "wild west" experience of a border town. In its earlier days there were occasional chases after Indians in the northern or eastern hills. There is a tale of how a posse of citizens ran down a band of horse thieves at the junction of the Gila and Salt and buried them, Attila like, in the sands of the river bed. It is remembered that three "rustlers" were found hanging one morning from trees in the northeastern part of the village. Then there was the Mexican who was lynched on the crossbeam of Jim Monnihon's corral gate, and the killing of the fellow who shot Lew Bailey through the window at a dance in the old adobe back of Goldman's corner. There are many who remember how Marshal Enrique Garfias gathered in the cowboys who last attempted to shoot up Main street, after emptying two cowboy saddles by good equestrian pistol work.

In 1879 the town was at its roughest. In August of that year it reformed. In the mass of miscellaneous crime there have been 2 stage robberies and 7 killings in a single week. Then the vigilantes came out, composed of about 100 of the best citizens. They took 2 prisoners from Jailor McDonald and hanged them to cottonwood trees on the Washington street side of the plaza. The fellows hanged were McCloskey and Keller, murderers, respectively, of John Le Barr and Luke Monihon. That good job accomplished, the vigilantes assisted Sheriff Thomas in clearing the community of desperadoes and all who had no visible means of support.

July 4, 1887, the Maricopa and Phoenix Railway materialized, giving steam connection with the world, and Phoenix became a city. In 1889 she took a further step in becoming the Territorial capital. March 12, 1895, she assumed the place of southwestern center and metropolis, upon the completion of the Santa Fe, Prescott and Phoenix Railway, through which she not only secured competitive freight rates, but was given outlet for her products to the northern part of the Territory.

The Phoenix of to-day, the county seat of Maricopa County, and capital of the Territory, has 15,000 inhabitants, and its people are an enterprising and progressive body of citizens. The large transient population, principally composed

of pleasure and health seekers, add much to the busy appearance and material resources of the city, while rapid progress has of late been made in the erection of buildings of substantial character, as well as architectural beauty. The streets are wide and level, and Washington street, the principal thoroughfare of the city, is 3 miles in length, lined on either side for many blocks with handsome business establishments.

Large and commodious hotels are among the especial features of the town. The Adams, the Ford, and the Commercial are up-to-date hostelrys. The Adams is the finest and best-equipped hotel in the Southwest, and compares favorably with the best hotels of California. Its equipment is thoroughly modern in every way. The Ford is also an exceptionally well-constructed and attractive building, finely arranged for the comfort of visiting tourists. The Commercial, although an older hotel, is popular with the traveling public. Phoenix is very fortunate in possessing such fine hotel facilities.

West of Center street are the avenues, running north and south, which are numbered, First avenue being immediately west of Center street, and on the east are the streets, also numbered, First street being directly east of Center street. The streets are named after the presidents, alternately in the order of their succession, and keeping this in mind the city of Phoenix is not a difficult place to find one's way about in. On the north side of the city lies the principal residence district, which is ornamented by some as handsome residences as can be found in any city in the Southwest; the climate being a most perpetual spring and summer, the growth of trees, shrubs, and flowers is luxuriant during the greater part of the year, and the floral display and abundance of foliage add much to the appearance of the city generally, and the residence district particularly.

The city hall, on Washington street, between First and Second streets, which since the seat of government has been located in Phoenix, is the official home of the governor and the legislature, is a handsome three-story building of brick. It is situated in the center of a plaza, and surrounded by a lawn planted with trees and shrubs, and ornamented directly in front of the main entrance by a fountain, which in a dry and thirsty land is a very agreeable feature; its cool plash is most refreshing to the tired and overheated wayfarer, who gratefully takes advantage of the comfortable seats under protecting shade trees, which have been considerably provided by the city authorities.

The court-house on Washington street, between First and Second avenues, is also a three-story brick structure, and is surrounded by a blue-grass lawn, shade trees, and flowers. The floral section of the court-house plaza is a most attractive spot, especially so during the winter season, and visitors are fully appreciative of the beautiful display.

Phoenix has a first-rate water supply, an efficient system of sewerage, 2 gas plants, 2 foundries, 2 ice factories, 2 steam laundries, 2 steam flouring mills, a soap factory, and a creamery.

The Maricopa and Phoenix and Salt River Valley Railroad (Phoenix short line) connects the city with the Southern Pacific system at Maricopa junction. The depot is on Seventh street, near Harrison.

The Santa Fe, Prescott and Phoenix Railway connects the city with the Santa Fe system at Ashfork. The depot is on South First avenue and Jackson street.

The Phoenix City Railway Company's lines run west on Washington street from Phoenix Park to a point about 1 mile west of the capitol grounds, and north from Washington and First streets to the McDowell Road.

The central station of the Phoenix fire department is on the northeast corner of Jefferson and First streets. The department comprises an engine company, a hook and ladder company, and three hose companies.

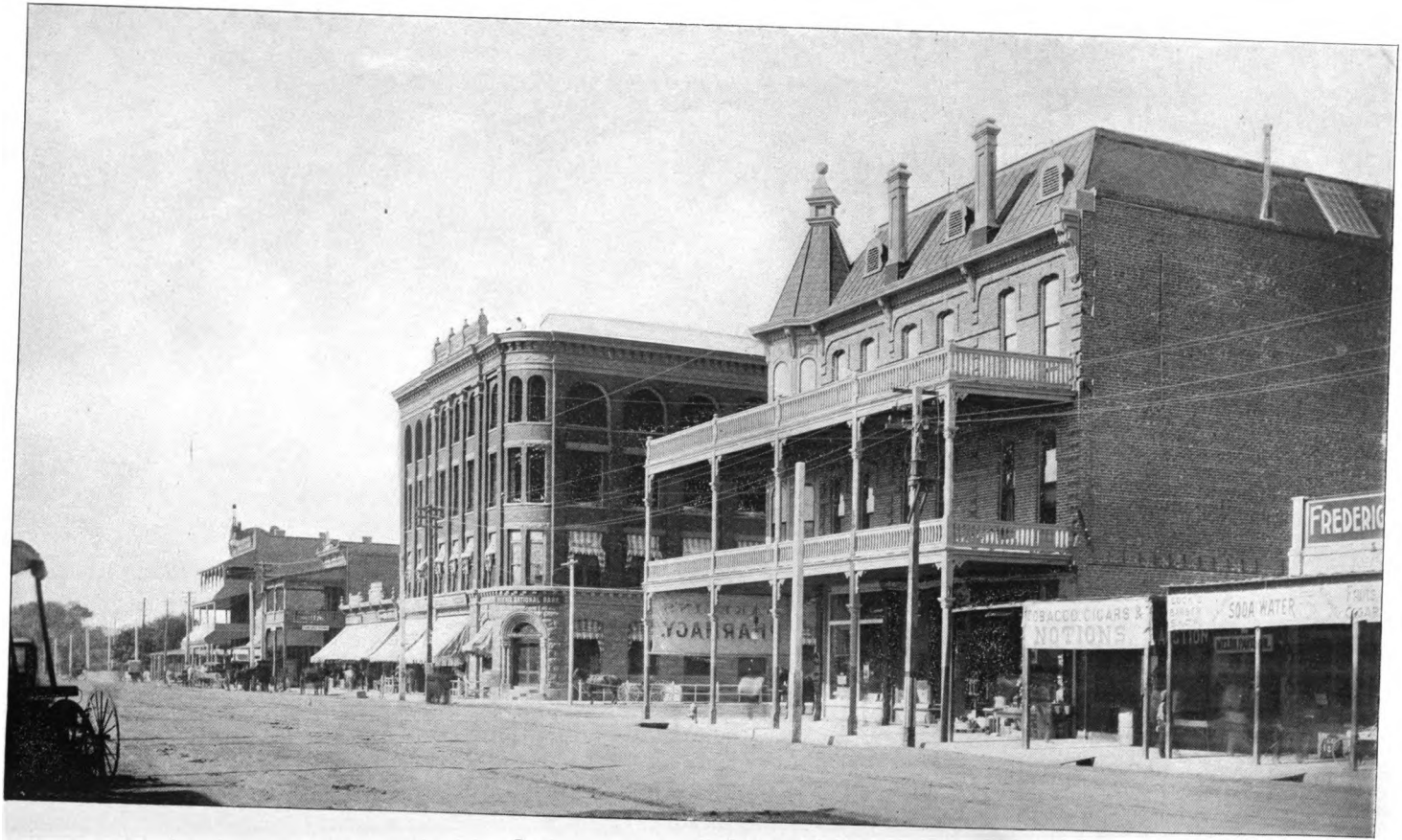
The United States Weather Bureau is established in the Wharton Building.

The Mexican settlements in the vicinity of the Catholic church and on the south side of the city have no longer their former prominence, but are sufficiently in evidence to be of great interest to Eastern visitors, who, having traveled so far to escape the monotony of modern ways of living, are naturally more interested in the picturesque remnants of the past than in present improvements and embellishments.

Having described the city, it only remains to state that well-kept driveways extend far into the country and afford the tourist and health seeker every opportunity of enjoying delightful and invigorating outings. There is scarcely a day throughout the season when it is not sufficiently warm and bright to make a trip into the surrounding country very enjoyable. The trees with which the roads are lined on either side afford a grateful shade, and the vast fields of alfalfa, stretching for miles in every direction, are a delightful rest for tired eyes. Altogether, for the health or pleasure seeker and for the overworked man or woman who needs rest, a winter residence in Phoenix is a continual delight, to be ever looked back to



HOTEL ADAMS, PHOENIX.



PHOENIX—WEST WASHINGTON STREET.

with fond remembrance, and especially when winter lays its icy hands upon them in their Eastern homes. But a good many such visitors, unable to resist the seductions of this climate, have remained here and become permanent residents of the Territory.

For several years Phoenix has been attracting more and more attention from people in search of an equable climate, and it is now generally understood that such conditions as are most desired are to be found here. It is not only people in ill health who seek our genial climate, but many sojourn here during the fall, winter, and spring for the pleasure incident to an unrestricted out-of-door life.

It is this class of people who have made southern California what it now is.

Phoenix now derives not less than \$2,000,000 a year from people who are attracted by our climatic conditions. This source alone will, in the course of time, give us a population many times greater than we have at present. Florida and the erst-while popular winter resorts of the South can not compare with beautiful and healthy Phoenix.

PHOENIX CLIMATE.

The climatological data for Phoenix for the year ending 1898, just issued from the weather bureau, contains some very interesting information about the wonderful climate of Phoenix and the Salt River Valley. It shows that the mean temperature for the year was 70°. The mean for the winter months of January, February, and December was 47°, 59°, and 49°, respectively. The coldest temperature recorded for these months was 23°, 36°, and 28°, not cold as compared with the East. The relative humidity for the same months was 56, 41, and 51 points respectively. For the spring months of March, April, and May the mean temperature was 57°, 72°, and 73°.

The hot summer months of which Eastern visitors hear so much—July, August, and September—show a mean temperature of 92°, 90°, and 84°, respectively, but the relative humidity for these months was only 37°, 44°, and 32°. The maximum temperature recorded on any date in these months was 111°, 109°, and 106°. But this temperature is that registered by the dry-bulb thermometer. While to the Easterner it seems enormously high, it is not as severe or oppressive a heat as is experienced every summer in New York, Chicago, and Cincinnati, Washington, and other Eastern cities. As an illustration may be cited one of the hottest days of last July, when the dry-bulb thermometer registered 102° at 8 o'clock at night. The wet bulb showed at the same hour but 72°, it registering the appreciable heat as one would experience a hot, stifling night in the East; and 72° there is not considered bad.

In all the year there was not a day when the mean temperature for the day fell below 32°, and but 11 days when it fell below 41°. On 319 days the mean temperature was above 50°, and on 249 above 59°.

The total rainfall for the year was 5.95 inches, of which 1.63 inches fell in January, 0.18 inch in April, 0.08 in June, 0.24 in July, 1.03 in August, 1.01 in November, and 1.70 in December, the remaining 0.08 falling in March, May, and September.

But it is in the amount of its sunshine that Phoenix and Arizona particularly excel, and it is a fact that there is not another habitable spot on the globe that shows such constant sunshine. Of the 365 days of the year there are but 35 set down as cloudy, and 71 as partly cloudy, giving 259 absolutely clear days. The percentage of possible sunshine for the months of December and January—the months of most cloudy days—was 62 and 73, while for the months of February, March, April, and May the percentage of sunshine was 88, 82, 86, and 90, respectively, and for the fall months of October and November 95 and 92 per cent. For the month of September the percentage of sunshine reached the high figure of 98, there being but one partly cloudy day in the month. The director of the weather bureau states that for periods of ten days to two weeks at a time here there will not appear a single cloud in the sky during the entire day, not even the cloud "no bigger than a man's hand." Such a climate affords the ideal place for invalids and health seekers. Nor are high winds encountered here. The average hourly velocity for the year was but 4.3 miles, and the highest for any month was 4.9 miles in March and April, and the lowest 3.3 miles for the month of February.

It will be remembered that February, 1899, was an exceptionally cold month in all parts of the country east of the Rocky Mountains. The minimum records were broken at nearly every weather bureau between the 11th and 14th during the progress of the severe cold wave of that period, and many of the minimum temperatures occurring on these dates were from 10° to 26° below any previously recorded. It is difficult of belief that during this exceptionally cold period in the

East the temperature in Phoenix was slightly above the normal. The actual figures for the period under notice are :

1898.	Maximum.	Minimum.	Mean.
February 11	72	41	56
February 12	69	40	54
February 13	68	43	56
February 14	70	38	54

CAPITOL BUILDING AND GROUNDS.

The plans for the new capitol, the construction of which has made rapid progress during the present year, call for a structure four stories in height and 184 by 84 feet in size. The first story is to be of granite from the granite quarries near Phoenix, and the superstructure of tufa stone from Kirkland, Skull Valley. The style of architecture is classic, but not severely so, and the building on completion will present a handsome and imposing appearance.

The rotunda is 44 feet in diameter, and extends from the ground floor through all the stories of the building to a height of 78 feet, being surmounted by a dome, which is crowned by a statue of Liberty 16 feet in height.

The dimensions of the halls provided for the legislative bodies are 38 by 36 feet, and special attention has been given to the acoustic properties of these halls and their efficient ventilation. The gallery space in each hall has a seating capacity of between 200 and 300, and surrounding the halls will be the committee and other rooms required for the accommodation of the legislators.

Special offices are also provided for the governor and other Territorial and Federal officials.

The capitol grounds, 10 acres in extent, were donated to the city some ten years ago, and were laid out at the expense of the Territory nine years ago.

The design on the east side of the grounds is geometrical in style. The lawns on the west half of the grounds have not yet been completed.

The principal deciduous trees with which the capitol site is ornamented are the Arizona ash, the Russian mulberry, the umbrella, the Mexican chinios, the eucalyptus, and a few elms.

Among the palms are the California fan and date palms, the blue and Japanese fans, and a large variety of yuccas. The shrubs comprise specimens of Australian, Chinese, Japanese, European, and native varieties, and there is a nice collection of cacti and a fair one of roses.

When the work in contemplation has been carried out the capitol grounds will form an admirable setting for the new building.

THE TOWN OF MESA.

Twenty-two years ago a caravan of Mormon people from Utah settled on the land which is now covered by the lively little town of Mesa. The name was derived from the topography of the country, the Spanish word mesa meaning table. The country surrounding Mesa is high, flat, and nearly level. The town is 8 miles east of Tempe, and 17 miles east of Phoenix. It is 100 feet higher than Tempe and 180 feet higher than Phoenix. The Maricopa and Phoenix and Salt River Valley Railroad enters the place and runs two trains to Phoenix daily. The town is situated in the center of a thickly settled country of small farms, on the outskirts of which district are large grain and cattle ranches. The mesa country is thrusting itself forward as a fruit section. There are more large and small orchards, vineyards, and nut groves on the mesa than anywhere else in the Territory. The Mormon is a small farmer and the highest state of cultivation is reached under his care, as can be readily seen by a passing visitor. The soil on the mesa can not be surpassed, and the water supply is second only to Tempe, while the canal system is nearly perfect.

The town of Mesa is 1 mile square. The blocks are twice the size of the ordinary block, and the streets are as wide as boulevards. There are many beautiful residences and grounds, and the business blocks are for the most part substantial bricks.

The hotel accommodations are ample and first-class; the water pure and the atmosphere healthy, and the people and conditions make the city an ideal place for a home. The place is thoroughly lighted by electricity.

There are 900 progressive, energetic people in the city.



OLDEST PALM IN PHOENIX.

Situated as it is, at the upper end of the Salt River Valley, Mesa will always be the gateway for everything going to and from the great mining regions north and east of Mesa. Lack of transportation facilities prevent the rapid growth of the mesa district as a produce and fruit center, but with the advent of the Globe wagon road, now in course of construction, this will be nearly overcome. The building of this has stimulated a general move among the fruit and truck men to greatly increase their shipments this year.

THE TOWN OF TEMPE.

Situated on the south bank of the Salt River, and nestling behind a towering butte 9 miles east of Phoenix, is the pretty little city of Tempe. The spot which it covers inspired "Darald Dipper," the son of an English earl, thirty-one years ago to name it Tempe, because it so vividly brought to his mind the Vale of Tempe in Greece, which he had visited in his travels. The people of the place have caught the spirit in which it was named, and every year sees the place a little prettier than the preceding one.

The town is one of the principal shipping points of the Territory, as it is the outlet to the whole south side of the Salt River Valley. The Maricopa and Phoenix and the Phoenix and Mesa short line railways pass through the place. Six trains run through the town daily and give it better train service than is enjoyed by any other city in the Territory with the exception of Phoenix. It is likely that Tempe will become one of the greatest railroad centers in Arizona, because of its situation at the only practical railroad crossing of the Salt River in the valley. All roads that will go through the valley will undoubtedly cross at Tempe. This natural advantage is a very significant one, and as the valley develops will be fully realized.

The country surrounding Tempe and contributory to it is the wealthiest and the most developed in the valley. This is due to the Tempe Canal. The Tempe Canal is the oldest but one in the valley, and the largest but two. It is entitled to and receives more water than any other canal, and consequently the land under it supports a wealthy community. The town quickly feels the prosperity of the surrounding country, and this year an unusual amount of building is going on. Seven new houses and stores have been finished this season and extensive improvements made on a half dozen others. Two handsome residences and one two-story business block were completed during the month of March. There are in course of construction two large and beautiful churches, two elegant homes, and one three-story brick and business block. One mile of grading and graveling of the streets has been done this spring, which gives Tempe the best streets of any city or town in the Territory. An electric light system has been nearly established and is in operation. There are no city waterworks, but the people are agitating the question so earnestly that the near future will undoubtedly find this all-important factor to a city's growth in full working order. Neither is there a first-class hotel to accommodate the public, but this, too, is assured, and will be provided in the near future.

Besides these things of the present, Tempe has its projects and dreams, as does every other energetic and growing little city.

The population of Tempe is 2,000, and is increasing at a healthy rate.

THE TOWN OF WICKENBURG (MINING).

Although Maricopa County is preeminently an agricultural region, the mining industry is not a small one. Phoenix, of course, is an important center for mining transactions, covering all portions of the Territory. In the capital city mine owners and prospectors congregate in large numbers to spend the winter months, and few capitalists seeking mining investments in the Territory fail to come to Phoenix. Here they find a common news center, and buyers and sellers naturally gravitate to Phoenix.

But in actual mining the county is making a good record. Activity continues in all the mining camps, particularly at Goldfield, Castle Creek, the Harquahala Mountains, and around Wickenburg, and no review of the general conditions and progress of the county would be complete without a notice of its most important mining camp—Wickenburg.

This famous old town is the third oldest in the Territory, Tucson being first and Yuma second. The original location was made by Henry Wickenburg, who was the second white man to explore this section, and the first and only one who had courage enough to stay here any length of time, braving death at the hands of the murderous Apaches.

It was in October, 1863, that Mr. Wickenburg, accompanied by Theodore Green Rusk, afterwards known in Tucson as Verde Green, and Major VannBibber, left Peoples Valley in search of a rich gold ledge which Capt. King Woolsey had described as being located on the south side of the Harquahala Mountains, and of which he exhibited specimens of great value. Coming down along the Hassayampa River Mr. Wickenburg and party camped near the river, on the site of the present town, in what was then called Pumpkin Patch by the Indians, as they had been raising pumpkins there and the vines strewed the ground. In hunting for Captain Woolsey's tracks Mr. Wickenburg discovered some rich gold ore about 14 miles west of the river, and as he thought it was rich enough for him he gave up the search and located what has ever since been known as the Vulture mine. The big, black ledge, standing up so prominently before him, induced Mr. Wickenburg to call it the Vulture, and paradoxically it became the prey of unscrupulous men not many years after. In the face of torture and death from the then bloodthirsty savages, Mr. Wickenburg worked alone and as best as he could this great discovery, until in the spring of 1864 he built arrastres and worked some of the richest ore in Wickenburg, getting in bullion some \$25,000 to \$30,000.

In 1865 Captain Tyson built a 5-stamp mill at Wickenburg, under contract with Mr. Wickenburg to give him 50 per cent of the bullion obtained from the ore furnished by the latter, but as the Captain failed to make returns, his supply of ore was cut off, and the mill fell into Mr. Wickenburg's hands. It was about this time that a sale was negotiated by Mr. Wickenburg of 300 feet of his original discovery ledge of the Vulture to Bechtuel Phelps for \$25,000, of which sum \$20,000 was paid, when a dispute arose, necessitating the expenditure of this amount in unsuccessful litigation to obtain Mr. Wickenburg's rights. The company formed at that time built a 40-stamp mill in 1866, which was located about where the Phoenix Extraction Company's cyanide works are now. In fact, these works are now, and have been for years, cyaniding the immense quantity of rich tailings left after the operation of this 40-stamp mill for ten years. During this time, from 1866 to 1876, it was estimated that some \$15,000,000 in gold bullion that was accounted for was taken out of the Vulture mine, and it is claimed that as much more was taken out that was not known of or accounted for. Through the manipulation of its officers the company got into difficulties, incurred a debt of \$400,000, and the property was sold to satisfy creditors, after having produced a colossal fortune.

Thus the old mine that was the means of starting this town went from one hand to another, till it is now being operated in a very small way, though still one of the largest and richest prospects in the country. While Wickenburg was named after the discoverer, the now venerable Uncle Henry Wickenburg, it was not named by him, but by James A. Moore, who was stopping with Uncle Henry at his ranch in 1864, and who, in correspondence with Territorial Governor Goodin and Secretary McCormick, dated his letters first Wickenburg Ranch, and later Wickenburg, thus giving it its present name. It was in the winter of 1868 and 1869 that Jack Swilling promoted his irrigation scheme, and Henry Wickenburg took a gang of men with a mule team to what is now the city of Phoenix, and dug the first ditch in the valley, known as the Swilling or Town Ditch.

The original town site of Wickenburg was platted by Robert Groom, known as Uncle Bob, in 1868, but not having been filed, it was replatted and filed some years later. Before the Walnut Grove dam burst and washed out all the bottom land along the river there were few finer ranches in the Territory than the Brill and Wickenburg ranches. In 1894 the Santa Fe, Prescott and Phoenix Railway was built through here, and with its construction and the facilities it afforded for the development of the country, witnessed the return of the mining activity that has continued with unabated vigor since. It is now one of the most promising and growing towns in the whole Territory. Surrounded as it is by some of the richest mining districts of the southwest, and with an abundant supply of good water, excellent railroad facilities, a fine, equable climate the year round—being at an elevation of 2,150 feet—it bids fair to be, as one optimistic New Yorker calls it, "The Cripple Creek of Arizona." There are several very rich properties being worked both to the east and west of the town proper, and the flourishing condition of the townspeople and merchants indicate that its growth is rapid and sure.

Glendale, Peoria, Alhambra, Agua Caliente, Gila Bend, and Maricopa are prosperous villages.

ASYLUM FOR THE INSANE.

The Territorial asylum for the insane is at Phoenix, and is under able and progressive management, with every convenience that modern methods have devised.

INDIAN SCHOOL.

The most important Indian school in the United States is located 3 miles north of Phoenix, at the end of a beautiful drive from the city. Several hundred pupils are receiving an education which will fit them for civilized life. The institution is under good management, with an able corps of teachers.

CHURCHES.

The following denominations have active organizations in this county, and some of these have church edifices that would attract attention and favorable comment in much older communities: Methodist Episcopal, 6; Methodist Episcopal South, 8; Baptist, 4; Episcopal, 2; Presbyterian, 2; Congregational, 1; Christian, 1; Dunkard, 1; Catholic, 3; Mormon, 3; Salvation Army, 1.

FRATERNAL SOCIETIES.

There are in the county: Masonic lodges, 3; Odd Fellows, 3; Foresters, 1; Knights of Pythias, 1; Ancient Order of United Workmen, 2; Woodmen of the World, 4; Grand Army of the Republic, 1; Confederate Veterans, 1; Benevolent and Protective Order of Elks, 1; Independent Order of Red Men, 2.

PREHISTORIC RELICS AND RUINS.

Maricopa is rich in prehistoric relics. Ruins of ancient cities, towns, and temples can be traced in many parts of the valley. Lieutenant Cushing, of the Hemmingway Archæological Expedition, informed the writer hereof that he had traced the foundation of a city south of Tempe a distance of nearly 6 miles. He also expressed the opinion, from investigation, that what is now Maricopa County at one time contained a population many times greater than the entire population of the Territory. Many remains of irrigation works are to be found, and some of them have been utilized by modern engineers.

Assessed valuation of property in Maricopa County.

Land (251,729 acres)	\$3,322,967.00
Improvements.....	506,673.00
Patented mines (14)	7,300.00
City and town lots	2,464,002.00
Improvements.....	1,205,214.00
Horses:	
Range (1,962)	19,620.00
Work (2,529)	75,870.00
Stallions (7)	5,550.00
Mules (222)	5,550.00
Jacks (3)	160.00
Asses (42)	210.00
Cattle:	
Range (18,537)	185,370.00
Beef (762)	15,240.00
Milch cows (3,354)	83,850.00
Bulls (147)	4,410.00
Sheep (7,006)	14,012.00
Goats (1,305)	2,610.00
Swine (4,369)	10,922.50
Railroad, standard gauge (97.09 miles)	563,513.91
All other property	824,438.09
Total.....	9,312,482.50

YAVAPAI COUNTY.

County seat, Prescott.

County officers.—Supervisors, George H. Schuerman, J. R. Beatson, D. E. Dumas; district attorney, Reese M. Ling; probate judge, C. P. Hicks; school superintendent, C. F. Cox; assessor, Joseph P. Dillon; sheriff, John L. Munds; treasurer, Dennis A. Burke; recorder, W. I. Johnson; clerk board of supervisors, John H. Robinson.

From the first settlement of the Territory no section has been more favored or sought after than Yavapai County. Its natural advantages have attracted capital, and enterprise has been conspicuous in developing the county.

Richer in a great variety of resources than any other portion of the Territory, possessing a climate free from the extremes of heat and cold, it was but natural that the first north and south railroad possessed by the Territory should be built for the purpose of developing the resources of this favored region.

The completion of this road, named the Santa Fe, Prescott and Phoenix Railway, removed forever the only obstacle that has ever delayed the development of this diversified and extensive section, by placing it in direct railroad communication with the great centers of the nation; and to the homeseeker, capitalist, or tourist no other portion of the Union can present more varied and numerous attractions.

No other portion of the Southwest has secured so large and so desirable an increase in its population during the last few years as has this county. While there are isolated instances of a few sections having, under the excitement of a "boom," attracted, for the time being, more attention, the growth of this portion of Arizona has been a steady one, permanent and stable in its character, and entirely free from the feverish intoxication of speculation, which so often forms the only basis on which new regions of the West are brought into prominence, to be maintained there until the schemes of unscrupulous speculators are consummated, and then allowed by their "boomers" to relapse into their former obscurity. To present, in writing, a satisfactory idea of any frontier settlement is a most difficult matter. The causes that have called such settlement into existence may be narrated, and its growth may be explicitly set forth with conscientious observance of statistical minutiae; yet the impression created may be far from being more than approximately correct. Within less than a quarter of a century more people have found homes within a radius of a hundred miles of Prescott, Ariz., than lived along the entire Atlantic coast of North America during the first half of the century following the landing of the Pilgrim Fathers.

POPULATION.

The population of Yavapai County is about 25,000, and so evenly distributed that wherever one goes he will find within easy distance every element of civilization.

The towns and settlements are bustling and progressive, among which are Prescott, the county seat and the first capital of Arizona, with a population of 3,500; Jerome, a distinctively mining camp, with over 3,000 souls; Congress, with 1,000; Crowned King, with 500; McCabe, 300; Ash Fork, with 500; Congress Junction, with 200; Mayer, with 200; and many other places with from 100 to lesser numbers. In addition to the above numerous "camps" make up in their numbers thousands of souls scattered here to-day and everywhere to-morrow.

EDUCATIONAL.

The educational facilities presented by Yavapai County are excellent and far surpass even older settlements. For instance, at the present time over 50 school districts are maintained in the county, with an aggregate attendance of over 1,600 pupils, and calling for an annual expenditure of over \$43,000 to sustain them.

CLIMATE.

The most attractive feature of Yavapai is its climate—language can not do it justice. The extremes of heat and cold are rarely felt here, as the meteorological report of the signal service at Fort Whipple for a period of ten years proves:

	Degrees.
San Diego	61
Los Angeles.....	61
Santa Barbara	60
Monterey	57
Prescott.....	58
San Jose	57
Oakland.....	55

The altitude of Prescott is 5,500 feet above sea level, and the atmosphere accordingly dry and bracing.



PRESCOTT.

RAINFALL.

A large part of the water that serves to reclaim the lands of the Salt River Valley comes direct from central Arizona, and if it were not for the large rainfall of this region there would be little civilization where the rich and prosperous settlements north of the Gila and in its near neighborhood now exist. Phoenix and Tempe, with their thousands of acres reclaimed from the desert, are largely dependent upon this section for water, and the land which is now selling there for hundreds of dollars an acre owes its reclamation to northern Arizona. The average annual rainfall of the vicinity of Prescott during ten years is shown by the records of the United States observers to be 15.18 inches.

The following tabulated statement is reproduced and is taken from the United States Signal Service station at Fort Whipple, and covers a period of ten consecutive years.

Annual rainfall.

	Inches.
San Diego	11.01
Anaheim	11.01
Riverside	9.37
Colton	9.84
Spadra	12.39
Los Angeles	17.64
Monterey	14.96
Visalia	9.39
Fresno	9.57
San José	12.95
Prescott, Ariz	15.18

As will be seen by inspection of all the noted localities mentioned, Los Angeles is the only one possessing a greater annual rainfall than Prescott, yet among the places named are the most prominent orange and grape growing regions of the Golden State.

If the invalid is in search of pure and invigorating air, it is here he will find it. If the army of consumptives who "have gone before" in southern California and Florida had wandered to this Mecca, life would not have been a burden under these clear, cool skies. The terrible cold of the North or the withering heat of the tropical South is here unknown.

Reports from the Medical Department of the United States Army, embracing the zone of which Fort Whipple (but 1 mile from Prescott) is the center, give the remarkable statement that that military post is one of the healthiest regions of the world.

AGRICULTURE AND KINDRED PURSUITS.

With the possible exception of the Verde Valley, very little land has, up to the present time, been strictly devoted to agriculture. In the above locality, however, embracing a cultivated area of 3 miles wide by 45 miles in length, there is to be seen one of the most prosperous and progressive farming communities in the Southwest. It is well watered throughout the entire year, and, by means of canals recently constructed, a considerable area has been reclaimed in the past few years. The demand for its products is greater than its supply—a fact which is proven in the price paid for hay, grain, fruits, and farm produce, each of the above commodities ranging in price in near-by markets from 25 per cent to as high as 50 per cent over that shipped in from outside points.

In the county there are about 40 miles of irrigating canals and laterals. There are many water courses in the county upon which men of capital or corporations can erect dams for the conservation of water, so that an area aggregating 200,000 additional acres can be put under irrigation at a minimum cost.

The ranges for cattle, horses, and sheep are almost unoccupied, owing primarily to the fact that the land suitable for that purpose has been either overcrowded or eaten out. Last year it is estimated that over 100,000 head of steers were shipped or driven out of the county to pasture fields, which will have a tendency to renew interest in this calling in future years.

Very little land is devoted to horticulture, although the climatic conditions are such that an unequalled quality of fruit of certain kinds can be raised. The lack of water in the best localities is the main drawback. Peaches, apples, pears, cherries, and all kinds of berries do well, and are superior to those raised in the valley counties; grapes also mature well and are of exceptionally good quality. Fruits mature from July to September. There is a good field for the orchardist

here, as the demand is large and fruit of all kinds keeps well. The only enterprises of any importance in this line are those of Ross & Clay and Haskell & Kirwagen. The former have 4,000 trees about ready to bear and the latter some 1,500 bearing.

The consumption of butter, eggs, and cheese is fifty times greater than the supply, necessitating the shipment of these products from the Salt River Valley and Kansas.

LUMBERING.

One of the prominent features that first impresses the stranger in Yavapai County is the vast and seemingly inexhaustible supply of timber suitable for all branches of the lumber business. The appearance presented by these primeval forests, after the long days spent by the traveler in journeying through the monotonous expanses of Eastern prairies, or the still less interesting wastes of California deserts, is a most pleasing one, and the beauties of the forest scenes presented grow with acquaintance. The principal timber is the pine, there being not less than three distinct varieties. The piñon, ash, elder, cedar, cottonwood, oak, walnut, and quaking asp are also found in abundance. The property values show an increase of over a quarter of a million dollars over the previous year, and had not the city of Jerome been nearly wiped out by conflagration the total valuation would unquestionably have reached the six million dollar mark.

POINTS OF INTEREST.

There are many houses of the cliff dwellers situated not far from Prescott, and many historic ruins. The Castle Creek Hot Springs will soon become famous as a health resort, the waters being considered superior to most of the famous hot springs of the country. It is claimed and well authenticated that these springs will cure the most obstinate cases of rheumatism, stomach disorders, or scrofulous diseases of any character or origin, no matter of how long standing. The accommodations are excellent and the comforts and care of a home are ever ready. Convalescents from typhoid fever readily attest to the merits of its curative waters, while the emaciated victims of years of suffering from the "grip" seem to find here the only help possible in the restoration of health and vigor. The writer has personally talked with several people afflicted with the latter disease who have visited these springs, and each and all cheerfully and voluntarily attest to the curative effects of the water.

BUILDING STONE, ETC.

Throughout the county are numerous deposits of onyx, lithographic stone, red and gray sandstone, and other building materials. Notable among these are the extensive and beautiful onyx quarries at Big Bug. Extensive deposits of an excellent quality of lithographic stone are found on Sycamore Creek, fine red sandstone at Rock Butte, and red and white sandstone within 3 miles of Prescott. The latter quarries furnish a very fine quality of stone for building purposes, and it is being extensively used in the construction of homes and business houses in the city.

RAILROAD INTERESTS.

Yavapai County has four distinct railroad corporations, viz: The Santa Fe, Prescott and Phoenix, the United Verde and Pacific, the Prescott and Eastern, and the Congress Gold Company Line. The Santa Fe, Prescott and Phoenix runs from Ash Fork, on the Santa Fe Pacific Railway, to Phoenix, a distance of 200 miles, and is known locally as the North and South Road. The United Verde and Pacific Railway branches from the Santa Fe, Prescott and Phoenix at Jerome Junction and runs to Jerome, a distance of 30 miles. The Prescott and Eastern Railway leaves the main line near Prescott and terminates at Mayer, a distance of 28 miles to the east. The Congress Gold Company's road is but 4 miles in length, leaving the main line at Congress Junction, running thence to the Congress mine. There is no doubt that the railroad mileage will be materially increased during the coming year and the Santa Fe, Prescott and Phoenix line extended farther from its present routes to reach several important mining districts of the county. In fact, it seems to be the general belief that mining interests demand cheaper and more ready means of transportation, and no doubt is felt that the Santa Fe, Prescott and Phoenix system will meet the requirements. Since the completion of the road from Ash Fork to Phoenix, and running hand in hand, as it were, with its advent to Prescott, there has followed a



CONGRESS MINE, YAVAPAI COUNTY.

steady and stable growth of the commercial interests of this section, in mining, home building, lumbering, and immigration. The United Verde, Congress, Crowned King, McCabe, and other prominent mines owe their wealth and prosperity to its influences; the stock raiser, farmer, and lumberman are enabled to reach with their products other fields. This railroad has been in operation but six years, and while its volume of business in freight and passenger traffic nearly doubles with each year of its life, the industrial interests of the county have increased accordingly. In equipment and service this road is strictly first class. In the country it traverses the scenery is bewildering yet fascinating, and is relieved of that monotony always present in the plains of the East and the deserts of the West. Its headquarters are at Prescott, as well as the location of its machine and other shops.

MINES AND MINING.

The prediction of Humboldt that the mineral wealth of the world would be found in Arizona and New Mexico seems to be verified to-day. The correctness of that opinion seems to have been demonstrated. Mines that have been idle for years are once more resounding with the miner's pick and shovel, and a general waking up and activity is noticeable throughout the mining districts. More gold has been produced than ever before in the history of the county, and, what is even better, mining men have finally realized that this is the country of deep mining. The completion of the North and South Railroad has solved the problem of working the mines economically, and the industry is now entering upon its greatest era. New capital is coming in to develop the great properties of the county and the production of the precious metals is increasing daily.

With legitimate mines there has come a change in the scene, and the old has been pushed aside for the new, the benefit of which is to-day attested in this vicinity by the number of men on the ground and the manner in which they are operating. It is such an improvement over the played-out past, and the country is now being so firmly and legitimately handled in the practical and energetic work that goes with deep mining as to give us greater consideration, probably, than any other section of the Southwest.

The past five years has seemingly solved the future of this county as a mining section, and if only one-half of the mines being developed prove successful, Yavapai will be the most prosperous field for mining of any subdivision of the Union. Although one of the oldest mining sections in Arizona, it is nevertheless, in a practical sense, the newest.

Ten years ago there were not half a dozen gold claims in this section that had a 250-foot shaft, and in silver mines not many more. To-day in any district the opposite prevails, and when we look around and size up the miles of underground shafts and drifts in the United Verde, the 2,400-foot main shaft in the Congress, the thousands of feet of the Crowned King, the McCabe, the Jessie, the Empire, the Senator, the Poland Hamilton, Del Pasco, the Gladiator, the Favorite, the Peery, the Henrietta, the Accident, and especially the Planet Saturn, that has struck it at 1,000 feet richer than ever, the Johnson mine, and dozens of good prospects in the vicinity of Rich Hill in Weaver district, besides many others, we realize that the country asks to be "showed up."

Below are enumerated some of the plants in operation or ready to run, and with the general product of these must be associated the 150-ton smelter plant of the famous United Verde, which is running day and night, the 40 stamps (60 more now being added) and the 100-ton cyanide works of Congress, the Zonia copper smelter, the 2 smelters on Big Bug (soon to be in operation), the Prescott sampler, and numerous other smaller concerns, and over 15 cyanide plants, which in the aggregate represent over 500 tons of ore which is daily being handled from the mines of Yavapai County:

Congress, Lyons, Briggs, Sundance, Mescal, Red Rock, Last Chance, Pine Mountain, Empire, Yarnell, Henrietta, Harlan & Son, Etta, Monte Christo, Crown Point, Banell's, Crowned King, Richenbar, McCabe, Silver Flake, Placeritas, Dodge's, Sterling, Star, Waters, Bully Bueno, Peery's, O'Brien's, Senator, Pickrell, Providence, Jessie, Milligens, Storm Cloud, Harlans, Dividend, Del Pasco, Agua Fria, Cleveland's.

Big Bug is just as active as the Bradshaws. The Placeritas, Chaparral, Stanton, Lynx Creek, Briggs, Castle Creek, Humbug, Black Hills, Stoddard, Jerome, Santa Maria—in short, from one end of the county to the other, north, east, south, and west, the mines are nearly all producing, and if not producers are developing.

In talking with miners and endeavoring to form an estimated value of the proceeds of Yavapai mines for the current year which the above plants are expected

to return, and including ore shipments to the outside, \$10,000,000 is placed as a very low and conservative figure.

In tonnage of ore handled for shipment outside and mining machinery hauled in, the Santa Fe, Prescott and Phoenix has in the past year handled more than in all of the previous years since it was built.

The year 1898-99 has simply been marvelous in production and in capital invested.

Assessed valuation of property in Yavapai County,

Land (61,069 acres)	\$163,508.75
Improvements	107,155.00
Railroad land (232,036 acres)	46,407.14
Improvements	3,600.00
Land grants (99,289 acres)	62,055.62
Patented mines (299)	329,812.00
Improvements on patented mines	623,278.00
City and town lots	476,627.50
Improvements	569,457.00
Horses :	
Range (3,183)	31,830.00
Work (1,809)	53,695.00
Saddle (1,487)	41,660.00
Stallions (10)	550.00
Mules (74)	2,105.00
Asses (201)	1,882.00
Cattle, range (46,736)	467,360.00
Milch cows (929)	12,185.00
Sheep (51,938)	103,876.00
Goats (3,870)	7,640.00
Swine (558)	1,674.00
Railroad, standard gauge (60.552 miles)	103,051.46
All other property	1,021,928.85
Total	4,280,738.32

PIMA COUNTY.

County seat, Tucson.

County officers.—Supervisors, M. G. Samaniego, M. W. Bernard, L. M. Jacobs; probate judge, S. W. Purcell; district attorney, William F. Cooper; sheriff, L. W. Wakefield; treasurer, Harry A. Drachman; assessor, J. W. Bogan; recorder, C. A. Shibell; surveyor, Phil. Contzen; school superintendent, J. T. Hughes; clerk board of supervisors, W. P. B. Field.

Pima retains the legal classification as a county of the first class, that is, it still shows taxable property in excess of the required \$3,000,000, notwithstanding that out of a portion of its territory a new county (Santa Cruz) of 1,200 square miles has been created since the last report. Last year the taxable wealth was fixed by the Territorial board of equalization at \$3,753,340, and this year it is \$3,376,512, or only \$376,728 less than a year ago, although the territory surrendered for the new county makes the fine showing of \$937,985 worth of taxable property. Altogether there is an increased valuation for the whole territory comprised within the former limits of the county of \$561,157. As the assessed valuations are notoriously low, these figures indicate an actual increase in wealth of \$2,000,000 over a year ago. As these figures show, no other county in the Territory is sharing to a greater extent than Pima in the general prosperity now prevalent in Arizona.

The progress made in the mining industry, so notable during the past few years, has continued unabated through the present year, greatly stimulated by the widespread revival of interest and confidence in mining, so manifest among the people of the Eastern States. Heretofore the development of the prospects and mines of this section has been made almost entirely by local energy and capital, but the great merit of Pima County mines is at last attracting outside capital in large quantities, and important sales are frequent. Promising prospects are being purchased by people financially able to develop them, and there were never so many prospectors exploring the hills as now.

The production of all the precious metals has increased during the year, that of copper particularly. The high price of copper having directed the attention of mining investors to Pima County, a number of the better-developed mines have

been equipped with modern machinery and smelters, while prospecting for copper is being rewarded by numerous new discoveries. Even silver is receiving more attention than for years past, and, taking advantage of improvements in machinery and the treatment of ores, silver mines that have been idle for years have been started up with satisfactory results.

In commercial lines the situation is no less satisfactory.

The live-stock industry remains in a flourishing condition. Heavy shipments of cattle have been made to the eastern and coast markets and sold at remunerative prices, while the increase on the ranges has fully maintained the supply. As a reference to the table of assessed valuations will show, the actual value of the cattle in the county approximates \$1,500,000. Abundant rains in July and August put the ranges in a most satisfactory condition.

Considerable attention is being given to the larger production of sheep in the mountain ranges than heretofore, both on account of the higher price of wool, incident to the passage of the late tariff legislation by Congress, and the greater demand for mutton as an article of food, owing to the increased price of beef cattle.

The great mountain ranges of Pima County are especially fitted for the support of immense flocks of sheep; they produce large quantities of the most nutritious grasses which are not as accessible to the larger stock as to sheep. This field of sheep industry presents a decidedly inviting opportunity for the employment of capital with the most profitable results. This is especially so for the person with limited capital, as it takes much less capital to start into sheep raising than it does in cattle raising, while the returns in sheep are much earlier than with cattle.

Compared with other lines of business farming does not make the showing made in some other counties. The area of cultivated land has not been materially increased, and will not be until the adoption of some system of water development. But possibilities in that direction are very flattering, and the prospects for the construction of one or more reservoirs are good. It is only recently that the serious attention of our people has been generally arrested and directed to the possibilities and certain profits of an increased water supply; and the energy with which the question is being agitated promises important results for the county, which is certain in time to take a good position among the agricultural sections of the Territory.

Twenty per cent of the land of Pima County can be successfully irrigated and reclaimed by a system of ditches, subdrainage pipes, and reservoirs for water storage at a reasonable outlay, and 201,420 acres thus added to the cultivable area at an average cost of reclamation of \$6 per acre. Wheat, barley, oats, alfalfa, hay, corn, sorghum, tobacco, potatoes, pease, beans, beets, all kinds of vegetables, fruit, etc., can be produced on these lands. The yield of wheat, barley, and oats will be from 35 to 40 bushels per acre; corn, from 40 to 60 bushels; hay, 3 tons; and alfalfa, 5 to 7 tons.

There are 650 acres of land devoted to orchards—peaches, apricots, nectarines, apples, pears, quinces, figs, pomegranates, and grapes being the most profitable crops.

Only about 10 per cent of the present fruit consumed is produced in the county.

The Santa Cruz Valley, which extends from south to north across the entire county, was undoubtedly the first seat of agriculture in the Territory of Arizona. The old settlements of Huebabi, Tumacacori, Tubac, Tucson, and San Francisco maintained a considerable population and supplied the Spanish military posts with provisions by agriculture in the earliest dawn of civilization on the American Continent, and the descendants of these early producers, augmented by more recent settlers, still carry on successful agriculture at all these points, and at many new places, until agriculture has become an important industry. For more than three hundred and fifty years, ever since the Spaniards first set foot in this section, crops have been produced in the Santa Cruz Valley every month in the year with irrigation and without a particle of fertilizer being used, and still the soil is rich and abundantly productive, and is annually growing richer from irrigation. Two crops are raised on the same land each year.

The running bodies of water are the Santa Cruz and San Pedro rivers, and the Pantano, Rillito, and Sonoita creeks. During the rainy seasons immense bodies of water flow to waste, which, if impounded, would bring thousands of acres of the most fertile land in the world under cultivation. In any of the valleys and on the plains where flowing water can not be found the same can be reached at a depth varying at from 10 to 600 feet.

County lands.

	Acres.
Total area	6, 714, 000
Surveyed lands	1, 147, 849
Unsurveyed lands	5, 279, 328
Unappropriated lands	6, 426, 677
Reserved lands	197, 414
Disposed lands	89, 909

As nearly as can be ascertained the amounts of land now under cultivation and irrigation in the county are as follows :

	Acres.
Allison ditch	1, 000
City or Farmers' ditch	1, 400
Between Tucson and Indian Reservation	2, 000
Indian Reservation, 9 miles south of Tucson	1, 200
Hart's ranch	100
Canoa ranch	200
Sopori district	500
Arivaca district	800
Pantano district	500
Rincon Valley	700
Tanque Verde and Rillito	3, 500
Redington	1, 200
Total	13, 100

TUCSON.

The county seat, Tucson, is growing rapidly, and throughout the Territory Tucson is recognized as a place where the expression "hard times" is not heard. The claim is often made for Tucson that it is the wealthiest city of its size in the United States, and certainly there can be no question that it is among the most solid towns financially in the country.

Tucson, founded about the year 1555, as is proven by the ancient records recently discovered among the archives of the San Xavier Cathedral, was a Jesuit settlement long before the institution of San Augustine in 1595, and Santa Fe in 1605, and in consequence is entitled to the honor of being the mother of cities so far as the United States is concerned.

The trials of the Catholic padres, surrounded as they were by dangers and almost insurmountable obstacles of every character, make an interesting story too long to be told here. At the same time the charm of antiquity, tinged though it may be by the innovations of modern civilization, is with it still. The Spanish adobe architecture, demonstrated by experience to be the most suitable for the prevailing climatic conditions, is prevalent to an extent greater perhaps than in other Arizona cities of its size. Yet Tucson has very many handsome modern dwellings and business houses of stone and brick, which contrast strangely with the low but comfortable structures of sun-baked brick. In them is blended the romance of the past and the realistic conditions of the present.

Containing 10,000 inhabitants, the ancient city does an enormous business annually with the surrounding counties and the State of Sonora, Mexico. Its mercantile institutions are among the largest and most important in the Territory. Owing to its enviable standing as a cash town, due to the fact that it is the commercial center of important mining, cattle, and railroad interests, its prosperity is unquestioned. Discounting their bills and purchasing in large quantities, the merchants are enabled to sell at prices which compare favorably with the rates prevailing in much larger places.

The past three years have shown a steady and marked advance in the construction of modern buildings, particularly in the matter of business blocks and tasteful dwellings. Upper Congress street, a wide and handsome thoroughfare, has been lined with brick and stone structures, the majority of them containing two stories and basement and all new and in strict conformity with the requirements of the time. The demand for such buildings is greater than the supply, and each is engaged long prior to its completion. An excellent indication of the financial condition of the town itself is the fact that all realty improvements are based strictly upon home capital, which appears to be both plentiful and cheap.

Hundreds of pretty dwellings, built by the two building and loan associations, have been erected, so that entire new blocks have sprung into existence, necessitating a street-car service, an innovation unthought of by the Tucsonian five years ago.



204

PIMA CO. COURT HOUSE.

PHOTO. ENG. CO. N.Y.



WORKMEN'S BLOCK AT TUCSON.

The Southern Pacific Railroad Company has extensive repair shops and round-houses in Tucson, second only in importance to the shops at Sacramento, Cal., and necessitating the employment of a large force of men. Between \$65,000 and \$90,000 in wages are paid every month, nearly every dollar of which remains in the town. Tucson is preeminently a commercial center, the surrounding country, owing to its topography and lack of irrigating canals, being far from agricultural in its nature. The cattle industry, large and rapidly growing, is most important and a prominent factor, since the results of the semiannual trades are directly to her financial betterment. She is as well the base of supplies for the numerous mining camps scattered through southern Arizona.

One of her conspicuous manufacturing enterprises is the immense 4-story flouring mill, which from a modest beginning has sprung into one of the largest concerns of the kind in the West. A curious feature, and one scarcely credible were it not strictly true, vests in the proposition that these mills flourish in a locality where very little if any wheat is grown. In the beginning the company procured its raw wheat from California, and, despite the cost of transportation, was able to manufacture it into the finest flour and reship at a profit to outside points. At present, however, the principal supply comes from the Salt River Valley and Pinal County.

A drawback heretofore has been the insufficient water supply. This defect is now being remedied by the erection of modern waterworks, affording an adequate supply for all purposes, including sewerage facilities.

An illustration of the financial condition of the town is the work recently accomplished by the various fraternal societies. The A. O. U. W. lodge owns a magnificent brick block on a principal business street, which yields a monthly rental of \$400 and upwards. The order of Elks have constructed a fine 3-story brick building, to be devoted entirely to the uses of the society, which has cost, with the ground and furniture, in the neighborhood of \$20,000. The Masons have a very elegant structure which would reflect credit upon cities many times the size of Tucson, and these show plainly the earnest backing of a prosperous community, else such results could never be accomplished.

Tucson is situated in southern Arizona on the line of the Southern Pacific Railroad, about 500 miles east of Los Angeles, about 300 miles west of El Paso, and about 670 miles south of Denver, almost in the center of the climatic belt recommended by the United States Medical Commission as the most favorable region in the United States for those afflicted with pulmonary ailments, asthma, and various chronic diseases.

Altitude above sea level 2,420 feet. The climate is dry and pleasant during the entire year. During the months of June, July, and August the average temperature is about 90°, but there is so little humidity in the atmosphere that little inconvenience is experienced. This mild, semitropical atmosphere is probably owing to the physical conditions which are prominent. The Santa Catalina, the Rincon, Tucson, and Santa Rita mountains form a circle of high mountains curving three-quarters around the valley, to the west of which stands another range, all of which prove a complete barrier to storms. While three of the summer months are warm during the day, the nights are always cool. This is on account of the rarified condition of the atmosphere, which becomes instantly cool on the setting of the sun, there being no humidity to retain the heat.

The fall, winter, and spring months can be compared with the Italian climate. There is little or no frost. Flowers bloom during the entire winter months, and much of the shrubbery retains its foliage. As compared with the southern California climate, Tucson and its surroundings are far superior in every respect, and such is the verdict of invalids who have tried both localities.

Dr. N. H. Matas, a physician of high merit and eighteen years' practice in this city, among other things, says:

"Since consumptives must depend on the resisting forces of nature for the cure of their disease, it is evident that an early selection of a good winter climate is the most important factor for their cure and future welfare. They need a warm, dry climate in winter, free from fogs, heavy frosts, storms, chilling winds, and sudden atmospheric changes, and a climate where there is constant sunshine and plenty of pure air and where they can have outdoor exercise daily. Treatment as well as climate must be undertaken early to do good when there is yet a good foundation upon which to build the system. We must remember that nature alone cures, and where there is no nature there is no hope. Physicians and climate can only help nature, and they can do no good when nature is destroyed."

The official weather reports and observers of the United States, as well as the scientific climatologists, admit that Tucson is the center of the most favorable zone in the Southwest for the improvement and maintenance of life for consumptives in the United States if not in the world.

Dr. W. B. Purcell, county physician, observes: "It is an undisputed fact that proper climatic conditions give the greatest relief to those afflicted with or having a tendency to phthisis. When a phthisical tendency exists great care should be exercised to prevent its development; as humidity is such an important factor in the cause of consumption, those afflicted with or having a predisposition to lung disease should immediately seek the proper climate favorable to their conditions.

"The climate of Colorado has been recommended for its beneficial effects for consumption. My long residence there gave me ample and sufficient opportunity of judging climatic conditions there existing during the summer months. The mountainous portions of Colorado have undoubtedly a beneficial effect on tuberculous subjects, but I can not recommend Colorado during the fall and winter as the changes are often severe, becoming raw and cold within a few hours, and as these are atmospheric conditions to be avoided, it would not be advisable to spend these seasons there. Those having a peculiar type of constitution with a hereditary tendency to consumption, would do well to avail themselves of an opportunity and come here and remain exempt from disease. It is a fact that those born here of tuberculous parents seldom if ever have the disease develop so long as they remain in this climate. It is my opinion that there is no other section of the United States which will compare favorably with that in and about Tucson for the relief of pulmonary affections."

The Hon. Whitelaw Reid in his journal, the New York Tribune, on Arizona in winter, among other things, says: "During five months' residence in southern Arizona in winter time there was but one day when the weather made it actually unpleasant for me to take exercise in open air at some time or other during the day. Of course, there were a good many days which a weather observer would observe as cloudy, and some that were showery, but during this five months (from November, 1895, to May, 1896) there were only four days when we did not have brilliant sunshine at some time during the day. Even more than Egypt, anywhere north of Luxor, Arizona, is the sunshine. The nights throughout the winter are apt to be cold enough for wood fires and blankets; half the time an overcoat is not needed during the day, but it is never prudent for a stranger to be without one at hand.

"The atmosphere is singularly clear, tonic, and dry. I have never seen it clearer anywhere in the world. It seems to have about the same bracing and exhilarating qualities as the air of the great Sahara, in Northern Africa, or of the desert about Mount Sinai, in Arabia Petraea. It is much drier than any part of the valley of the Nile north of Cataract. It seems to me about the same in quantity as the air on the Nile between Assouan and Wady Halfa, but somewhat cooler."

TUCSON INDUSTRIES.

Tucson has a population of 10,000, about one-third of Mexican descent. It is the commercial center for southwestern Arizona and northern Sonora, Mexico. It is the seat of Pima County, the location of the United States surveyor-general's office, the United States land office, the United States district court, and the United States marshal's office. It is the headquarters of two divisions of the Southern Pacific Railroad, comprising over 600 miles of the line; also the shops, roundhouse, etc. The monthly pay roll averages from \$60,000 to \$90,000 to its employees, which adds much vitality to the commercial prosperity of the city. The city is lighted with electricity and gas, and the telephone and street railway are well sustained. The water is supplied from the Santa Cruz River, and is absolutely pure.

There are nine hotels, most of which are conducted on the European plan, and a score of restaurants and lodging houses. Cost of entertainment at hotels ranges from \$1.50 to \$5 per day; furnished rooms can be had at from \$5 to \$15 per month, and table board from \$4 to \$7 per week.

Several important industries are located here, among which are the Eagle Flouring Mills—the largest in the Territory, two ice factories, machine shop, ore-reduction works, and sampling works. There are also various classes of mercantile houses—6 wholesale, 2 grocery, 5 clothing, and about 80 retail stores, 3 furniture, 2 tin, glass, china, and other wares; 3 drug stores, 3 stationery, 3 jewelry, 4 livery stables, 2 daily and weekly newspapers—the Star and Citizen and El Fronterizo, a Mexican, 17 practicing attorneys, 11 physicians, 4 dentists, 2 photographers, four Protestant churches—Methodist Episcopal, Congregationalist, Episcopalian, Baptist—and Catholic; all are supplied with able pastors.



TUCSON CATHEDRAL, TUCSON.

INVESTMENT OPPORTUNITIES.

Tucson is on a remarkably sound financial basis. Business failures during the last five years have been practically unknown. Many brick buildings have been built during the last year; scores are now under construction. Commercial houses are steadily increasing in number.

The ruling price of money is from 1 to 1½ per cent per month on best security. A large volume of money could readily find investment here on gilt-edge security at from 6 to 8 per cent per annum. A loan and savings bank would be a safe and profitable business as there is no tax on mortgages; the value of interest speaks for itself.

Tucson has 2 flourishing national banks, 2 building and loan associations—one with a capital of \$65,000, the other \$25,000. This being the center of a vast stock country shipping from this point is very large, and as the country for more than 100 miles tributary is rich in gold, silver, and copper, and vast marble and onyx beds, the financial business of Tucson is very great.

EDUCATIONAL.

Tucson has an organized municipal government with mayor and city council and excellent public buildings; a public library which would do well for a city of 20,000 inhabitants; is the seat of the University of Arizona, under management of which are the agricultural college, the school of mines, and the United States experimental station. It is favored with a strong faculty of 17 professors, and at present 100 or more students. Tuition free, dormitory accommodations and table board, \$15 per month. The college equipments are equal to the best in the land. Families who come to spend the winter here can allow their sons and daughters to enjoy the advantages of this institution, while they are assimilating the vigorous tonic of the climate.

The public schools are on a high plane, well graded, with an able corps of 14 professional teachers, receiving salaries ranging from \$60 to \$125 per month; excellent buildings of modern style of architecture.

The St. Joseph Academy for young ladies, under the management of the Sisters of St. Joseph, and the parochial school for boys, under supervision of the Catholic Church, have a large attendance.

The Indian Industrial Mission School under the auspices of the Presbyterian Home Mission is established here with an average attendance of 150 Indian boys and girls.

Taking into consideration the many natural advantages, our rich climatic resources, our vast deposits of mineral, opportunities for agriculture, and the stock industry, and other general interests tributary to Tucson, no better field is opened for the profitable and safe investment in scores of industries, and the development of wealth resources.

NEIGHBORING POINTS OF INTEREST.

Because of its antiquity there are many places of interest within the radius of a few miles of Tucson, notably the San Xavier Mission, the old mission church of Escala Pura, the abandoned Government post Fort Lowell, and the fortified hills west of town. By whom or by what race the fortifications were built is not known, but their lines of defense are still plainly visible. Many large rocks, having an eastern face, are covered with hieroglyphics of a lost race, and the riddle has yet to be read. For many miles north of town, in the Santa Cruz Valley, are to be found evidences of dead cities. The plains may bear no mark of human occupation, but relics of the past are unearthed by a little labor. Broken pottery, ornaments, household utensils, implements of agriculture and war are common to the inquiring mind of the archæologist. Burial urns, with their incinerated contents perfect as the day when they were first consigned to the earth, are occasionally to be found. The whole country is full of interest, not only for the capitalist and the home seeker, but for men of leisure in search of recreation and the invalid in quest of health.

WATER SUPPLY AT TUCSON.

There are two chief sources of water at the city of Tucson—one from the valley of the Santa Cruz, the other the underground flow from the Rincon and Catalina mountains. The Santa Cruz heads in the mountains south of the city and across the line, in Sonora, Mexico, and flows northerly to Tucson, where it sinks below the surface and continues onward toward the Gila at or near Casa Grande. Even

above Tucson it can not be called a steadily flowing stream above ground. It sinks and rises at intervals and only in seasons of flood it deserves the name of a river. The course of the Rillito flow is from east to west or northwest, and this water course, like the Santa Cruz, is dry at some seasons and in flood at others. But there is a well-defined underground flow—not only along the immediate valley of the stream, but under the broad, gravelly mesa which skirts the Rillito and the Catalina and blends with the mesa slopes of the Santa Ritas in the southeast. The Rillito drainage becomes confluent with the Santa Cruz a few miles below Tucson, from which point the flow may be considered as one extending underground northerly and westerly toward the Gila River. It may be said that water can be obtained by wells or by boring at almost any point along the course of these streams. The Rillito flow not only follows the main channel or trough of the valley, but is believed to extend out laterally under the broad mesa south of it. The flow must receive a considerable accession from the water of the Sabina, which, at times during the year, when the rains are heavy or when the snow accumulates and melts from the summit of the Catalinas, becomes a raging torrent even as far down from the mountain as the edge of the plain or mesa and even to the Rillito. At other seasons, when the water supply is greatly reduced, the torrent disappears and shrinks back to the inner and higher gorges, where, however, there is a continuous flow during the entire year, and there can be little doubt that there is an underground flow even to the Rillito. The existence of an underground flow along the slope of the mesa north of Tucson, and upon which the University of Arizona is located, is made known by wells. These wells vary in depth from 50 to 100 feet, depending upon the rise of the ground or surface of the mesa.

The well at the university is about 100 feet deep and 7 feet in diameter. It is sunk through granite "wash," a coarse gravel, which alternates with pebbly and sandy layers, some of which are mingled with red arenaceous clay. The same conditions were found at the well of W. P. Blake, on the same mesa, about one-quarter of a mile west. This well is 6 feet in diameter and 90 feet deep. Water stands in it to a depth of 3 to 4 feet, and as at the university well flows in as fast as it is drawn out.

CHEMICAL ANALYSIS OF TUCSON WATER.

Prof. W. H. Forbes, chemist of the United States agricultural experiment station at the University of Arizona has made a chemical investigation of the drinking water of Tucson, the samples being from the new wells for the supply of the city.

Two samples were taken from the company's wells. The first sample was composed of equal parts from each of the west four wells, and the second, in like manner, from the east three wells in the company's trench just south of town. The complete analysis of the sample from the west four wells, from which it is understood the city supply will be chiefly drawn, is as follows:

West four wells of new waterworks.

[Parts in 100,000.]

Sodium chloride (common salt)	3.95
Sodium sulphate (Glauber's salt)	16.18
Potassium sulphate .....	.74
Calcium sulphate (gypsum)	1.74
Calcium carbonate (tem. hardness)	14.49
Magnesium carbonate	4.07
Iron oxide and alumina .....	.40
Silica	3.10
Total solids in 100,000	44.67

NOTES.

Organic matter	Faint traces.
Nitrates	Traces.
Nitrites	Faint traces.

This is not an alkaline water.

The samples from east three wells contains: Total solids in 100,000, 35.40. This water is of the same general character as that from the west four wells.

Organic matter, none; nitrates, traces; nitrites, faint traces. A complete sanitary analysis of these samples was not made, for the reason that the wells are at present open, unprotected, and not continuously pumped, and are consequently subjected to contamination from matter blown into them from the surface of the surrounding ground.

It is interesting to note that the salts are largely of the nature of limy hardness, which is deposited when the water is boiled. Calcium sulphate, which is particularly objectionable as the cause of a very hard and refractory boiler scale, is also present in small amount. Sodium chloride and sodium sulphate are neither of them present in objectionable amounts.

Assessed valuation of property in Pima County.

Land (48,146 acres).....	\$163,311.00
Improvements.....	95,413.00
Land grants (25,888 acres).....	6,472.00
Improvements.....	4,500.00
Patented mines (152).....	59,100.00
Improvements on patented mines.....	13,000.00
Improvements on unpatented mines.....	13,100.00
Town and city lots.....	719,177.00
Improvements.....	881,205.00
Horses:	
Range (2,386).....	23,860.00
Work (841).....	22,037.00
Saddle (863).....	16,025.00
Stallions (42).....	1,560.00
Mules (209).....	5,265.00
Asses (23).....	115.00
Cattle range (40,454).....	404,540.00
Milch cows (269).....	4,955.00
Bulls (158).....	3,310.00
Sheep (2,990).....	5,980.00
Goats (482).....	964.00
Swine (339).....	1,017.00
Railroad, standard gauge (64.75 miles).....	394,417.40
All other property.....	537,189.00
Total.....	3,376,512.40

YUMA COUNTY.

County seat, Yuma.

County officers.—Supervisors, Dr. P. G. Cotter, C. V. Meeden, T. W. Underhill; probate judge, W. E. Marvin; sheriff, John M. Speese; district attorney, C. L. Brown; treasurer, D. L. DeVane; surveyor, W. H. Elliott; recorder, W. E. Marvin; clerk board of supervisors, W. E. Marvin.

Yuma County, one of the four original political subdivisions of the Territory when it was first established by the act of Congress on February 24, 1863, as an independent commonwealth, forms the extreme southwestern portion of Arizona. It lies between 32° and 34° 2' north latitude, and 113° 20' and 114° 14' west longitude. It is bounded by Pima, Maricopa, and Yavapai counties on the east, the Colorado River on the west, Mohave County on the north, and Sonora, Mexico, on the south. It has an area of 10,138 square miles (6,488,320 acres), an expanse greater than any of the seven smaller States of the Union, and larger than Connecticut, Rhode Island, and Delaware combined.

For more than 100 miles it is crossed from east to west by the Gila River, which thoroughly drains the southern and eastern portions, eventually flowing into the Colorado at the town of Yuma, while the Colorado washes its western boundary, effectually draining the remainder.

The topographical configuration of the surface includes a series of wide plateaus, rising gradually from a point situated at the southwestern extremity, with an altitude of 60 or 80 feet above sea level to an elevation in the north and north-west very much higher, the whole sloping gently in a southwesterly direction.

These plateaus are crossed by numerous mountain ranges, especially in the northern part, the ranges being separated by broad valleys, many consisting of excellent lands. The various mountain systems, though rough and abrupt in character, are highly mineralized, carrying gold and silver, copper and lead, iron, and other metals in paying quantities. The eastern and southern divisions include

gradually sloping plains, covered in places with natural grasses and trees, among the latter being the mesquite, ironwood, and palo verde. Here and there are detached hills and spurs of eruptive origin.

All the country embraced within the county confines, situated north of the natural watershed of the Gila, owing to the slight rainfall and few streams from which water can be taken for agricultural purposes, is practically worthless, so far, at least, as the feasibility of bringing large bodies of irrigable land under cultivation is concerned. The available arable region, therefore, is limited to broad strips of country lying directly north of the Gila and east of the Colorado River, and also hundreds of miles of splendid lands stretching directly southward from Gila River to the Mexican frontier. Consequently, it is upon these rivers that water-storage reservoirs must be established.

It is more than probable that less is known of the physical and topographical peculiarities of Yuma County than of any other county in the Territory. According to the map of the Interior Department, issued from the General Land Office in 1883, it is shown that less than 10 per cent of the total area was surveyed by the Federal authorities. It is believed that no further surveys have been ordered since the date mentioned, and therefore so far as official recognition extends, more than nine-tenths of the county is a veritable terra incognita. The population numbers 3,200 souls.

THE VILLAGE OF YUMA.

Although the town of Yuma is the second oldest community in the Territory of Arizona, it is astonishing how little its resources are known to the world at large and how slightly developed is the natural wealth of the county. This is owing to Yuma's reputation for unbearable heat, and partly to the fact that, lying next to California, it has been assumed that the country has been thoroughly prospected for mineral wealth, and prospectors have, in the main, kept the traveled highways in crossing its territory. As a matter of fact, one suffers less from the heat here than in almost any of the settled communities of the East, owing to the dryness of the atmosphere, and there is no healthier climate anywhere.

People labor out of doors from the rising to the setting of the sun and suffer no inconvenience. There has never been known in this section of the country an authentic case of sunstroke. Our climate, taken in time, never fails to cure pulmonary complaints of any description. Diseases such as smallpox, cholera, etc., rarely visit us, and then only in a very mild form, and are never fatal except through the perversity of the patients. Contrary to the belief of the uninformed, the dry heat of the summer months is especially conducive to good health and exceptional vigor, acting naturally upon the human system with the same effect as the artificial results of a Turkish bath, purifying and renovating it. As a further matter of fact, this county has never been even superficially prospected, and it is only now that the people are beginning to search its hills with any degree of systematic enthusiasm for the mineral wealth hidden there.

Portions of country traversed for years by commonly traveled trails are developing into rich storehouses of golden wealth. New and rich placers are being discovered, and shipments of placer gold from this point, through Wells, Fargo & Co.'s Express, are increasing in value. From a mining standpoint Yuma County is rapidly developing, and yet, as far as that industry is concerned, this section has received but little recognition.

Agriculturally, the country is fast improving. Enterprises that have lain dormant the last two years, owing to the general financial depression and consequent dearth of money for investment purposes, are waking up to new life and vigor. A greater area of old farms has been put under cultivation, and new lands have been inclosed and new fields started. Fields of cereals and alfalfa have been added to the cultivated area on the Colorado River below town; the lands lying under the Mohawk and Farmer's canals have been made to yield heavy crops of every variety of agricultural products, as in other sections of Gila Valley, and the gardens of Yuma have been added to and beautified in fruits, flowers, and shrubbery. Altogether, we may feel proud of our progress.

It speaks well for the industry and pluck of our people, and the showing made constitutes the best evidence of the merit of our soil and climate and the richness of our mineral resources.

The Territorial penitentiary is situated at Yuma.

THE CLIMATE.

It is not the intention to dwell in detail upon the sanitary advantages offered by our most perfect climate, and yet a few words upon this subject may not be inappropriate.

Nine out of every twelve months the climate is simply superb. Three months are

warm, but not excessively so, although the thermometer ranges far higher than would be conducive to health or comfort in any section of the East. The conditions, however, are most dissimilar, as may be seen by the following, taken from an official communication of Lieut. W. A. Glassford, of the United States Signal Corps, to the governor of the Territory of Arizona in 1897:

"A few words upon the heat. It is recorded as extreme, yet no one suffers and sunstrokes are unknown. This is usually accounted for from the purity and dryness of the air. Both are true, but the dryness is, perhaps, the correct reason. I have calculated between the shade and sensible temperatures at Yuma during the heated hour of the day, and it is about 30°. At New York or Washington it is only a few degrees less and often identical. The highest shade temperature ever recorded at Yuma is 118°. When the heat is at this point the sensible temperature is about 88°. The shade temperature at New York being 105°, the sensible temperature is certainly nearly 100°. The difference between the mean temperature and the mean sensible temperature for July is over 17° at Yuma. These considerations of the sensible and shade temperatures will account for the absence of any detrimental effect from the extreme heat of Arizona.

"The air is dry; the moisture in the atmosphere is from 25 to 30 per cent as against 75 to 85 per cent in other localities. Every afternoon in summer there is a refreshing breeze from the Gulf of California that relieves the day of undesirable heat. It passes over a desert, much of which is below sea level, that acts as a desiccant, so that when the plains of central Arizona are reached the air is dry to the last possible degree.

"There are neither sunstrokes in summer nor pneumonia in winter; neither fever nor malaria live nor generate in this section. The air is absolutely free from those compounds that poison the system and bring disease. In no country is there a greater number of bright nights and sunny days. Hundreds afflicted with lung trouble, after visiting Florida and southern California, have found relief in this invigorating climate, where the pure air is a tonic to shattered constitutions, a healing balsam to the consumptive."

The meteorological conditions are indeed admirable for the cure of all rheumatic, bronchial, and pulmonary troubles, as has been proven time and again. In summer the rapid evaporation lowers the temperature and promotes comfort, while in winter the mild, equable, and pleasant weather is delightful and health-giving to the invalid.

Concerning the effect in regard to early fruit, the late commissioner of immigration, Hon. Cameron H. King, has this to say:

"The average spring, summer, and autumn temperatures of Yuma are nearly 9 degrees more than at Riverside, Cal. This is sufficient to explain the fact that the citrus and other fruits of Yuma ripen from a month to six weeks earlier than at Riverside or other points in southern California.

"Yuma has an earlier and warmer spring. The trees have an earlier start, and the higher temperature matures the fruit sooner. It is evident, since oranges ripen in Yuma by the 15th of November instead of about the middle of January, as in southern California, that the fruit in Arizona can never be injured by any low temperature in the winter season. And since the labor of the tree is for the season practically over at Yuma before the winter season begins, it is better prepared to stand a low temperature in winter than it could in California, even were the atmosphere as dry in the latter State as in Arizona.

"It is known that Riverside raises better oranges than the country around Los Angeles, and the reason is that Riverside escapes the fogs which hang over Los Angeles.

"It is proper to observe the maximums and minimums of temperature, as shown by the Signal Service records, are of little practical utility, since such extremes may not last more than a second and may be the effect of one small wave or ripple of air.

"The warm sunshine of the spring, summer, and autumn days causes the fruit in Yuma to mature early and gives a delicious sweetness, flavor, and color to the orange, lime, lemon, and other citrus fruits which they can not attain on the coast of the Pacific, where fogs dampen the fruit, mildew is produced, and dust coats both fruit and leaf."

It is undeniable that nowhere on the face of the globe can a spot be found more favorable than this for the growth of the citrus fruits.

The statements of the commissioner can be thoroughly substantiated, as may be seen by the following, showing the time of maturity for certain products: Strawberries, January 15; apricots, April 1; mulberries, April 14; figs, April 10; grapes, June 1 to 7; watermelons, May 20; peaches, June 15; pomegranates, August; limes, September 5 to 10; lemons, September 15 to 25; dates, September 1; oranges, November 15 to December 1.

WATER SUPPLY.

The original source of water supply is comprised in the fall of rain and snow in Arizona and the States and Territories north and northeast of it. Where the fall is greater than the evaporation, the water eventually finds its way to the rivers and streams that drain the mountain ranges by seepage, percolation, and surface flow. It may also be taken from springs and wells fed similarly. Water occurs in any portion of the Gila and Colorado valleys at a depth of from 12 to 25 feet; but, of course, the quantity thus obtained is insufficient for extensive irrigation. But the supply upon which the settlers are forced to place reliance is the inexhaustible volume that during high water passes along the channels of the Gila and Colorado rivers to the sea. The drainage of much of Nevada, Utah, Colorado, and all of Arizona finds lodgment in the Colorado throughout its 1,200 miles of channel. An admirable feature in this connection is the peculiarity of reaching its highest dimensions in the months of June and July, the very time when other streams are low. But it must be said that there is sufficient at all times to irrigate every acre of land under and tributary to it. The river supply at the season of irrigation is greater than that of all the utilized streams of California combined.

The Gila at certain annual periods spreads to close upon 2 miles, where the surface contour so permits, with an average depth of 4 feet. In June, July, and August for 40 miles from its mouth it is either very low or absolutely dry, although considerable running water can always be found along the rock bed. It happens frequently that where reefs of rock cross the river the water comes to the surface, only to disappear again when the barrier is passed. An excellent site for storing enormous bodies of water has been surveyed by a competent engineer, the location being in the Gila Valley, as well as the outlying mesas and higher plains, while the construction will not be attended with unusual difficulties, nor would the cost prove excessive in comparison with the increased value of the lands, large portions of which are worthless. Such works would effectually obviate the disheartening effects of the sinking of water to bed rock in summer, for the amount saved during high water, that would have otherwise gone to waste, would furnish the means of livelihood to a large population as against the present population, which is very meager.

The Colorado and Gila are considered among the most prominent streams of the Pacific coast, and afford more than sufficient irrigation capacity for the cultivation of the rich areas included within the county lines. The former drains a catchment area of more than 242,000 square miles of mountainous country, while the latter also drains an immense surface, very similar topographically. Thus, it can easily be seen that water is abundant.

TRANSPORTATION.

An important factor in connection with the early ripening of horticultural, viticultural, and agricultural products is the question of easy and rapid conveyance to prominent market centers east and west. The Southern Pacific Railroad, one of the largest transcontinental lines in America, passes through the city of Yuma, runs through the Gila Valley as far as Adonde, a station some 30 miles east of Yuma. It then passes upon the mesas south of Gila River, the track extending upon the average not more than 5 miles from the river until the county line is reached. Thus is afforded convenient egress from any section of the valley and direct communication from thence to all parts of the United States.

Other railroads have been surveyed along both sides of the river. The direct broad-gauge line to San Diego, which heretofore has been a matter of conjecture, will, beyond a doubt, soon be a reality, one of the results of the settlement of the vexed grant question, mention of which will be found elsewhere in this article.

The Colorado River, being navigable, affords transportation by light-draft river steamers, northward from Yuma to the Needles, where connection is made with the Santa Fe Pacific, thence on to the Grand Canyon of the Colorado, and southward from Yuma to the Gulf of California. The Colorado Steam Navigation Company is now constructing in Yuma a new light-draft steamer to make regular trips up and down the Colorado River. The new boat is to be known as the "Cochan," and since the recent rich mining discoveries and the marvelous irrigation and agricultural developments have been made up and down the river, the glory of the old steamboating days (when the supplies for all Arizona were boated up the river) is expected in part to be revived.

CANALS OF YUMA COUNTY.

There are five large irrigation canals operating in Yuma County and various others are being projected which will in a matter of time be built. Canal building is comparatively of recent origin in the county. A few years ago the fertile valleys were almost literally destitute of human inhabitants, while to-day it is safe to say that every acre of valley land along the line of the canals has been filed upon, not to mention considerable mesa land taken up along the line of their projected extensions. The Mohawk Canal is taken out of the Gila River, and irrigates about 40,000 acres of the Mohawk Valley, there being no shortage of water, in all seasons. The Farmer's, the Ives, and the American canals are taken out of the Colorado River below Yuma and can be made to irrigate 100,000 acres or more of the richest bottom land on earth, their water supply being abundant.

The Cibola Canal is taken out of the Colorado River about 50 miles above Yuma and covers an area of 25,000 acres. For further mention of the Cibola Valley, see another page.

The "duty" of water is not constant, but varies according to the locality. It should be explained that but little of the land has been irrigated earlier than five years ago, and being virgin soil requires more water than will be necessary during the coming seasons. For this reason it is fair to assume that the "duty" per inch will be materially increased.

It may be stated incidentally that by irrigation the fertilization of land fluctuates according to the nature and quantity of the silty matter deposited upon it by the water, and this, it is estimated, is from 30 to 100 per cent. Both Gila and the Colorado are especially rich in such matter, and therefore the constant fertilization effected through the opening canals renders any further enrichment of the soil superfluous, useless, and unnecessary,

SCHOOLS.

There are 9 public schools in Yuma County and 1 high school. Twelve teachers are devoting their time to the education of over 600 scholars. The average school term is seven months. The high school in the Yuma district is presided over by a thoroughly competent professor, and the graded schools of this district require the services of 4 teachers. The Catholics have also a parochial school, presided over by the Sisters of St. Joseph. It is in a prosperous condition.

NEWSPAPERS.

There are 2 weekly newspapers published in the county—the Arizona Sentinel and the Yuma Sun. Both papers are published in the village of Yuma.

CHURCHES.

There are two regularly organized churches in the county, viz, the Roman Catholic and the Methodist. These are in a flourishing condition and are well attended.

RIVERS.

The Gila.—The Gila River, though second in size to its mighty rival, the Colorado, is destined, for the present at least, to figure far more prominently in the solution of the problem of redeeming and making valuable to the husbandmen the immense bodies of hitherto arid and valueless land tributary to it.

The Gila drains a vast territory. Rising in the western part of New Mexico it flows in nearly a westerly direction through the entire Territory of Arizona. Its northern and eastern sources are among mountains covered for several months in the year with snow of varying depths, the melting of which, added to the many natural springs emptying into it at different points, forms a considerable river long before it passes through Graham County. It enters the Gila Valley some few miles above Florence; thence for nearly 300 miles it winds through the now famous Gila Valley, eventually merging into the larger stream at the village of Yuma. The total length of the river is 650 miles. Before reaching the eastern boundary of Yuma County it is fed by numerous rivers, among the most important being the San Pedro, a stream rising near the line between Sonora, Mexico, and Arizona.

Another noble tributary is the Salt River, in itself a large stream, having its head waters in the White Mountains. It enters the Gila some distance below Phenix. An important adjunct toward increasing the volume of the Salt is the heavy rainfall about Prescott, amounting during the last ten years to an average

of 15.18 inches annually. Other rivers, like the Agua Fria, Hassayampa, and the Santa Cruz, bring down further supplies drained from the heavily timbered mountain regions traversed by them in the north and from the mountainous regions of the south.

Thus, the major portion of the year the Gila carries a large stream, more than sufficient, in fact, to irrigate a domain princely in extent. None of the rivers so far touched upon, however, are navigable.

THE COLORADO.

The Colorado River is formed by the union of the Green and Grand rivers. The former rises in Wyoming, the latter in Colorado. From their junction the stream takes the name of the Colorado, and following a generally southerly course flows into the Gulf of California. The entire length, including tributaries, is over 1,200 miles. It flows, during the low-water period, at a rate not exceeding 4 miles an hour, although, of course, the speed is very much greater when the river is high. Among the principal feeders are the Rio San Juan, the Colorado Chiquito, the Bill Williams Fork, and finally, as already explained, the Gila.

The Colorado constitutes the entire western boundary of Yuma County, its total length between the Sonora line and the Bill Williams Fork—the latter forming its northern boundary, separating, as it does, the counties of Yuma and Mohave—being about 235 miles. It is navigable for nearly 650 miles from the Gulf of California to the Virgin River by steamers regularly registered and licensed. The river is capable of affording at all periods an almost incredible amount of water for irrigation purposes, sufficient, in fact, to bring hundreds of square miles of fertile lands on each side of the river under cultivation, and thus provide support for an enormous population.

LANDS AND SOILS.

Within the limits of Yuma County there are large aggregations of Government land. The majority of the most favorably situated in the valleys were the first taken, the early pioneers occupying the tracts nearest the rivers, for the reason that they could be more cheaply irrigated. The mesas are for the most part unoccupied, although they comprise much of the most desirable land, such especially as are adapted to the growth of the citrus and other semitropical fruits. Water can not be easily brought upon them on account of their elevation above the river bed. Canals capable of carrying sufficient water for irrigation would entail comparatively heavy expense, because many miles must necessarily be constructed before the water can be brought to the surface. Such outlay would prove too expensive for the slender resources of the average settler, and so, as matters stand, they lie idle under the rays of a semitropical sun, untouched by the spade and plow. This condition of things, however, can not long continue. Neither physical nor topographical difficulties exist that can not be surmounted by the expenditure of a reasonable amount of capital.

It may be safely assumed, in view of what has just been said, that the large bodies of available agricultural land are confined to the valleys of the Gila and Colorado, and also to the comparatively level plains stretching from the Gila River to the Mexican line.

THE GILA VALLEY.

The Gila Valley extends from the Gila Canyon, near the junction of the San Pedro River, westerly to the east bank of the Colorado, a distance of slightly exceeding 250 miles. That portion of it situated in the county of Yuma, known as the Lower Gila Valley, is about 100 miles long and from 2 to 10 miles wide, all of which is susceptible of profitable cultivation. The river from which it takes its name cuts the valley in two. Its watershed extends some 30 miles north and upward of 50 miles south of its channel, the land from either extreme inclining more or less rapidly toward the stream. The Gila traverses a marvelously fertile country, very great in extent, and splendidly adapted to the cultivation of nearly all the products of the temperate and semitropic zones, besides many of the fruits common in the tropics. Nor is this longer a matter of idle speculation, for flourishing ranches in various portions of the valley, drawing water from several important canals, amply demonstrate the magnificent results that will ensue should the water supply be rendered permanent, equable, and adequate through appropriate storage systems.

The following, taken from that excellent work, *The Handbook to Arizona*, by R. J. Hinton, alluding to the valley in question, is interesting and accurate:

“This consists of a broad expanse of tillable valley land, sometimes overflowed by the river, which is at times ‘mighty uncertain,’ and a steep range of volcanic



COLORADO RIVER, GRAND CANYON.

hills coming close to the highways, for a dozen miles or so, hot, heavy, sandy. It is hardly fair to say sandy as it is really a friable alluvial soil of grayish hue and loose texture. Several ranches are passed, showing that the Gila bottom is cultivated. With irrigation, every square mile of the Gila Valley is capable of producing prolific crops of grains and semitropical fruits, as well as cotton and sugar in great abundance. The river is able to furnish all the water needed and a good deal more. It would take no very great skill in engineering, and not a very large sum of money either, to construct reservoirs or lakes in which to receive and store the overflow. There are natural basins or dry lakes into which, by simple means, the water could be conveyed."

The lands situated in and about the Gila Valley may conveniently be classified as follows: (1) The bottom or overflow lands; (2) slightly higher valleys, lands subject to no overflow; (3) mesas or sloping uplands; (4) high but comparatively level plains; (5) mountains.

THE BOTTOM AND HIGHER LANDS.

The bottom lands, as well as those slightly higher, stretch along either side of the Gila and Colorado rivers for varying distances north and south, until they meet the more elevated mesas which rise from the valley. The bottoms lie directly along the river and are subject to inundation annually. Immediately following the subsidence of the waters the local Indians were in former times accustomed to plant corn, pumpkins, melons, and other vegetables. These spring into maturity with startling rapidity, rarely failing to yield bountifully without additional irrigation. The custom is occasionally followed by resident farmers to this day, with excellent results, although but a single crop can be harvested. These bottoms form perhaps 25 per cent of the valley lands, and may without difficulty be secured from further invasion by a system of dikes and levees, if deemed necessary or desirable. The soil throughout the valley is a rich brownish yellow sandy loam, generous, mellow, porous, with a depth ranging from 6 to 20 feet, the whole resting upon underlying strata of gravel and sand that readily carry from the surface such excess of water as might otherwise prove injurious to seeds and growing plants.

Concerning the geological formation of these lands, the following from the report of the citizens' executive committee is sufficiently comprehensive:

"There is unmistakable geologic evidence that all this land during some pre-historic period was covered with water, constituting in fact an enormous lake, the surfaces rising in places to the upper portion of the outskirting mesas. The soil lying at the bottom was made by the washing and erosion of the surrounding mountains. The soda from the decomposed vegetation, the magnesia and lime from the magnesium-lime formations, and the potash from the decomposing granite rocks were carried with unceasing regularity year by year, until deposited in the bottom. Eventually upon the disappearance of the lake, the rich fertile alluvium, than which there is none better, was left to reward the efforts of the modern husbandmen. But nature, not yet satisfied with her handiwork, directed the accumulation of the detritus washed from the distant mountainous region. As a result, the soil is extremely rich in the elements best adapted to thorough fertilization, for it contains a certain amount of organic matter which, on decomposing, further enhances its agricultural value. By constant overflow and change of channel the deposits are evenly distributed over considerable areas, the process continuing through centuries. These soils are further enriched by decomposed organic contributions, including the sandstones, marls, limestones, shales, etc. Besides the ingredients mentioned, a chemical analysis shows that iron, ammonia, and phosphoric acid enter into its composition in the proportions best adapted to add to its productive qualities. The extremes of temperature are somewhat greater than on the highlands, but there is also more moisture.

"The bottom lands are so easily cultivated that it is not uncommon, after clearing the surface from the brush and stubble, to pass over the ground with an ordinary cultivator a single time, afterwards sowing to grain and grass. In three or four months large crops are harvested, the soil meanwhile being entirely innocent of the plow. All plants seem to grow rapidly, maturing remarkably early. Indications of ancient ditches are apparent throughout the valley, showing plainly the existence of irrigation works by the ancient Aztecs. Curiously enough, in certain instances, the identical routes of these long extinct people have been followed for considerable distances by their modern successors."

THE MESAS.

The mesas are warmer and better adapted to the cultivation of citrus fruits. The soil is also somewhat different, being of a reddish color, loose enough to receive

water without causing the ground to bake, and, while of a loamy nature, is more sandy or gravelly. It is in addition lighter, but therefore better adapted for the raising of figs, the olive, and the various kinds of wine grapes. Indeed, it has been asserted by several of the experienced wine growers of California that these very mesas are better calculated for the production of the true port and sherry grapes than any other of the lands within the borders of their own grand State. It is claimed that wine can be made possessing great preserving qualities, such as would allow improvement year by year instead of deterioration. These lands are greater in area than those directly upon the river, and almost imperceptibly slope away from the distant mountains. The drainage is admirable, not too excessive, and just sufficient to carry off surplus water. Vegetables, grasses, grains, sugar beets, cane, cotton, and in truth almost everything can be successfully raised.

HIGH PLAINS.

These include extensive bodies of land connecting with the mesas along the south side of the Gila River Valley. So gradual is the slope that they hardly deviate from the horizontal. At the highest points southward they gently incline toward the Mexican line, the slope in this case being directly opposite to that along its northern bank. In the latter instance it is first toward the mesas, and from thence indirectly to the river. The soil is very similar to that of the mesas, the two classes exhibiting common characteristics. Like the mesas, these plains are susceptible of the highest cultivation, providing always that ample irrigation facilities are afforded. Here and there they are crossed arbitrarily by mountain ranges, which do not all tend in the same direction, but they present no important engineering obstacles to the canal builder.

The wonderful fertility of the bottoms and other valley lands, as well as the mesas and plains, is established beyond denial by actual experiment. Neither is the soil likely to degenerate in the future, for, in answer to the question, "Will it last?" O. D. Wheeler, D.D., LL.D., a recognized expert in such matters upon the Pacific coast, says:

"To this query the answer in general is, the longer lands are properly cultivated and properly fertilized the stronger and more productive they become. While the mountains surrounding the valley continue to disintegrate under the operation of the elements, and while the detritus thus eliminated continues under the laws of gravitation to descend and work its way over the plains, so long will there be perennial additions to the amount of producing element in a state of refinement and assimilation. And so long as the water flowing from these mountains, holding in solution the débris which always in some degree is spread upon the land in irrigation, so long will the fertilizing properties of the soil continue to receive additions and its fecundic power continue to be increased; and so long as the water containing more or less of salts and ammoniacal compounds, as all water does, is used for irrigating purposes and so long as the process of cultivation continues to throw up the soil, exposing it to the indispensable and ever fructifying influence of the atmosphere, so long will the soil continue to be refreshed and invigorated and prepared to give large rewards to the labor of the husbandman."

THE VALLEYS OF THE COLORADO.

Concerning these we print the following, taken from the report of the citizen's committee of Yuma County, which report has already been referred to:

"Several miles above Yuma, in the neighborhood of Explorer's Pass, near the Purple Hills, the great Colorado River Valley proper commences. From this point northerly the river is shut in by cliffs which, with intervening mountain systems, absolutely preclude the possibility of canal construction. Passing southward, the cliffs are seen to gradually disappear until they become merged in the low bottom lands. The bottom meanwhile widens with every mile until the Gulf of California is reached. There are large quantities of land which could be made productive were irrigation practicable. These are generally fertile bottoms inclining toward the river and covered in spots with dense undergrowth and cottonwood and mesquite trees. Considerable of the valley is raised above the river as much as 100 feet, and to this height water must be brought, as the bottoms are during certain months completely overflowed by the waters of the swollen streams. The soil is extraordinarily rich and particularly adapted to the cultivation of sugar, rice, and all the textile plants, in addition to an extended list of tropical, semitropical, and temperate products. According to a careful chemical analysis, the fertilizing mud carried by the Colorado closely resembles that of the waters of the Nile, while its volume at low water has been estimated by competent authority as sufficient to easily irrigate more than 1,750,000 acres."



APRICOTS.

The lands of the lower Colorado River Valley have not been developed very extensively, owing to the litigation over what is known as the Algodones land grant, which has been in the courts for the last decade. The vexed question has lately been settled by the Supreme Court.

YUMA HEIGHTS.

One of the most promising developments in the vicinity of Yuma is that of the Yuma Heights fruit ranch of the Yuma Light and Water Company, located on the almost frostless mesa lands adjoining the town on the south, who have 130 acres planted to oranges, lemons, grape fruit, limes, bananas, cocoa nuts, dates, apricots, plums, prunes, blackberries, and strawberries, all of which are making a truly tropical growth. Strawberries bear practically all the year round, while the other fruits have their regular season for ripening. Apricots ripen about April 12, and the Sweetwater variety of grapes on June 1, when watermelons are also ripe. Melons are shipped in carload lots to points from Tucson, Ariz., to San Francisco, Cal., there being no competing melons between these points. Apricots and grapes are shipped all over California, Arizona, New Mexico, Texas, and Colorado, no section in the above-named States producing such early fruits.

Of all the above-named varieties of fruit, the orange, lemon, and lime seem the most at home in this hot, dry climate. Scale is unknown, and will probably never thrive in the vicinity of Yuma, where a fog or dew is a curiosity.

The soil of the mesa lands above referred to was a very sandy loam when the ranch was started less than four years ago, but during that time the muddy water of the Colorado River, which is pumped to the heights by a powerful steam pump on the bank of the river in the town of Yuma, has changed it to a rich, sandy loam—an ideal fruit soil, which is improving every year. The fertilizing elements in the water used on each acre of land are worth fully \$12 per year—a sum almost sufficient to pay for pumping the water 80 feet higher with which to irrigate.

Orange avenue connects the fruit ranch with the town of Yuma, and it is kept in fine condition. It is an ideal driving or bicycle road, and is much made use of by visitors and residents of Yuma. Orange and pepper trees are used for shade and ornament, and beautiful residences are being built on the avenue.

THE CIBOLA VALLEY.

Among the recent enterprises and developments in this county is the construction and operation of the Cibola Canal. Cibola Valley—so called by the original projectors of the enterprise, after the name of the Zuni villages of the sixteenth century—contains 25,000 acres of as fertile, irrigable land as there is under the sun; 5,000 acres susceptible to annual overflow from the silt-laden Colorado, and 5,000 acres too high to be watered by gravity, making 35,000 acres in all, the major portion of which is now beginning to blossom as the rose.

A colony of California agriculturists have recently become interested in the Cibola Valley, and have commenced the work of building homes there. They will plant beet fields, orange groves, vineyards, and orchards of deciduous fruits.

This land lies, as the crow flies, 50 miles north of Yuma, 86 by river or wagon road, on the Arizona side, and 60 by the more direct route to Picacho on the California side, and from thence on the Arizona side to the valley. The land is fertile beyond comparison with any but the land of the Colorado River, and will bountifully yield of any crops suited to the climate of Yuma County, including all of those of the south temperate zone, and many of those of the semitropic belt. For agricultural purposes the section is unsurpassed, for the cereal and hay crops, wheat, oats, barley, corn, sorghum, alfalfa, etc., are here in their element.

A little more than two years ago the preliminary survey was made and the feasibility of the proposition demonstrated. Since then the details have been perfected; men seeking location and profitable, safe investment have interested themselves and assisted in the proposition. The canal is 16 miles in length, 12 feet wide at the bottom, and 4 feet in depth after it gets out on to the land. A heading has been secured where quicksand does not trouble, and one of the greatest obstacles to taking out gravity canals from the Colorado is avoided. The headgate has already stood the test of the high water.

The climate of Cibola Valley is all that can be said of the section immediately surrounding Yuma. The world's peerless climate for nine months in the year, it is not dangerously warm in the summer. The dryness of the atmosphere renders sunstroke unheard of. Small game is in abundance, while the lagunas during the cooler months teem with ducks and geese, and the hills adjacent contain deer and mountain sheep.

MINES AND MINING.

There is no section of the United States, or probably of the earth, more rich in mineral wealth than the county of Yuma. All the country north, east, and south of Yuma lies directly within the main gold belt that commences in Alaska and ends in Mexico.

From the San Bernardino Mountains in California to the Sonora boundary line the mountains and hills are exceptionally rich in the precious metal, as though demonstrating the theory often advanced that the richest gold mines are found bordering the beds of extinct oceans. The great Colorado Desert was once an inland sea, cut off centuries and perhaps ages ago from the main ocean, leaving its waters to evaporate in this intense heat. Throughout all the country bordering the desert, including this section, rich mines are being discovered, and some of recent location are already producing profits. In this neighborhood claims exceedingly rich are being located, and all signs portend a great mining boom for this county. It seems wonderful to believe that all this mineral wealth has been lying at our very doors for so many years without a taker; but the tendency of prospectors is to go a long distance off into strange lands, rather than to seek for mines in a county as old as Yuma and so accessible. The greater the distance, the hardship, and the danger the greater the fascination for the prospector. Distance seems indeed to "lend enchantment."

So it is that this county is almost a virgin field for the mine hunter, and now, with a few hundreds searching in its mountains, its mineral secrets are still in effect secrets, for thousands upon thousands might be wandering through the rock-ribbed fastnesses of our mountain ranges and their presence be unknown almost, so vast is the extent of the county.

La Fortuna mine, near Yuma, has largely added to the list of valuable gold properties in the Territory. It is also a prominent example of the fact that the gold-bearing regions of Arizona have been greatly neglected and not well prospected nor developed.

The mines and mill of this company are situated about 30 miles southeast of Yuma, in Yuma County. It is in a region without a natural supply of water, but capital and skill have remedied this defect by pumping water from the Gila River at a point 12 miles north of the mine. A large and powerful pump, requiring 100 horsepower, is placed at the river and the water is forced through a 4-inch pipe to the mill at the mine, overcoming an elevation of 750 feet. The difficulty of working a mine and mill without water is thus overcome and the supply is unfailling. A 100-ton cyanide plant has recently been installed, making the average output of the mine about \$60,000 per month. There are also upon this property, and within less than 2,000 feet of the Fortuna, four other distinct and well-defined ledges, one 10 inches wide, one 2 feet wide, one 4 feet wide, and one averaging 12 feet wide. The assay value of the ores from these ledges averages, respectively, \$20, \$25, \$8, and \$12 per ton. The several shafts or pits sunk on these ledges amount in all to about 375 feet and the drifting to 320 feet. All this drifting and sinking is on ore, and from the prospects it would appear that these ledges will develop into extensive and valuable mines, comparable with the Fortuna. Work is progressing upon all.

Thus in a few short months this place (Fortuna) has developed from a desert and wilderness into a prosperous and growing camp, and intelligent and legitimate mining, with sufficient capital, is having its golden reward.

The King of Arizona gold mine is a recent discovery, and vast preparations are going forward to work the mine on an extensive scale. The richness of the mine is fabulous, the ore having assayed as high as \$3,200 per ton. Owing to a scarcity of water this mine has not been worked before now, but an abundance of water has recently been discovered at a depth of 400 feet about 4 miles from the mine. There is 80 feet of water in the well and it is now being pumped up to the mine. A crushing mill, a cyanide plant, and much other modern mining machinery is being installed. The discovery of water near the mine will accentuate prospecting in the district, which is computed to be one of the richest in the world.

The Castle Dome lead mines are being worked successfully and new machinery has lately been installed there. New developments and discoveries are constantly being made in the Copper Mountain district. New locations are being made in every portion of the county, and the mining outlook was never brighter.

PRODUCTS.

Fruit culture has so far been prosecuted upon a somewhat limited scale, but enough has been learned from experimental tests to demonstrate the positive



IRRIGATING FRUIT TREES.

feasibility of not only producing an excellent quality of the most profitable fruits, but also the ability to raise them for market from three to six weeks earlier than any section of California.

Concerning the various products of the county, we quote again from the report of the citizens' committee:

"The orange, lemon, and lime finding soils and climate congenial, yield in abundance large, clean-skinned, and exceedingly luscious fruits. They color handsomely, contain the requisite acidity and sweetness, and are very juicy. The fig and pomegranate offer a character of fruit that almost stamp them as indigenous. The latter is not yet recognized to any great extent, but it will certainly become an important factor in arboriculture when its economic qualities are better known. As to the fig, the most desirable variety has yet to be determined. The true White Smyrna would probably prove the best, and that its yield would be prodigious goes without saying, for the trees will bear three crops annually. This assertion is based upon actual productive results of the Mediterranean white fig that is known not to be the true Smyrna.

"The grape seizes upon what is proffered to it, and becomes hardy, thrifty, and adaptable. The choice naturally inclines to the earliest for table purposes. What those varieties should be is in process of experiment upon a scale that will soon solve the question, but it may be said that all kinds mature from three to four weeks before they do in California. They attain great size, cluster tightly in bunches, are firm and highly colored, and possess exquisite flavor.

"Heavy wines and brandies of an excellent character can be made; but with light wines the reverse is true, for everything apparently goes to saccharine. For ripening wines the climatic conditions are admirable. A quantity of common white wine, costing 45 cents per gallon, was brought here from California by water years ago, and being found unsaleable, was placed in cellars and its history almost forgotten. Nine years later the wine was brought to light, when it was discovered that it resembled a brown sherry, rich in bouquet, smooth as oil, and delicious to the taste. It was carefully drawn from the casks, bottled, and sold at \$2.50 per bottle.

"The olive grows luxuriantly, and will in the future become a most profitable investment. Whatever its characteristics are elsewhere, here it requires water and cultivation—the more water the better. The mulberry matures rapidly, and when firmly rooted vigorously withstands great heat and lack of water. It produces an early, large, and sweet fruit, and is a highly desirable tree to plant along the canals for its grateful shade. The plum can easily be raised from seed. It fruits early, though so far the product does not commend itself particularly for table use; but as a stock upon which to graft prunes, or even superior varieties of plums, it is everything to be desired. An experiment in this line with the best prune known in California showed a growth of 23 inches in forty days from the insertion of the graft. The date has passed beyond conjecture. The plant produces magnificently, and its cultivation will be prosecuted more extensively this winter than ever before. The soil is in every way suitable and with occasional cultivation and intelligent irrigation a quick and early growth is assured. Apricots and peaches have been tested. They mature rapidly, bear choice fruit, and are always healthy, giving flattering indications of future success.

"As facilities increase, other fruit trees will be introduced, and with the same care that is bestowed upon them elsewhere will, so soon as they become acclimated, come to a yield materially in advance of the place from whence they come. The field is too large to admit of extended comment at this time, but it may suffice to briefly refer to certain other products which may in time equal, if not surpass, fruit growing as a commercial proposition, as, for example, cotton, wild hemp, ramie, sugar, sugar beets, etc.

"Cotton has been tried from time to time for years, with varying, but always satisfactory results, and even then without care. If watered regularly, it becomes a large bush, and if properly pruned, a tree, being in flower, boll, and cotton the year round. These bushes and trees have in instances borne steadily for fourteen years, the staple of course diminishing in course of time; but at ten years it is not inferior to the average staple of western India.

"Wild hemp is a textile plant indigenous to the country. It grows freely and luxuriantly to a great height, often averaging from 15 to 17 feet. It has a long strong fiber, and is frequently worked into nets and fishing lines by the Yuma Indians. Convulsive attempts have been made to utilize this plant, with the practical result of fixing its value among the fibers used in the manufacture of cordage at about \$160 per ton of 2,000 pounds. After proper bleaching and manipulation a beautiful fiber has been produced and manufactured into colored fabrics, taking the dye and retaining the elasticity and luster exactly as well as

the fabrics of true flax and ramie. It seeds itself annually, and, immediately following the overflows of the Colorado River, takes possession of every nook, corner, and open area, to the exclusion of everything else. It covers not less than 100 square miles in an unbroken stretch, commencing near the boundary line of the Gadsden purchase and extending southward along the river to Hardy's Colorado, below the point where the rising tides of the Gulf of California force back the flow of the Colorado River proper.

"The fibrous plant ramie has been given a partial trial. The soil on analysis was found to contain all the essential properties to render the most favorable results; but the absence of water, together with injudiciously planting the roots too late, retarded the growth. Enough data has been obtained, however, to warrant the belief that this will eventually become one of our most important industries.

"Sugar cane has been fairly tested with the Sonora cane. The growth was surprisingly great, and the percentage of juice much increased over the yield at the place from which it was originally brought. A superior quality of pianoche and sirup were manufactured, the price realized leaving handsome margins for profit. The capriciousness of the water supply, as in the case of ramie, dissolved the industry, and it has not since been revived.

"The sugar beet promises better results for the future than many of the products already mentioned as prominent in the same direction. Samples not fully matured polarized 17 per cent. With proper cultivation, the percentage can be raised to from 20 to 25, and besides will harvest two crops each year.

"Wheat does splendidly, but complete data are not at hand from which to compute the average yield. In one instance, however, 483 pounds seeded to 20 acres, about 9 miles east of Yuma, on the Gila River, returned 52,750 pounds after having been irrigated five times. This was sold in San Francisco, bringing 50 per cent over every other kind then in the market. The grain is remarkable for its plump, berry-like appearance. The winter and spring are warm enough to insure a vigorous growth, and cool enough in April and May to allow the heads to fill out without shriveling. It is so perfect as to sell for seed, and, so far as is known, is proof against rust. The crops are raised annually.

"Barley also does well, and will produce two crops, the first yielding from 35 to 40 bushels of barley and the second a large amount of hay.

"Corn is produced in great quantity; yields enormously, and can be grown the year round. The Cocopah corn is noted for sweetness, plumpness, earliness, and for its firm and solid grains. Five weeks after planting, roasting ears are plentiful. This variety commands a ready sale at higher prices than any other kind.

"Alfalfa will cut from five to seven times at an average of 2½ tons to the acre. Eight acres but 1 year old have this year yielded 74 tons, with more cuttings yet to be made. The hay brings \$15 per ton.

"Sorghum raised for feed is both valuable and prolific, it frequently reaching 15 feet high, and is worth \$15 per ton, yielding 15 to 20 tons per acre. Several crops can be harvested annually.

"Vegetables, kitchen and garden stuff, melons, etc., grow all the year round in unlimited quantity and excellent quality. Some time since a Gila Valley farmer planted 15 pounds of Irish potatoes on a piece of bottom land that had been overflowed, from which he harvested over 700 pounds, and this record, it is believed, has rarely, if ever, been excelled. The sweet potato produces enormously, and equals the choicest brought from South Carolina.

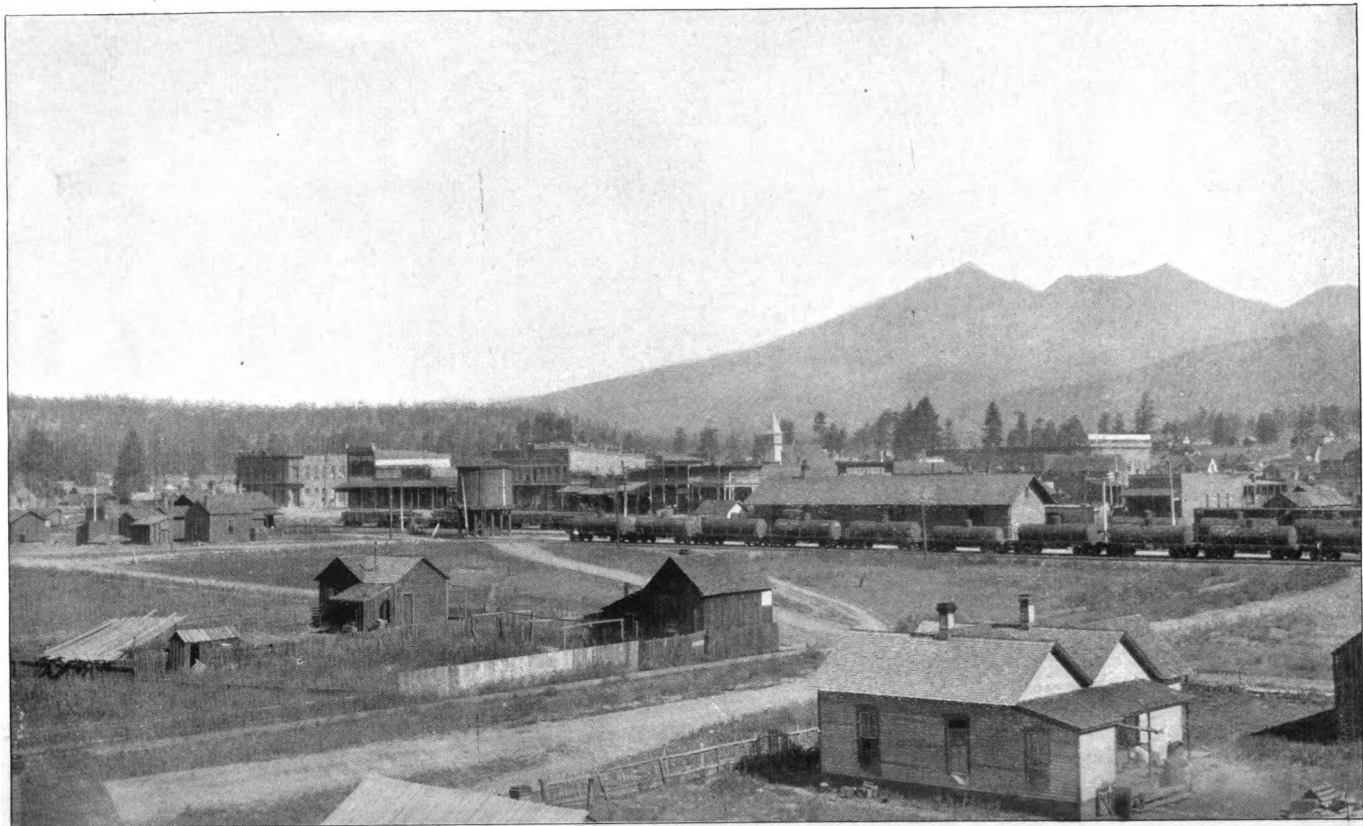
"Peanuts mature rapidly and abundantly, yielding a nut both plump and toothsome.

"Whenever there is sufficient moisture, the natural flora abound in profusion and variety. They are of rare beauty and delicious fragrance, the bulbous plants particularly. The lily surpasses the famous imported Japan. It has been claimed by experts that at no distant period opium will be manufactured from the poppy, and attar from the rose, both flowers thriving vigorously. There are but few trees and shrubs capable of adorning the surroundings of a lovely modern home that can not be satisfactorily grown.

"Every plant, vine, or tree mentioned in the foregoing list has been actually proven adaptable to our soils and climate. Many others have been omitted through lack of space, but there seems no doubt that time will demonstrate our ability to profitably raise all the semitropical and most of the tropical and temperate productions."

CONCLUSION.

In the valleys of the Colorado and Gila rivers there is room for thousands. It is not too much to say that nowhere within the limits of this broad Union can be



TOWN OF FLAGSTAFF.

found a more desirable region for the making of a home. No laborious cleaning of the land is required; it lies almost ready for the plow. Trees and shrubbery have so rapid a growth that within eighteen months the immigrant can surround his abode with attractions which would require years to mature in less favored climates. Fruits ripen and are ready for market a full month before the California product. The bright sunshine makes life a luxury, and the pure dry atmosphere brings health to all who inhale it. For the establishment of colonies, such as are made in southern California, Arizona presents unrivaled opportunities. Thousands of acres now profitless can be made productive by the construction of irrigating ditches, and there is no investment which assures larger or more permanent returns.

Assessed valuation of property in Yuma County.

Cultivated land (19,941 acres)	\$59,351.14
Improvements	11,733.00
Uncultivated land (14,578 acres)	15,044.65
Improvements	1,225.00
Patented mines (18)	2,550.00
Improvements	70,170.00
City and town lots (859)	63,064.00
Improvements	73,035.00
Horses:	
Range (133)	1,689.00
Work (423)	10,998.00
Saddle (24)	444.00
Stallion (1)	30.00
Mules (44)	1,100.00
Asses (13)	87.00
Cattle, Range (882)	8,820.00
Milch cows (86)	1,765.00
Bulls (14)	180.00
Swine (569)	1,422.50
Railroad, Standard gauge (82.5 miles)	502,539.55
All other property	77,230.50
Total	902,478.34

COCONINO COUNTY.

County seat, Flagstaff.

County officers.—Supervisors, J. C. Phelan, J. B. Jones, C. A. Greenlaw; sheriff, James A. Johnson; district attorney, James Loy; probate judge, N. G. Layton; recorder, T. E. Pulliam; treasurer, George Hoxworth; clerk board of supervisors, T. E. Pulliam.

Coconino County includes within her boundaries a large part of the natural scenery of Arizona. The immense plateau extends from the northern boundary line across the Grand Canyon and south to the south line of the county, upon which is the largest belt of pine timber in the Southwest.

The summer climate and scenery are a wealth within themselves enjoyed by no other locality in America. Hundreds of visitors are now taking advantage of our climate during the summer months, and many from the far East are now coming here for the benefit of the curative properties of our dry and healthful atmosphere.

In the past two years every line of business has made giant strides of progress. At Flagstaff, the county seat, renewed activity is seen among the commercial men. New buildings—handsome ones of brick and stone—have taken the places of vacant lots, and others remodeled to supply the increasing demand for more room in which to conduct the growing business of the place. At Williams a similar condition of affairs is found.

The disadvantages attendant on sheep grazing in the past few years have been overcome, and now the splendid ranges of this county are fully stocked with sheep. The stockmen are prosperous and much revenue is annually paid into the county from this important industry.

The area of lands under cultivation has materially increased. The products of the rancher are fast assuming important proportions. The soil in the valleys is rich, and as fast as ranchers find the best means of treatment for it under our climatic conditions, these lands become invaluable. Instead of the primitive homes that at first were built, now may be seen model well-furnished homes, where the ranchers dwell in comparative comfort.

Lumbering, the chief industry of the county, furnishes employment for hundreds of men. The Arizona Lumber Company has just completed one of the most complete and modern of sawmills in the Southwest. New machinery, new buildings, and new methods of handling the great supply of logs have greatly facilitated the work of supplying the Territory with lumber, and it is necessary for them, owing to the great demand for their product, to run night and day. The Saginaw Lumber Company, of Williams, and the Dennis Lumber Company are each equally busy.

Copper mines have been discovered in the Grand Canyon district and are now being developed. Eastern capital has become interested in them and will undoubtedly make this an important industry in time to come, as there is a large field for development in that vicinity.

After many ventures and the organization of many stock companies for the building of a railroad connecting the Santa Fe Pacific with the Grand Canyon of the Colorado, a company under the caption of the Santa Fe and Grand Canyon Railroad Company have commenced building grade and laying rails from Williams, and there is every evidence that the project will be a successful one. When this railroad is completed it will connect a great expanse of fertile lands lying to the north with the lands now under settlement and permit of its being fully and rapidly developed. It will furnish means for the ranchman and stockman to dispose of his products, permit of many additional settlements along its line, and otherwise reclaim this territory heretofore but partly utilized.

The educational advantages afforded by Coconino County are equal to any of the counties of twice the number of inhabitants. Large, new, splendidly ventilated roomy schools are provided for pupils at Flagstaff and at Williams, where the best talent is employed to teach. Two new districts have been formed in the past year in the county, making altogether seven districts in operation.

The normal school, the largest and most sightly of public buildings in the Territory, located at Flagstaff, will open its doors in September for the first time, under the supervision of Prof. A. N. Taylor, an instructor of known ability, and one who will undoubtedly make for it a name its graduates will be proud to honor as their alma mater.

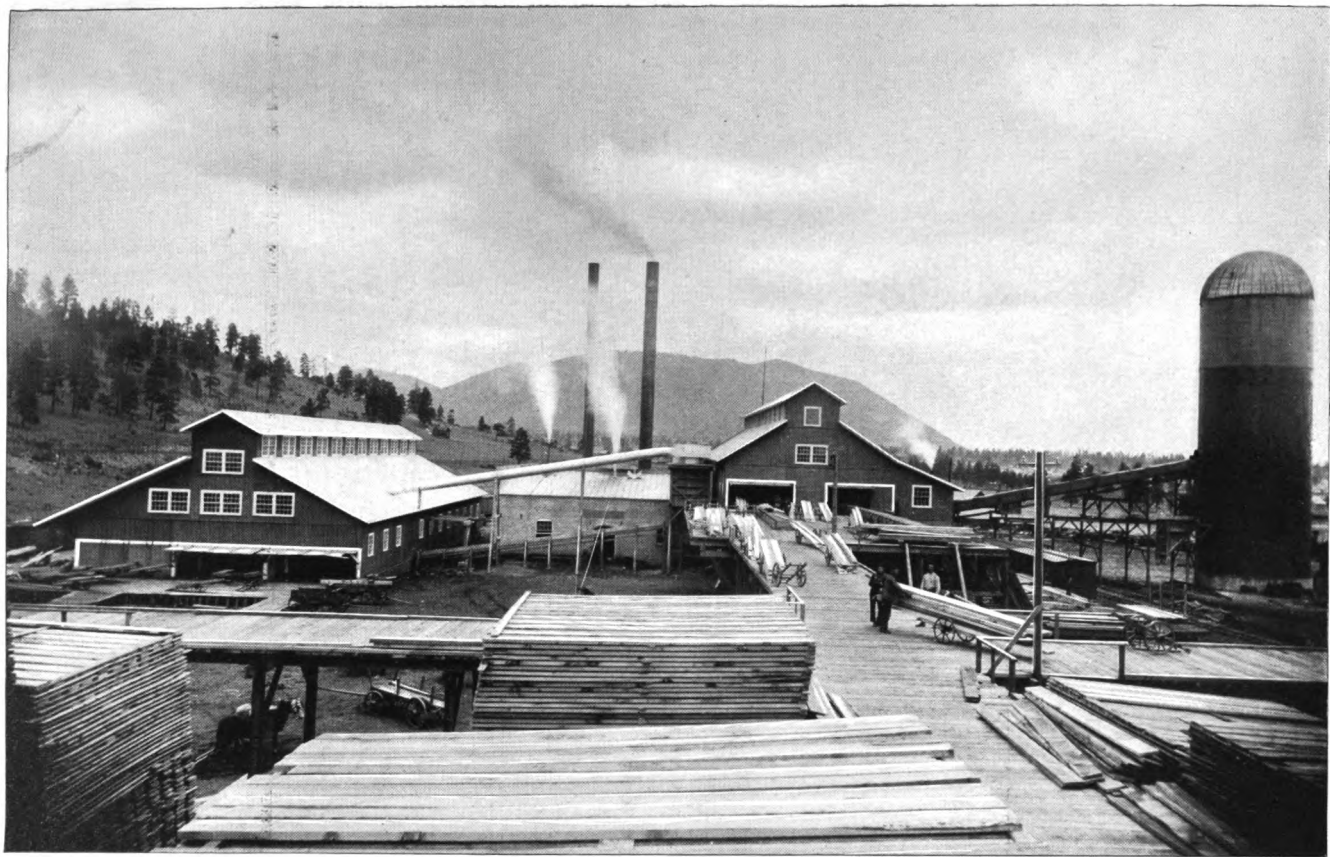
The forest reservation set aside by Executive proclamation on August 17, 1898, including all the timber lands and land heretofore open for settlement, at first seemed detrimental to the best interests of Coconino County. Since rules different from those governing other reservations of a similar character have been promulgated, allowing sheep grazing as well as the settlement of lands included in the reserve which were more valuable for agricultural purposes than for timber, the people have come to realize that it will result ultimately in benefits rather than otherwise. In the matter of sheep grazing it prevents the nomadic sheep grazing, closes the ranges to the whole country, and reserves the ranges to those who are legitimate citizens of the Territory, who are assisting in the development of the country, and to those who annually pay into the local treasury thousands of dollars in taxes. It will prevent the indiscriminate slaughter of timber, but does not remove the timber from the reach of those who need it, and, further, prescribes that such timber shall be used in the upbuilding of the Territory.

The only drawback, and the one experienced throughout the Southwest, is the scarcity of water. At Flagstaff \$125,000 has been expended in the past year in bringing down from the San Francisco Mountains, 18 miles to the north, a supply of sparkling spring water into the city, and a complete system covering all parts of the city has been established for fire protection and sale of water.

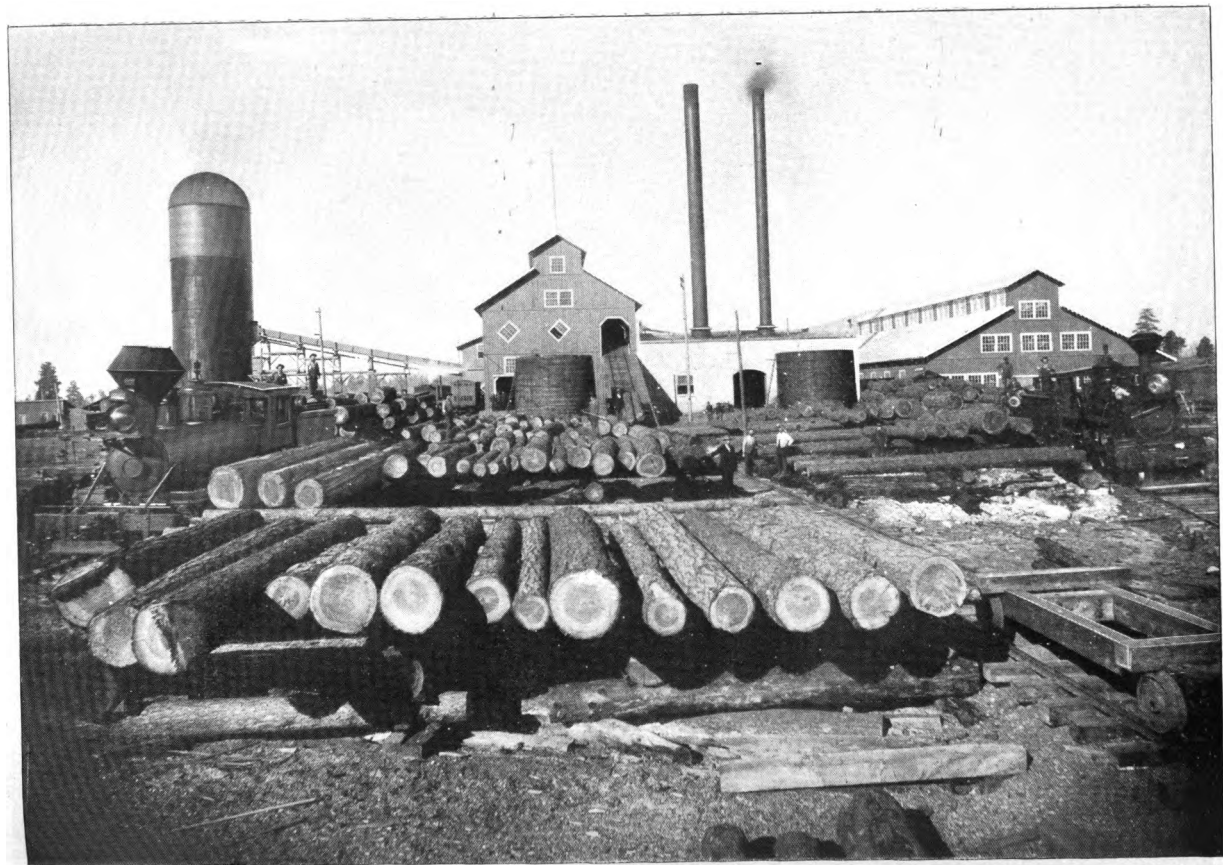
Other companies have been incorporated for the purpose of developing immense catchment reservoirs for irrigating and other purposes. In time this evil that comes periodically will be overcome and the surrounding lands will be fully developed as veritable gardens of productiveness.

Assessed valuation of property in Coconino County.

Land (25,896 acres)	\$57, 445. 00
Improvements	31, 099. 00
Railroad land (302,423 acres)	66, 484. 61
Land grants (375,286 acres)	118, 051. 70
Town and city lots (4,608)	159, 114. 50
Improvements	229, 422. 50
Horses :	
Range (1,964)	19, 640. 00
Work (736)	29, 440. 00
Saddle (820)	20, 500. 00
Mules (24)	960. 00
Asses (70)	350. 00



MILL AND BOX FACTORY OF ARIZONA LUMBER COMPANY, FLAGSTAFF.



MILLS OF THE ARIZONA LUMBER COMPANY, FLAGSTAFF.

Cattle, range (15,423)	\$159, 628. 05
Milch cows (204)	5, 100. 00
Sheep (164,000)	328, 000. 00
Goats (901)	1, 802. 00
Swine (201)	1, 005. 00
Railroad, standard gauge (123.66 miles)	283, 650. 00
All other property	370, 646. 05
Total	1, 876, 338. 41

PINAL COUNTY.

County seat, Florence.

County officers.—Supervisors, R. W. Kersy, George F. Cook, J. F. Meyhew; probate judge, L. C. Herr; district attorney, W. R. Stone; sheriff, W. C. Truman; treasurer, W. Y. Price; recorder, F. A. Chamberlin; surveyor, W. H. Merritt.

Pinal County has a full share in the general prosperity which the year 1899 appears to have brought to every section of Arizona. Every industry has made substantial progress. In mining, particularly, the year is notable for the profitable development witnessed. All kinds of live stock have done well, and while farmers have had to face, as usual, an unfortunate shortage in the supply of water for irrigation, they are realizing good prices for their products.

Pinal County was organized in 1875 from portions of Pima, Maricopa, and Yavapai counties, and contains an area of 5,338 square miles, or 3,435,520 acres. One-third of this acreage is fine agricultural land, and is admirably situated for irrigation where there is sufficient water available.

The Gila River flows through the county, and at certain seasons of the year carries sufficient water in flood to irrigate a goodly portion of the county the year round, could the floods be stored for use as needed. Of late years the shortage of water has become more acute on account of the rapid development of irrigation higher up the river, in Graham County; and in consequence of the inroads made upon the water supply by the Graham County irrigators, Pinal has had to take third place among the agricultural counties of the Territory, yielding second place to Graham. The principal irrigating canals are: The Casa Grande Valley Canal, which takes its supply from the Gila, 11 miles east of Florence, and has a total length of 45 miles; the McLellan Canal, heading 9 miles east of Florence, with a length of 5 miles; the Spinas Canal, heading 3 miles west of Florence, and the Charlean Canal, 2 miles west, each with but few miles of length, and all supplied from the Gila. There are about 9,000 acres irrigated.

WATER STORAGE.

On account of the shortage in the water supply, the most interesting topic with the residents of the county is water storage. There are a number of reservoir sites on the Gila, at least one of which it is hoped will be utilized by the United States Government for the construction of a reservoir.

There is good ground for expecting that the General Government will build a dam at one of the sites, not because there is any popular faith in the theory that the Government will take up the construction of reservoirs as a policy to be carried out generally in the arid regions, but because it can be demonstrated that there would be a saving to the National Treasury as a result of the construction of a reservoir in this locality. Farther down on the river is the Gila River Indian Reservation, on which several thousand agricultural Indians are located. These Indians, from being self-supporting and independent, are finding it more difficult each year to raise anything at all, because the water formerly carried to the lands by the river is now taken out by the various canals in the upper valley. Repeated failures of crops are having the effect of making the Indians helpless wards of the Government at a heavy and increasing charge. The enormous expense of providing for the inhabitants of this reservation led the Government some four years ago to make an exhaustive investigation of the water problem. A point known as the "Buttes" was selected for the first investigation, with a view to determining the cost of constructing an adequate reservoir. That a great storage capacity could be developed by making the necessary expenditure was soon demonstrated.

Popular interest in the project grows out of the fact that the construction of reservoirs at the Buttes or elsewhere on the river will not only supply the Indians, but afford a large surplus of water for white settlers in the valley between the

reservoir and the reservation. The construction of the reservoir would cut off the annual and growing expenditure for the support of the Indians, and it is claimed that the sum thus saved yearly would more than pay the interest on the cost of construction. Not only that, but the surplus of water could be sold to settlers at such remunerative figures that the Government would find itself reaping a profit from the investment. The report of the preliminary investigation was so encouraging that Congress at its last session made an appropriation to continue and complete the investigation, with a special view to the location of bed rock at the various sites available for supplying the Indians with water for irrigation.

Following this appropriation, an active and exhaustive investigation of the problem has been carried forward throughout the spring and summer under some of the most competent engineers and hydrographers of the Geological Survey. Speaking of the work so far accomplished, Mr. J. B. Lippincott, the engineer in charge, said in a recent interview:

"The Gila River Indian Reservation is situated about 18 miles south of Phoenix and extends along the Gila River for a distance of nearly 50 miles. Here are located the Pima and Maricopa Indians, to the number of nearly 5,000. These Indians are known throughout the Territory as good Indians. They have always been peaceful in their habits and agricultural or pastoral in their pursuits. They are now cultivating the lands where the prehistoric races built the now ruined Casa Grande and its neighboring canals. Irrigation has been practiced in this valley from prehistoric times. Many ancient ditches can be traced across the plain, showing evidence of engineering skill and testifying to the fact that large volumes of water were at one time carried.

"The Pimas and Maricopas have been until recently a self-sustaining nation. They raise their crops of grain and corn with a skill equal to that of the whites. The settlers, seeing the results which the Indians have produced, through the operation of the desert-land act brought under cultivation much land in the valley of the Gila adjacent to this reservation, and have built extensive canals between Florence and the railroad station of Casa Grande. Under the provision of the United States law all land bought under the desert-land act must be made productive by the application of water. In order to comply with the provisions of this law the settler was compelled to make diversions from the Gila River at points from the Indian reservation. Other lands were taken up under similar condition on the upper portion of the Gila River. These diversions by the whites quickly deprived the Indians of their water supply, and for the past five years they have been left on the desert without water for their crops and scarcely enough for their horses. They are put in the position of either having to steal, starve, or to be fed as public wards, and the Government has been forced to issue rations to them and feed them as it does the soldiers. Numerous court decisions have been rendered establishing beyond controversy the fact that the Indian has the prior and the better right to the water, but the whites have maintained their water supply despite the dictates of the court. The development of this newer civilization has become so extensive that to cut off its water supply would mean the desolation of many thousands of acres of fine farms and orchards. Evidently the situation is a difficult one, and the Indian Bureau is hard pressed for a proper answer.

"In 1896 an allotment of \$3,500 was made from the appropriation for the Indian Office for a preliminary investigation of the available water supply for these Indians. Mr. Newell was instructed to make this investigation by the Secretary of the Interior, and he delegated Arthur P. Davis to take the matter up in the field. The surveys were necessarily of a preliminary nature, but the storage possibility of the Gila River was fully demonstrated. It was shown that this stream drained about 15,000 square miles of the high plateau and mountain region of eastern Arizona, and that the river is remarkable for its exceedingly light grade.

"Consequently the storage possibilities of the stream are great. Recommendations were made by Mr. Davis calling for further and more accurate surveys, and in the spring of 1898 Congress passed a second appropriation of \$20,000 for the completion of this investigation. The hydrographic department of the Geological Survey was again delegated as the proper office to conduct these surveys.

"The Gila River derives its source from the White Mountains in western New Mexico and eastern Arizona, which rise to elevations of from 10,000 to 12,000 feet. At the point where it issues from its mountainous basin there are over 12,000 square miles draining through its canyons. The basin has been extensively explored, and three large reservoir sites located and surveyed. The capacity of these reservoir sites has been determined, and flings have been made under the United States laws for their segregation from the public domain. At a point known as the Buttes a dam 150 feet in height above the bed of the stream will store enough water to cover 174,000 acres 1 foot deep, or, as it is technically

expressed, 174,000 acre-feet. A dam at this point would be approximately 30 feet long at the bed of the stream and 800 feet at its crest. At Riverside, Ariz., it was found that a dam 350 feet long at its base and approximately 800 feet long on top will store a much greater quantity of water, the surveys at this site being still incomplete. At San Carlos, on the Apache Reservation, the river passes through a narrow gorge 100 feet wide, and a dam at this point 150 feet high would be but 200 feet long at the crest. Such a dam would store 361,000 acres 1 foot deep.

“Extensive explorations have been made to determine the depth of bed rock at each one of these dam sites. At the Buttes the bed rock is disappointingly deep, the depths ranging in the center of the channel from 75 to 124 feet beneath the surface of the stream. At Riverside the maximum depth on the axis of the dam is approximately 75 feet, while at San Carlos the depth to bed rock is believed to be substantially less than at either of the other dam sites.

“The records of the flow of the Gila River have been kept at the Buttes for a number of years and the estimates of available water supply are therefore based on actual measurements and not on surmise. The ordinary flow of this stream is ample to fill the the largest of these reservoirs, and on the driest years of which we have a record it has been as great as 200,000 acre-feet.

“It will be seen by the above figures that the possibility of storing water on this stream is very great. It is doubtful if it has any equal in this line among all the streams of arid America. The San Carlos dam site, particularly, is one of unusual merit. The size of the necessary dam, the available water supply, the great storage basin, and the proximity of railroad facilities are perfect, while the other two sites also have features of merit.

“The duty of water in southern Arizona is greater than in California. For the raising of the staple crop of alfalfa a depth of 24 inches of water is ordinarily applied to the land, which is equivalent to a flow for six months of 1 miner's inch to each 3½ acres. On this basis the San Carlos site will furnish enough water to irrigate over 150,000 acres of land. If it is assumed that each 2 acres will support one inhabitant, this would permit of a population of 75,000 souls to be sustained from this reservoir.

“These figures are more startling when the fact is realized that at the present time all of the canals below the San Carlos dam site are absolutely dry, and that the country from the Apache Reservation to the mouth of the Salt River is in a condition of withered drought, with its inhabitants, both white and Indian, reduced almost to the condition of abject want. It is estimated that 10,000 acres of land should be irrigated on the Gila River Reservation, in order to relieve the condition of the Indians. This would leave over 100,000 acres that could be irrigated on the public domain. If 100,000 acres of these public lands could be so irrigated and, being subdivided into 40-acre tracts, sold to actual settlers, at the rate of \$10 to \$15 per acre, the condition of the Indian would be wholly relieved, and it is probable the Government would be reimbursed for its entire outlay. In addition to this a district offering ideal conditions for irrigation, with a soil which is unexcelled, with a climate that will produce crops in continuous rotation, will be made to support a population of 75,000 and will add to the public wealth of the Territory, on a conservative estimate, over \$6,000,000.”

POPULATION.

The population of the county by the last census was 4,251, and it is not less than 5,500 at this time.

MINES AND MINING.

The silver mines of Pinal County being largely low-grade ore, the output of the white metal has been next to nothing for the past year, the present price being so low that they can not be worked with a profit. The Silver King is an exception, and work has been recently started up on this property, which has in time past paid over \$2,000,000 in dividends to stockholders. In gold mining, however, there has been considerable activity at Mammoth, Goldfield, Mineral Creek, Ripsey, and other points, and the bullion output of gold for the year has been about \$250,000. The principal mines of the county are the Silver King and Rayment (both silver and each with 20-stamp mills), the Ray (copper), and the following gold mines:

	Stamps.	Stamps.	
Mammoth	50	Victoria, south of Casa Grande..... 10	
Mammoth, at Goldfield.....	20	Mammon, south of Casa Grande..... 20	
Mohawk, at Mammoth	50	Southern Belle, at Catalinas..... 20	
Bulldog, at Goldfield	10	Norman, at Ripsey	20
Reksom, at Mineral Creek.....	5		

A small amount of placer gold has been taken out of the Catalinas and sold in Tucson. There is an evidence of awakening in all kinds of mining, and the prospects for the coming year are flattering.

CASA GRANDE RESERVOIR.

The reservoir of Casa Grande Valley Canal Company is the largest in the Territory. It is situated 15 miles southwest of Florence. A levee of earth has been thrown up across a depression in the plain 14,000 feet in length, 125 feet in width at the bottom, and 25 feet in width at the top, 2 to 1 slope on each side, and an average height of 25 feet. The waste is regulated by three cast-iron pipes 3 feet in diameter, set in solid masonry, regulated by gates and tower. This reservoir cost \$150,000 and supplies water for 6,000 acres.

METEOROLOGICAL.

The Signal Service of the General Government maintained a station at Florence from 1874 to 1882. The report, covering a period from July, 1880, to April, 1882, gives the following statistics, which may be given as a safe guide for the prevailing temperature, which varies but little from the mean temperature given during the series of six years:

Month.	Mean.	Maxi- mum.	Mini- mum.	Month.	Mean.	Maxi- mum.	Mini- mum.
1880.				1881—Continued.			
July	86.6	111	61	July	87.9	112	64
August	86.5	112	60	August	84.5	110	62
September	81	107	48	September	77.5	103	50
October	68	96	32	October	67.4	98	36
November	52.1	80	25	November	52.4	80	26
December	50.9	77	27	December	52.2	81	28
1881.				1882.			
January	45.7	78	21	January	46.4	79	23
February	54.7	85	21	February	49.5	72	27
March	54.7	93	29	March	57.3	92	25
April	69.1	100	48	April	62.1	100	32
May	74.7	104	45				
June	83.7	113	44				

The heat, as represented in the above table during the months of June, July, and August, is nothing like as unbearable as in the Eastern States, and death from sunstroke is unknown; in fact, during a residence of sixteen years in Arizona the writer has only known two people to be overcome by the heat, and they recovered. Their condition, however, was more the result of whisky than heat.

UNTOUCHED BY FROST.

Orange and lemon trees require slight protection during the winter for a year or two until the wood is sufficiently hardened. While it is a popular thing for one to say that he is not here for his "health," it is an undisputed fact that, for all pulmonary ailments, no climate is equal to southern Arizona, and there are numbers of active industrious citizens with but one lung who came here years ago expecting to live but a few weeks. But for all that, the wonderful Casa Grande Valley is something better than a health resort.

PRODUCTS.

The waters of the Gila River are fresh and pure. The soil contains no alkali, is a deep, rich, gray ash, especially adapted to the growth of prune, olive, almond, peach, fig, pear, apricot, and all fruits of all kinds, which pay largely on the investment. It is also the natural home of alfalfa, which grows in the most prolific manner. The grape does exceptionally well in this valley, and wine and raisin culture is destined to become a prominent industry. Citrus fruits have been cultivated to a limited extent. There are a number of orange trees in the neighborhood of Florence, which bear the golden fruit each year without protection, and a few date palms are also in full bearing. The season is from six weeks to two months earlier than southern California, which gives fruit growers an appreciated advantage in the early markets.

The absence of fogs and nightly dews is a formidable obstacle to the existence of the destructive and unsightly scale bug, and the fruits of the valleys are all bright and clean. All the agricultural products of the temperate and semitropic zones are easily grown here, and long seasons give succession of crops that double or treble the productive value of the land.

PRICE OF LAND.

Improved lands, with Government title and water right, can be bought for from \$20 to \$50 per acre, according to location and improvements. In the immediate neighborhood and to the south of the Casa Grande ruins there are thousands of acres, covered with a heavy growth of mesquite timber, yet open to settlement. These are among the choicest lands of the valley. Water in inexhaustible quantities is found at a depth of from 20 to 30 feet; in fact, a river seems to be flowing underneath. Here is a splendid opportunity to take up and improve land with a pumping system of irrigation, which is said to be successful on small tracts.

Assessed valuation of property in Pinal County.

Land (55,854 acres).....	\$364,709.50
Improvements.....	134,157.00
Patented mines (37).....	39,500.00
Improvements.....	75,840.00
City and town lots.....	44,276.50
Improvements.....	56,285.00
Horses (2,095).....	29,447.00
Mules (112).....	2,800.00
Asses (96).....	431.00
Cattle (23,213).....	273,666.00
Sheep (4,034).....	8,068.00
Swine (195).....	585.00
Railroad, standard gauge (80.29 miles).....	476,316.64
All other property.....	200,918.50
Total.....	1,707,000.14

GRAHAM COUNTY.

County seat, Solomonville.

County officers.—Supervisors, H. C. Day, D. H. Matthews, William R. Waddil; sheriff, Ben. R. Clark; treasurer, Burwell B. Adams; recorder, Pedro Michelena; probate judge, William A. Moody; district attorney, Wiley E. Jones; clerk board of supervisors, Pedro Michelena; surveyor, E. R. Stafford.

Graham County, in the southeastern part of the Territory, and almost the last spot to be wrested from the domain of the Apache, has, by reason of its mineral, agricultural, and pastoral resources, risen to a place of only second rank in the list of counties. Clifton, Morenci, and Metcalf are mining villages, and contain a population of 5,000, engaged in various occupations of mining.

Duncan, Solomonville, Safford, Thatcher, Central, Pima, Mathewsville, Fort Thomas, and Geronimo are agricultural villages, being located in the valley of the Gila, and all, with the exception of the first named, which is on the Arizona and New Mexico Railroad, are on the Gila Valley, Globe and Northern Railroad.

The river Gila, coming from its sources in New Mexico, enters the county near its center on the east, and, uniting with the San Francisco below Clifton, passes through the center of the county, leaving it at San Carlos on the west. The river valley is of rich alluvial soil, and is from 2 to 5 miles in width, much of which is under a high state of tillage by irrigation. The crops grown include those of the temperate zone and some semitropical fruits. Late apples are very productive and of excellent quality. Other fruits are of good quality, but are sometimes damaged by late frosts.

Prices of all farm products are very remunerative, owing to a local market in the mines near by. Wheat is \$1.35 per cental (sacks returned to producers); barley, \$1.25; Irish potatoes, 2½ cents per pound; apples, 3 cents per pound; hay, \$8 to \$12 per ton.

No portion of the county has a less elevation than 2,800 feet and varying to 10,000 feet for the mountain peaks. The climate is dry and healthful; winters in the valley are mild, the range of the thermometer being from 14° F. above zero to to 104°. Nights generally are cool and bracing in summer.

The mountain ranges are highly mineralized. The Arizona Copper Company at Clifton and the Detroit Copper Company at Morenci have each some of the most complete reduction works in the world, rich permanent ore deposits, millions invested in plants and railroads, and together employ a population of 5,000 people.

The Detroit Copper Company have just completed a plant for supplying their mines at Morenci, at a cost of \$50,000, with water supply from Eagle Creek, $4\frac{1}{2}$ miles distant. Eagle Creek at its lowest stage furnishes 30 cubic feet per second. At present the power used is a steam engine of 95-horsepower capacity, only 50 horsepower being required. The pipe line is 4-inch; length, $4\frac{1}{2}$ miles; elevation of Morenci above point of supply, 1,625 feet. Seventy gallons per minute is now delivered at Morenci. The steam power is to be supplemented or substituted by a turbine water wheel, connected directly to the pump with 207 net horsepower.

The Arizona Copper Company are also at work on an electric plant at Eagle Creek, using a water wheel under 500 feet pressure, developing 1,200 horsepower. The power will be carried by wire to Coronado and their mines and used to run all hoisting works, train roads, concentrators, etc., thus doing away with steam power altogether. The estimated expense of the plant and dynamos is \$45,000; cost of changes at mines and works not estimated. Since the so-called coal strip was cut off from the San Carlos Indian Reservation, about a year ago, prospecting has been very active in that locality, and one of the most promising mineral districts in the county is being opened. The principal ores are coppers; altogether other minerals abound. The coal deposits near by will soon be exploited and their value determined. They may give much additional value to all of our mineral properties. There are veins of precious metals in every mountain range in the county, and their extent can hardly be conjectured at the present. All of the towns show a marked and rapid growth during the last year. Brick blocks of modern architectural style, to accommodate the increasing business, go up; banks are established; manufacturing plants put in; school buildings constructed, with capacity to accommodate the increasing population, well furnished with modern seats and apparatus, and supplied with teachers who are graduates of the best State normal and high schools.

The county has 30 school districts. The teachers employed number 42. The average salary paid to teachers is \$58.98 per month. There is a school district indebtedness, represented by 7 per cent bonds, apportioned as follows: To the Safford district, \$5,500; Solomonville, \$6,000; Thatcher, \$4,500; total, \$16,000. The number of school children shown by the census of 1899 is 2,995.

Turning to the farms, notable improvement has been made in the surroundings of the occupants. Fine brick residences are taking the place of the old log and adobe structures, shade trees are planted, yards are embellished with shrubbery and flowers, orchards are planted—demonstrating that our rural population is not behind in civilization.

The Graham Mountain range has quite a timber area, but owing to its precipitous character the lumber output is limited. In the northern part of the county is a large forest area not yet available, as it lies partly on the Indian reservation, with no road to it yet constructed. The range cattle interest is very important and ranks with any county in the Territory according to area. Near Fort Thomas is a hot mineral spring much frequented by invalids and possessed of good healing power, especially in rheumatic complaints. Fine mountain resorts abound, where the heat of summer may be avoided among picturesque scenery, being accessible in a few hours' travel. Successful agriculture can only be carried on in Graham County by irrigation.

The river Gila and its tributaries afford a moderate supply for their immediate valleys. There are 24 irrigating canals, varying in size from 5 to 12 feet in width and from 2 to 14 miles in length. They were all constructed and are now owned by the farmers, and are carried on under the cooperative system. The companies are mostly incorporated, and the cost of irrigating an acre is what the necessary annual cost of maintaining the canal may be pro rata per acre, say from 50 cents to \$1.

There are approximately 45,000 acres of land actually under cultivation in this county, in the principal valley of the Gila.

Beginning at the easterly boundary of the county, near Duncan, the canals succeed each other every few miles, the fall of the stream and valley being favorable. This system is the outgrowth of the early settlement.

Each small community of farmers, when they settled, had to go to work first and secure a water supply according to their means, which were generally limited. This multiplicity of canals seems now unnecessary, but certain facts with reference to water supply justify it, and probably it will never be abandoned, for the reason that at the low stage of water, from April to July, a large part of the water

passing down the river is in subterranean streams and in springs rising in the river whose source is in the mountains bordering the streams.

The water comes to the surface between the dams, thus affording a new supply to the canal next below. The seepage from the irrigated lands above also largely swells the volume of water, as in the course of time it must all get back to the river, less the amount of evaporation. But this only applies to low water; the river at its ordinary stage runs a large surplus to waste, sufficient to irrigate every acre of available land in the county if conducted to it, during eight months of the year at least, making grain, fruit, and alfalfa crops possible and opening up the most healthful and picturesque portion of the county to settlement. To utilize the waste waters a large canal has been projected during the last year, designed to be built by the cooperative labor of the land owners.

This canal begins at the head of the principal valley, 8 miles above Solomonville and near where the Rio Bonito enters the Gila, and will run back into the mesa lands and be 36 miles long. A few miles of the head have been constructed. At the point it leaves the river it is in solid rock, securing permanence.

Artesian water has been developed on a small scale in different parts of the valley and at a depth of less than 200 feet. It is very probable that good supplies can be obtained from this source when the proper work shall be applied. This and a storage system should have the careful attention of the Government and its assistance whenever practicable.

Assessed valuation of property in Graham County.

Cultivated land (9,742 acres)	\$156,839.25
Uncultivated land (29,968 acres)	227,942.10
Improvements	298,710.25
Patented mines (74)	214,990.00
Improvements on patented mines	349,017.00
Improvements on unpatented mines	2,625.00
City and town lots	54,541.00
Improvements	102,119.00
Horses:	
Range (499)	7,131.00
Work (1,275)	42,058.28
Saddle (1,924)	40,517.60
Mules (112)	2,872.27
Asses (262)	2,647.00
Cattle:	
Range (56,325)	563,250.00
Beef (20)	400.00
Milch cows (730)	14,613.00
Bull (1)	15.00
Sheep (1,231)	2,462.00
Goats (3,883)	7,766.00
wine (579)	1,737.00
Railroad, narrow gauge (41 miles)	123,246.80
All other property	275,162.73
Total	2,495,662.73

NAVAJO COUNTY.

County seat, Holbrook.

County officers.—Supervisors, L. E. Divelbess, John X. Hoods, John Hancock; sheriff, F. J. Watron; probate judge, B. F. Jackson; district attorney, W. H. Burbage; recorder, A. F. McAllister; treasurer, J. H. Richards; clerk board of supervisors, A. F. McAllister.

Navajo County was created by an act of the eighteenth legislative assembly from the western portion of Apache County, and is situated in the northern and eastern portion of the Territory. On the north is the Colorado River, on the east Apache County, on the south Gila and Graham counties, and on the west the county of Coconino. The topography of the county consists of a high plateau, of which the main elevation is about 6,000 feet, cut from east to west by the Little Colorado River, sloping gently toward that stream and also toward the west, the general direction of the river. It is about 240 miles long from north to south and 53 miles wide from east to west, containing about 10,000 square miles. The Moqui and Navajo Indian reservations cover the entire northern

portion, and the White Mountain Apache Indian Reservation covers the southern part, leaving a strip 100 miles long and 53 miles wide for the occupation of white people.

The southern portion of the county is covered by a fine growth of pine, which is now embodied in the Black Mesa Forest Reserve. The population of the county is estimated at about 5,000.

HOLBROOK.

Holbrook is the county seat of Navajo county and has a population of about 300. It is one of the greatest shipping centers in northern Arizona. It is situated in the fertile valley of the Little Colorado, and has a bright future. Above the town is a fine site for a storage reservoir and when constructed it will reclaim several thousand acres of tillable land. Holbrook is also the distributing point for Snowflake, Taylor, Pinedale, Shumway, Linden, Showlow, Silver Creek, Pinetop, Woodland, Fort Apache, Heber, Pleasant Valley, Woodruff, Concho, St. Johns, Springerville, Keams Canyon, etc. Last spring over 10,000 head of cattle were shipped from this point, and 50,000 head of sheep, and several hundred thousand pounds of wool. All kinds of business are liberally represented in town. In 1898 a fine court-house was erected. The town has a graded school and a church building is in the course of construction. Four stages leave the town, two of which are daily.

WINSLOW.

Winslow is the largest town in the county and has a population of about 1,500. It is a freight and passenger division point on the Santa Fe Pacific Railroad. It has one of the finest railroad eating houses in the West; railroad shops, round-houses, etc., and the company employs about 600 men at that point. The town is growing rapidly, and contains several fine business blocks and numerous elegant brick residences. An opera house is under construction. It contains several churches of various denominations, and a fine brick school building that will accommodate about 300 pupils.

Several farms have been cultivated profitably around Winslow for years by diverting the waters of Clear Creek upon the soil. A large irrigation scheme is now being developed, and when completed will reclaim about 50,000 acres of land surrounding the town. The town has a pushing, energetic population and its future prospects are flattering.

ST. JOSEPH.

St. Joseph is a thriving village situated on the Little Colorado, between Holbrook and Winslow. Its inhabitants depend chiefly on agriculture and stock raising. Wheat, barley, oats, corn, alfalfa, sorghum, all kinds of vegetables, and many varieties of fruits. Water for irrigation is taken from the Little Colorado in two ditches, one about 9 and the other about 5 miles long, each having several miles of laterals.

WOODRUFF.

Woodruff is another farming village situated 12 miles east-southeast from Holbrook on the Little Colorado River. Water is secured by damming the Little Colorado. All kinds of small grains and vegetables are raised. Alfalfa is a staple crop; and fruits, such as peaches, apples, pears, apricots, plums, and a variety of cherries, do well. The village is located at the foot of Woodruff Butte, a noted landmark in northern Arizona. The Butte is of volcanic origin and rears its solitary head 1,000 feet above the surrounding plain. It is one of the most picturesque towns in the county.

SNOWFLAKE.

Snowflake is situated 30 miles south of Holbrook, and is the second town, based on population, in the county. The town is substantially built, containing numerous fine brick residences and several substantial business houses. It is built in the center of a rich farming section. The cultivated lands adjacent to town are watered from storage reservoirs, impounding the waters of Silver Creek. The town is handsomely laid out; broad streets lined with tall shade trees, beautiful buildings, etc., combine to give an air of opulence and prosperity to the place. It is the most beautiful and most substantially built town in northern Arizona.

The lands surrounding the town are very fertile, producing all kinds of cereals, hay, vegetables, and various kinds of fruit. The town has a telegraph line, a daily stage, and every convenience of an inland town.

TAYLOR.

Taylor is situated about 3 miles above Snowflake, on Silver Creek. Like Snowflake, it depends wholly on the tilling of mother earth. The two towns depend on the same irrigation system, and there is now about 4,000 acres of tillable land under cultivation in and about the two towns. Two more irrigation systems are now being constructed, and in a year or so two or three times the present amount of land will be cultivated. The productions at Taylor are the same as around Snowflake. Taylor is pushing ahead and rapidly forging to the front as one of the live towns of the county.

SHOWLOW.

Showlow is located on Showlow Creek, about 18 miles south of Taylor. It is principally a farming community, yet some of the sheep owners of Navajo County reside there and own ranches in that section.

PINETOP.

Pinetop, Linden, Pinedale, and Herber are situated in the timber belt south and west of Showlow. They are also farming communities, while several sheep and cattle men reside there.

SHUMWAY.

Shumway is situated on Silver Creek, 7 miles southeast of Taylor. It is hemmed in by surrounding mountains and is a picturesque and beautiful spot. It contains a fine flouring mill, which supplies the surrounding country with flour. That vicinity is particularly adapted to fruit raising, and the most delicious varieties are produced at Shumway. In addition thereto all sorts of cereals, vegetables, and hay are raised.

IRRIGATION.

There are many thousand acres of the choicest kind of farming land in the county and plenty of water to irrigate the land with. It will require only a small outlay to build a number of storage reservoirs to impound the water of the streams, and make a vast agricultural section out of this county. There is a good demand for all kinds of produce. The soil, with the application of water by irrigation, will produce abundantly wheat, oats, corn, barley, rye, beans, potatoes, cabbage, peas, and all kinds of garden truck, besides apples, peaches, pears, plums, apricots, prunes, berries of all descriptions, and sugar beets. An investment in a few reservoirs will bring returns in a thousandfold. There are numerous fine reservoir sites, where nature has hollowed out places, and all that is required is to dam up the narrow outlets. A natural basin above Holbrook, if dammed up, will reclaim 100,000 acres of land; another above Showlow, one near Winslow, and, in fact, the county is dotted with natural reservoir sites. So far only 9,000 acres of land have been reclaimed in the county, and the agricultural industry is in its infancy. The soil is black loam, and sandy, gravelly clay, and is rich and fertile whenever water is applied.

The rainfalls in the latter part of the summer always send torrents of water down the streams, which, if impounded, would be of vast value to the agriculturist, fruit raiser, and stockman.

BEEF SUGAR.

The soil is especially adapted to the cultivation of sugar beets. Actual experiments have demonstrated that beets can be raised here containing from 18 to 20 per cent of saccharine matter. Land once put in shape to cultivate beet sugar successfully is worth from \$200 to \$300 per acre.

TIMBER.

About one-third of the county is heavily timbered with pine, piñon, oak, and cedar. The pine makes fine lumber, and the other varieties make very desirable material for fencing and fuel. Coal can also be had for \$7 to \$8 per ton in any of the towns along the railroad.

RAILROADS.

The Santa Fe Pacific Railroad traverses the county centrally from East to West, a distance of over 53 miles. The main stations are Holbrook, St. Joseph, and Winslow.

AGRICULTURE.

Wheat, oats, and corn are the principal cereals raised. Wheat brings \$1 per bushel, corn 60 to 75 cents per bushel, oats 50 to 60 cents per bushel. Alfalfa is another staple crop and brings from \$7 to \$15 per ton. Fruit and garden truck bring good returns.

LIVE STOCK.

Agriculture, cattle, and sheep raising are the three great industries of the county. There are now about 60,000 head of cattle in the county, 150,000 head of sheep, 8,000 horses, and 2,000 swine.

MINING.

Several prospects have been discovered, but no paying mines have been found as yet.

WEALTH.

The assessed valuation for 1899 was \$1,211,058.19, which represents about three-eighths of the real value of the property in the county.

CLIMATE.

The mean elevation is between 5,000 and 6,000 feet above sea level. The climate is bracing and is an ideal retreat for pulmonary affections. The winters are mild and the altitude renders the summers comparatively cool. No extremes, but an even, moderate climate, suited to develop physical and mental activity. The snowfall during the winter is light, and the refreshing showers in the summer cool the atmosphere and temper the heat.

SCENERY AND NATURAL WONDERS.

Southeast of Holbrook is the world-famous Petrified Forest. To the north is the strange and weird Painted Desert, the Aztec ruins, the Moqui villages, where every year the snake dance, a remarkable religious ceremony, is held, and which attracts scientists and tourists from every part of the globe. To the south are the famous hunting and fishing grounds of the White Mountains.

EDUCATION.

There are 14 school districts in the county, employing 22 teachers. Five of the districts have graded schools, with two or more teachers. The number of months of school taught in each district range from 5 to 8, averaging about 6½ months. The salaries paid range from \$45 to \$100 per month; average salary about \$65 per month for both male and female teachers. There are about 1,000 children of school age in the county. The schools are in excellent condition, and the standard of the teachers is fully equal to the average in the East. Most of them are normal school graduates or have received professional training in normal schools.

PRESS.

Two papers are published in the county—the Mail, at Winslow, and the Argus at Holbrook.

CHURCHES.

There are 8 churches in the county. Several denominations who have no church building of their own, but hold services in the public halls, schoolhouses, and in the meeting house of the denominations who are fortunate enough to have one.

DAIRY PRODUCTS.

Dairy products are increasing, but the supply does not go beyond home consumption. It could be vastly increased.

OTHER INDUSTRIES.

Almost all over the county along the Little Colorado good clay and sand suitable for brickmaking can be found. The brick manufactured at Holbrook and Winslow rival the famous Milwaukee product.

Fine building stone can be quarried along foothills of the Little Colorado. At Penzance, 6 miles below Holbrook, the Santa Fe Pacific Railroad Company is operating a large rock quarry, employing about 100 men. This product is shipped east and west along the whole system.

A good grade of gypsum, in inexhaustible quantities, is found in many places, which would, if properly treated, make cement equal to the best.

Tanneries, woolen mills, a wool scouring plant, etc., would be profitable investments.

Assessed valuation of property in Navajo County.

Land (315,388 acres).....	\$125,436.85
Improvements.....	38,267.10
Railroad land (721,109 acres)	144,221.71
City and town lots.....	87,463.83
Improvements.....	173,540.00
Horses :	
Range (1,366).....	13,660.00
Work (568).....	22,720.00
Saddle (265).....	5,300.00
Stallions (8).....	390.00
Mules (61).....	1,995.00
Asses (78).....	390.00
Cattle, range (8,737).....	104,704.15
Milch cows (483).....	9,772.00
Sheep (88,455).....	176,910.00
Goats (530).....	1,060.00
Swine (247).....	1,113.00
Railroad, standard gauge (57.208 miles).....	143,020.00
All other property.....	161,094.55
Total	1,211,058.19

APACHE COUNTY.

County seat, St. Johns.

County officers.—Supervisors, A. V. Gibbons, L. J. Brown, B. Lopez; sheriff, Edward Beeler; district attorney, Alfred Ruiz; county recorder, John T. Patterson; treasurer, Benjamin Schuster; clerk board of supervisors, John T. Patterson.

Apache County was named from the Apache Indians, who formerly occupied this section, and still occupy their reservation to the immediate southwest. The county is 48 miles from east to west and 115 miles north and south, exclusive of the Navajo Indian Reservation on the north, and lies in the northeast corner of the Territory. It has an average of about 5,600 feet altitude, and is traversed by the Rio Puerco, Zuni, and Little Colorado rivers, flowing, respectively, from the northeast, east, and southeast. The greatest elevation is in the south, the region of the spurs of the White Mountains. The surface is a series of broad valleys and table-lands.

WATER SUPPLY.

The White Mountains on the south, containing about 600 square miles, which slope gradually to the north, furnish a considerable supply of water. The July and August rains are copious, the streams often overflowing their banks. This water is partially stored in numerous small reservoirs, the capacity of which is entirely inadequate to reclaim the available agricultural land.

FORESTS.

The best part of the country near the snow line is covered with a good growth of long-leafed pine, varying from saplings to immense trees 4 to 6 feet in diameter. This timber is protected by the Government and is practically untouched. The timber area is about 600 square miles in extent, and is worth millions of dollars in itself, besides its incalculable influence upon climate and water supply. The foothills of the mountains are covered with a growth of piñon, cedar, and oak, averaging at maturity about 12 inches in diameter. The timber of the foothills is not merchantable except for fuel and fencing, and may be had for the cost of hauling, which is only nominal.

CLIMATE.

The climate is that of most localities in our latitude and elevation. The air is light and dry, and the wind fitful, especially during the spring months, but cyclones and destructive storms are wholly unknown. The summers are mild and pleasant, with cool nights, while the winter season may be compared with the quiet sunny weather of late September in the Middle States. The spring months are dry, but abundant rains set in usually about July 1 and continue well into the fall months. Irrigation is usually employed during the dry season, but is not absolutely necessary for the raising of late crops of corn, wheat, and sorghum.

GRAIN.

Our cool seasons are peculiarly adapted to the raising of small grain. The land under irrigation produces abundant crops. The grain raised in this section is a very large kernel, oats weighing as high as 50 pounds to the bushel. The wheat is of an excellent quality for milling. About 1,250 barrels of flour are turned out annually by our county mills. Springerville is the center of the grain-producing district.

GRASSES.

The only tame grass cultivated is alfalfa or lucerne. This is a most remarkable grass, both in vitality and production. Its roots penetrate the ground to the depth of 8 feet. It does not yield easily to the drought, and in this section produces two or three crops a year. The wild grasses on the mesas consist of white and black grains, Sacaton, and several other varieties, which come up after the first summer rains, and mature and cure before the fall frosts and furnish strong and nutritious feed for all kinds of live stock during the winter. In the spring, after the snow melts in the mountains, a fine growth of bunch and blue grass starts up in the vicinity, and the live stock are driven into the mountains for summer range.

CATTLE.

The cattle industry of Apache County, which formerly was the chief industry of the county, has undergone a very remarkable change, which is attributable to natural causes: First, the liability of the occurrence of droughts in an arid country; and second, the disposition of stockmen to overstock a new country.

In 1888 the territory which now constitutes Apache County had not less than 40,000 head of cattle, while to-day the number of cattle in the county will not exceed 10,000 head, a condition far more favorable to the interests of the cattlemen than when the county was overstocked with cattle.

SHEEP.

The chief rival of the cattle industry is the sheep industry. In the latter less money is required to begin with, and hence more persons are engaged in it. The sheepmen are usually residents and personally superintend their business. The range is naturally adapted to sheep breeding and severe losses are unknown. The mesas are generally well covered with cedars, which furnish protection to the stock during the stormy winter weather, the sagebrush and other undergrowth being sufficient for their subsistence. During the summer months the flocks are all driven into the mountains where they find an abundance of green feed. The annual wool clip reaches about 750,000 pounds, and is one of the county's principal resources.

TOWNS.

St. Johns, the county seat, is located on the Little Colorado River, near the center of the county, 15 miles from the railroad. It has approximately a population of 1,500 inhabitants, 1 Catholic, and 1 Mormon church, 2 public schools, 1 flour mill, 4 large general stores, a substantial court-house and jail, and 1 newspaper, The St. Johns Herald.

Springerville is located in the southern part of the county, with a population of about 300 inhabitants, 1 flour mill, a Catholic church, 3 stores, and 1 substantial school building.

Concho is near the center of the west line of the county, containing a population of about 500 inhabitants, 3 stores, and 2 public schoolhouses. It is the center of the fruit raising and sheep industry.

Other small towns are Nutrioso, Alpine, Eagar, Greer, and Navajo.

SCHOOLS.

There are 12 school districts in the county, which employ 19 teachers for a term of five to six months, at salaries ranging from \$40 to \$85 per month. Teachers are generally graduates of first-class normal schools, and examinations are under the supervision of the Territory superintendent of public instruction.

IRRIGATION.

There are about 8,000 acres under ditch in the county. This has all been carved out of waste land, practically valueless to the Government. The work of water development and land reclamation has been done by our home people in every instance, without the aid of outside capital. The plan of operation, usually, is to organize a stock company, the stock being paid for by work in the construction operations.

Farming in this county is no experiment. It is an unqualified success, and is limited to a few thousand acres, solely because of a lack of water development. Substantial improvements in that direction are underway, however. The St. Johns Irrigation Company, a cooperative concern which now irrigates some 3,000 acres of bench land, has two reservoirs completed, at a total cost of \$15,000, and has another reservoir under construction, which will cost \$15,000 more, and which will irrigate between 3,000 and 4,000 acres in the neighborhood of St. Johns. All the water supply is from the Little Colorado River and its tributaries.

Apache County has been known as essentially a stock-raising county, but its agricultural interests are certain to become an important factor in the general prosperity within the near future. Our people are alive to the necessity and importance of water storage, and the undeveloped resources of the county in respect of available reservoirs sites comprise a valuable asset. Nor will the development of the county's agricultural resources conflict with the live-stock interests. The land reclaimed and available for reclamation forms little or no part of the grazing lands. As a matter of fact the stockmen welcome the farmers, from whom they are able to purchase all their supplies, while the extension of the alfalfa fields will mean better opportunities for fattening the range cattle.

Assessed valuation of property in Apache County.

Land (114,790 acres)	\$34,437.00
Improvements	69,300.00
Railroad land (769,360 acres)	154,128.89
Town and city lots (487)	16,999.00
Improvements	46,505.50
Horses:	
Range (1,195)	12,485.53
Work (882)	24,448.00
Saddle (761)	14,078.50
Stallions (16)	1,075.00
Mules (53)	1,350.00
Asses (179)	862.00
Cattle, range (7,589)	75,890.00
Milch cows (536)	9,414.00
Sheep (109,104)	218,208.00
Goats (3,001)	6,002.00
Swine (172)	619.00
Railroad standard gauge (54 miles)	196,205.00
Pullman Palace Car Company	2,986.99
All other property	182,435.66
Total	1,007,425.07

GILA COUNTY.

County seat, Globe.

County officers—Supervisors, G. D. Barclay, J. G. Oldfield, J. B. Freeman; treasurer, A. H. Morehead; sheriff, W. T. Armstrong; district attorney, P. W. Fleming; probate judge, T. M. Thurmond; recorder, R. J. Williams; clerk board of supervisors, R. J. Williams.

Gila County occupies a peculiar position, geographically, lying in the eastern central part of the territory, bounded on the north by the rim of the Mogollons,

stretching into the Apache Indian Reservation on the east, defined by the foot of the Four Peaks on the west. One glance at the map of Gila County recalls the expression, "a country of magnificent distances."

CLIMATE AND NATURAL OBJECTS.

The climate of Gila County presents features of the widest diversity. In winter one may drift from the snow-clad forests of Pine and Payson to the rare salubrity of Globe and the Salt River Valley; in summer he may be seen wending his way back to the perfumed groves in the shadow of nature's stupendous wall, "the rim" of the Mogollons. Even from Globe, where in summer the climate is sometimes on the ardent order during the heat of the day, a 10-mile drive to the Pinal Mountains will bring one to a cool and delightful atmosphere.

No other field in the wonderful West holds out greater attractions to the tourist, the health seeker, the man with the gun and rod, the brush and camera. Among other remarkable objects are the Natural Bridge, near Pine, the majestic "Rim," the Salt River Valley canyon, and the caves and labyrinths of the East Verde. The Natural Bridge brings hundreds of sight-seers every year from Globe, a distance of 118 miles, and no one who ever looked upon it ever regretted the four days of dusty travel necessary to reach it. It is a majestic span of nature's masonry, from the edge of which a tiny silver stream can be seen, 200 feet below, the mighty arch being over 300 feet in length and containing sufficient material to build a city. This arch at one point is only 6 feet thick, and a hole about the size of a man's body gives the delighted observer a perfect view of the wonders below him; yet on the top of the great bridge there is a fine farm.

The "Rim" of the Mogollons forms one of the most sublime pictures ever contemplated by man. It extends 150 miles, and simply constitutes an abrupt descent from the great elevated table-land known as the Coconino forest, down to the plains altitude of southern Arizona. For miles, in places, the mighty wall stands 2,000 feet above, as perpendicular as the walls of a house, with cactus, catclaw, and mesquite at the bottom, and the long-leaved pine dangling over the top. Altogether it may properly be considered one of the greatest natural wonders in America.

The valley of the Upper Salt, about 25 miles north of Globe, spreads out for several miles, where enterprising ranchers, aided by abundant water, exhaustless timber from the near-by Sierra Anchas, and every aid which generous nature affords, have made substantial improvements. The valley terminates in a canyon so narrow, deep, and precipitous that it constitutes a natural wonder, and this canyon has been selected by the Hudson Reservoir people as their dam site. A dam 200 feet in height will be constructed, which will store sufficient water to irrigate the whole of the Salt River valley and the adjacent mesas. Other fine attractions are the hot springs, 30 miles north of San Carlos, the cave dwellings, and other prehistoric ruins in the greatest profusion, together with wonderful fossils and almost every natural attraction known.

FRATERNAL SOCIETIES.

Globe is the most enthusiastic secret society city in the Territory. The Odd Fellows have just completed a fine brick hall which would be a credit to any town of 5,000 people. The Masons also control a commodious hall, the Knights of Pythias have a fine lodge, while the Ancient Order of United Workmen, Woodmen of the World, Elks, Foresters, Miner's Union, Good Templars, Red Men, Rebeccas, and Ladies' Auxiliary of the Red Men are in a flourishing condition.

AGRICULTURE AND HORTICULTURE.

During the present year, more than ever before, extensive practical experiments have proved that all standard varieties of fruit reach a degree of perfection in Gila County seldom equaled on the coast, while wheat, corn, barley, and alfalfa are raised in abundance by irrigation in the lower sections, and without it in the higher localities. The little settlement of Pine, which nestles at the foot of the "Rim," has demonstrated very forcibly what the possibilities of the soil are in Gila County.

CATTLE.

The cattle industry, which was somewhat crippled in 1897, has revived wonderfully since the beginning of 1898, and men are greatly cheered by the outlook. The past season was favorable and the range correspondingly good. The completion



GLOBE—LOOKING SOUTH.

of the railroad to Globe enables owners to market cattle which would not otherwise be moved out of the county on account of having to drive over a dry country, and the industry still holds its place, second only to mining.

RAILROADS.

The sad confession, unavoidable in Gila County's last report, that it was the only county in the Territory without a railroad is happily no longer necessary. The Gila Valley, Globe and Northern Railroad is in full operation, connecting with the Southern Pacific at Bowie, and has its terminus at Globe. It operates about 28 miles of road in the county, and will shortly be extended to the Black Warrior, 9 miles northwest of Globe. The road carries spurs to the smelters of the Old Dominion Copper Mining and Smelting Company and the United Globe mines. It is conceded that the road has been prosperous to a degree that astonished its promoters. It has not only been a great success for its investors, but has increased the prosperity of Globe and the whole county inestimably. For twenty long years the pioneers of Gila County have waited and prayed for the happy hour when the neigh of the iron horse should echo against the ribbed walls of Pinal Mountains; hundreds grew feeble with age and sank into the grave as they waited, but the survivors have lived to realize their hopes, and the enhanced value of their property since the advent of the road secures them an independent old age. The construction of the road distinctly marks a new and grander era for Gila County in every department of its industrial affairs.

MINING.

This is, of course, the crowning industry of Gila County. It is one matter in which Gila County ranks with any community in the coast country. Twenty years ago the copper mines of Globe realized handsome dividends, when it was necessary to purchase everything needed at a much higher price than now; when railroad freight rates were nearly double, and everything taken in or out was dragged from Willcox, a distance of 140 miles, through sand and dust, and while copper was 10 cents, instead of 18 cents. Nothing else could speak stronger for the extent and richness of these mines. The Old Dominion and the United Globe are the pioneer properties of the camp, and millions have been produced from the yawning stopes with which the mountain is honeycombed. The advent of the railroad, of course, has stimulated their operation and doubled their capacity to produce. The Old Dominion has, during the last year, put in thousands of dollars' worth of new machinery, one feature in their improvements being the finest hoist in the Territory, and the company employs something near 450 men. The United Globe has made similar strides, and contemplates putting in a leaching plant in the near future. It employs about 500 men.

The Black Warrior Company has two groups of mining claims located 7 miles west of Globe, in Gila County, there being 40 claims in all. The Black Warrior mines have been working continually for the past three years, and have been developed from a promising prospect to producing mines; during which time the company has made large shipments of copper ore, averaging 14 per cent copper, to the local smelters at Globe, and since the completion of the Gila Valley, Globe and Northern Railway the company has been making regular shipments of from two to six carloads per week of its high-grade ore to Silver City reduction works. During these shipments there have been from 50 to 75 men developing the property and blocking out ore, preparing to supply the 150-ton plant which the company has erected for the treatment of its own ore on its own property for the production of copper and bullion. The company has spared no pains in its equipment, and has in connection with the plant a reverberatory furnace and has now commenced the erection of a sulphuric acid plant.

It is claimed that the ore actually blocked out upon the Dadeville and Montgomery claims alone shows 100,000 tons of copper ore, averaging 10 per cent copper, the ore bodies being explored to the depth of 300 feet on the dip of the vein, there being over 3,000 feet of development work upon these two claims alone, in all the workings of which the ore bodies are encountered. The ore is worked by gravity from the mines through an adit tunnel, which taps the workings at the lowest level; the ore then passes by gravity along a tramway 6,000 feet, where it reaches the plant, which is constructed on the gravity plan, below which is the reverberatory furnace, which turns out the bullion in its finished state.

The company has a small town of its own near the works, consisting of a warehouse, office, store building, comfortable dining hall, blacksmith shops, laboratory, bunk houses, and residence of the superintendent, water-pipe lines being laid to

convey water to all the buildings in the camp. The plant has been especially constructed for the treatment of the oxide ores of the Black Warrior at the minimum expense, and nature has favored this property to that end. From the farthest workings of the mine there is a continual slope which does not end until the scales which are to weigh the bullion are reached, a distance of over a mile.

Besides the foregoing leading properties, many others are fast assuming the proportions of standard paying mines, while the hills are full of miners and chlo-riders who do well, working small properties on a private scale and shipping the ore and selling it to the large smelters.

The Pinto Creek district is coming to the front as a copper and gold camp, several important sales having been made to good companies during the last four months.

Valuable copper properties exist also near Payson, on Tonto Creek, and in the Gun Creek district, and the mining outlook as a whole is vastly better than ever before since the organization of the county. It is principally this industry which makes a demand for all the products of the range, the ranch, the garden, and the orchard, and has built up the wealth of Gila County, and to it the people look for the greatest measure of prosperity ever known to any section of Arizona.

NEWSPAPERS.

The press in Gila County consists of two weekly newspapers, the Arizona Silver Belt, owned and published by the venerable Judge Hackney and Joseph Hamill, and the Globe Times, published and owned by the veteran frontier newspaper man, R. C. Brown. Both papers are ably edited and work with true frontier enthusiasm for the upbuilding of their community.

A general recapitulation of the progress of the county since the last report would reveal astonishing advancement in industrial conditions, and the total value of all property would appear much greater in the report if people could learn that a full-value assessment, along with a light tax rate, advertises a community vastly better than an under assessment along with a heavy tax rate.

Assessed valuation of property in Gila County.

Land (3,002 acres)	\$16,574
Improvements	128,470
Patented mines (53)	152,900
City and town lots	66,430
Improvements	136,867
Horses:	
Range (1,226)	12,260
Saddle (1,875)	40,866
Mules (98)	2,450
Asses (357)	1,785
Cattle (40,766)	407,660
Sheep (13)	26
Goats (4,411)	8,822
Swine (377)	1,885
All other property	271,912
Total	1,248,907

MOHAVE COUNTY.

County seat, Kingman.

County officers.—Supervisors, Ed Imus, M. Scanlon, J. S. Kolar; sheriff, Harvey Hubbs; treasurer, A. Cornwall; district attorney, William G. Blakely; recorder, John P. Feeny; probate judge, J. A. Logan; clerk board of supervisors, John P. Feeny.

Prior to 1864 Mohave County composed a portion of Donna Ana County, N. Mex., but after the organization of the Territory of Arizona it was formed into one of the four original political divisions into which the Territory was divided. It embraces 16,000 square miles of the northwestern part of the Territory. It is traversed by high mountain ranges and broad valleys, covered many months in the year by luxuriant vegetation and nutritious grasses. Until 1882 its only means of communication with the outside world was by stage to San Bernardino, or river steamer to the Gulf of California.

LANDS.

The number of acres of land now under cultivation is over 2,500; and on the Colorado River below Fort Mohave several hundred more acres are in process of reclamation.

The irrigation canals of the county are purely of a lateral nature, built to carry water over small sections of land. On the Big Sandy each farmer has taken out a ditch from the creek to irrigate his own tract of land, consisting from 50 to 300 acres. Thirty-five miles of ditch will cover the irrigation district of the Sandy. In the valley of the Colorado River the Government has a pumping plant which supplies water for about 100 acres of land. Several ranchers irrigate small parcels of land from wells, while the Mohave Indians await the overflow of the river to put their land in proper condition for crops.

LAND RECLAMATION.

There are in the county of Mohave, not including the high mesas, over 4,000,000 acres of land that can be readily reclaimed. Lands along the Colorado River, in the Mohave Valley, grow every semitropical fruit. No frost falls in the lowlands. In the mountain ranges are many springs, the waters of which are used to irrigate small patches of land. West of Kingman several of these springs have been converged at Beale Springs and a beautiful fruit orchard propagated. This year the crop has been usually large, and thousands of dollars' worth was shipped to outside points. The peaches raised on this ranch are of the most luscious flavor and are of enormous size. North of this ranch is Oak Creek, the largest orchard in the county. Nectarines, peaches, apricots, figs, apples, pears, plums, pomegranates, almonds, grapes, and many other fruits are here grown in abundance.

LIVE STOCK.

A decrease is shown in the number of range cattle in Mohave County as compared with the number reported by the assessors last year. In 1898 there were 25,705 head, while this year only 22,257 are reported. The drought of the past several years has caused some loss, and at the same time influenced cattle growers to dispose of their herds and get out of the business. Under ordinary conditions this country would be an ideal cattle-breeding country, but the uncertainty of the rainy season keeps men from investing in the industry.

MINING.

The people of Mohave County depend almost entirely on the product of the mines. For years the mines were worked almost exclusively by "chloriders," and the product has been enormously large. Forty million dollars will not cover in value the gold and silver taken from the mines since their first discovery. Since the discovery of the mines of White Hills in 1892 many mining companies have invested in mines and have expended thousands of dollars in development. Notably is this the case at White Hills, where an English company, after paying \$1,750,000 for the White Hills group of mines, has expended over \$500,000 in developing water and blocking out ore bodies in the mines. This company has built a ten-stamp mill on the G. A. R. mine and a 40-stamp mill on the Occident. Failure to develop a sufficient water supply has been a great drawback to the company's operations, but to date the production of bullion runs up into the millions of dollars. A carload of ore shipped under the former régime from the G. A. R. mine contained 29,000 ounces of silver and over 100 ounces in gold. Chloriders took from the surface of the White Hills veins many tons of this grade of ore. Under the new management a new prospecting shaft 2,000 feet in depth will be sunk, the work to begin as soon as the heavy machinery is put in. At Chloride a Scotch syndicate has in operation a concentrating plant capable of handling 100 tons of ore daily. This plant handles the output of the Elkhart mine. On the same lead the Hualapai Mining Company has 2 hoists in operation, the mine product passing through a process which cleans the metal from all gangue. The main shaft is down 400 feet, and the vein shows 16 feet of well-mineralized filling. The output at present is about 20 tons daily of clean lead. Farther to the south, on the same lode, is the Bullion Beck and Mollie Gibson, with one hoist. The main shaft is down nearly 300 feet and has the richest lead ore in the district in the bottom. The claims are worked by E. J. Carter, of Montana, brother of Senator Carter. About a mile southeast of the Mollie Gibson is the Payroll. A new hoist has just been installed, and 3 shifts are at work in

the shaft. The ore of this vein carries good values in lead, gold, and silver. The vein is 12 feet wide on the surface. John Bany has 16 feet of ore in the Minnesota, and the assorted product runs away up in the hundreds of ounces in silver. Mr. Bany has a hoist on the mine and has exploited it thoroughly above the 200-foot level. He also has a hoist on the Juckahoe, a claim northwest of Chloride and about 2 miles from the post-office. The Merrimac, west of the Chloride, is producing big ore. It has a good hoisting plant and is working a good force of men. The Juno is operating a hoist. Prospectors have flocked into the hills in all directions from Chloride. Good ore is being discovered in all the surrounding hills, and prospectors are feverishly doing their title work. The town of Chloride now has an estimated population of 800, where a year ago there was but little over 100. Across the valley from Chloride new gold discoveries have been made, and a Philadelphia company has put in a 10-stamp mill to work the ores from a claim which they recently purchased. Frank Rockefeller, one of the Standard Oil magnates, has purchased one of the claims in the new camp and is opening up a wonderful body of gold-bearing lime-carbonate ore. The extraction of the gold from its ores in the camp is an easy matter by the cyanide process, the loss of cyanide being 16 cents per ton of ore treated. At the Sheeptrail mines, near Bulls Head Rapids, the Arizona and New England Mining Company has put in a 20-stamp mill and are making a great success. In Mineral Park Basin are many veins carrying gold and silver. A number of the old abandoned claims have been relocated and are producing gold ore. Notably is this the case with the Quick Relief. After doing considerable dead work the former owner abandoned the property, which, relocated by the present owner a few feet in new ground, brought to light 2 feet of very rich silver ore. A drift is now being driven on this ore, and it is holding its width and value. The Keystone and Buckeye are the only mines in the basin having hoists, but there are several mines being worked. The Queen Bee is an ore shipper, as is also the Lady Bug, Lone Star, and Home Pastime. At Layne Springs the Nighthawk mine continues to be a big producer. The Mint, one of the old abandoned claims, has developed into a phenomenal ore producer. Ore as it comes from the mine is valued at 1,300 ounces silver and 12 ounces gold. The Blackfoot and Oro Plata mines, in Todd Basin, are big producers. The Oro Plata produced nearly \$200,000 last year under leasehold workings. In Union Basin are many good veins of mineral. At Cubat the Golden Gem mine has been opened up at a depth of 330 feet and has produced \$150,000. It has a good hoist. The Flores, on the west of the Golden Gem, has a 5-stamp mill and hoisting plant. The Cubat mine has been exploited to a depth of 200 feet. All these claims are gold-bearing, and the latter claim is also copper-bearing. In and around this camp are many veins carrying lead in paying quantities. To the east of Cubat is the famous Stockton Hill Camp. Here are located many rich veins of silver ores, and the united product of the mines will reach into the millions. The deepest mine is only 40 feet, and above this depth \$500,000 has been produced. The vein in places has a width of 20 feet. The Infalible, Tigress, Little Chief, Bluebell, Pine, Metal, Fountain Head, Miner's Hope, Prince George, Dictionary, and many others have been wonderful producers. The C. O. D. mine has produced 1,000,000 ounces of silver, besides gold and lead, above the 400-foot level. Ore left in the old drifts and stopes, and which was considered worthless, is now found to contain $4\frac{1}{2}$ ounces gold to the ton, and preparation is being made to unwater the mine and give the property a new lease of life. At Gold and Lost Basins are many big veins of low-grade gold ore and smaller veins of shipping values. Lack of water is the drawback to successful operations in these districts, but conditions are constantly changing, and the future may have good things in store for the mine owners who have held on to their properties for years. Peacock district has a few good mines, but at present little work is being done on them. In the Hualapai Mountain, the Old American Flag Mine, is being reopened by a small force of men. In early days its ores were rich enough to ship to Swansea, England, for treatment. Cedar, Ruby, and Owen districts are producing shipping ores in a small way, although they merit a better fate.

The old McCrackin mine, in Owen district, produced nearly \$4,000,000 in silver, all ores being mined through tunnels. The deepest working is only 80 feet below the lower tunnel level. Along the Colorado River, from the mouth of the Grand Canyon to Bill Williams Fork, are immense gravel beds, carrying from a few cents to \$2 to the cubic yard of placer gold. Thousands of locations have been made along the river and considerable gold extracted. At Temple Bar a French company has put in a hydraulic plant to work the rich bench diggings, but were depending upon catching driftwood sufficient for fuel. A glance boom has been put in the river, but no drift has come down since its completion, and outside of

a trial run to test the machinery no sluicing has been done. The gold is mainly very fine, but nuggets weighing four ounces have been taken out. In the Cheme-huevis Mountain occurs a sedimentary deposit carrying gold. Detritus from this deposit has furnished ground for the operation of panners and dry washers for twenty years, and fully \$1,000,000 has been taken out.

Three mountain ranges traverse the county from north to south, and their rocky ribs are seamed with ledges of gold, silver, copper, and lead. Near Mineral Park are many ledges of turquoise, which show evidence of having been systematically worked by a prehistoric race. Stone hammers and rude tools have been found in all the openings in the mines. For the year ending June 30, 1899, the ore shipment through the Kingman Sampling Works and to the smelters and bullion by express is valued at \$1,500,000. Shipments of lead aggregate over 600 tons.

CLIMATE.

The climate of Mohave County is indeed delightful. In the mountains it is cool and exhilarating during the summer months, while in the valleys it never becomes oppressively hot. For an all-the-year-round climate it surpasses anything in the world, and some day in the not distant future it will be the resort of invalids from all parts of the country.

AGRICULTURE.

The amount of barley produced for the year ended June 30, 1899, was 200 tons; wheat, 100 tons; corn, 10 tons. On the Big Sandy and in many parts of the county a good business in the culture of bees has sprung up in recent years, and now there are over 800 stands.

HORTICULTURE.

In bearing orchards there are 40 acres in the county. The fruit is so well known that it readily sells in the outside markets at figures far in advance of the California products. Seven cents per pound is realized from the fruit delivered at Kingman. Peaches, figs, apricots, apples, nectarines, and grapes bring the same price. Little patches of land in the vicinity net the owners enormous profits.

SCHOOLS.

Mohave County boasts of more schools to the population than any county in the United States. Wherever the necessary number of children can be found there will also be found a school. There are 14 school districts, with 15 teachers. Kingman has a handsome brick schoolhouse capable of accommodating 200 children. Hackberry, White Hills, and Sandy have also good school buildings.

CHURCHES.

There are 2 churches in the county, and Kingman and White Hills are the proud possessors.

NEWSPAPERS.

There are 2 newspapers published in the county—the Mohave Miner (Independent) and Our Mineral Wealth (Populist).

HOTELS.

There are 14 hotels in the county.

UNDEVELOPED RESOURCES.

We would call the attention of our Chief Executive, and through him the Interior Department, to the great undeveloped wealth of our valleys, rich in nature's fertile soil, only awaiting the moisture of our mountain streams to make them yield a golden harvest. Mountain gorges there are in which to impound the flood waters sufficient to irrigate thousands of acres, and, were this not feasible, there runs through our northern border one of the mightiest streams on the continent—the great Colorado of the West. The water runs through the canyon like a tail-race and will generate millions of horsepower, and this power can be used in pumping water onto the uplands. Capital to carry out this immense project is all that is necessary to develop these millions of acres.

Hualapai Valley is overrun with the canaigre plant, and a factory to extract the tannic acid could be carried on successfully. Another industry that could be carried on here successfully is the production of cement from the immense gypsum beds along the Colorado River northwest of Kingman. Tanneries could be run successfully at any of the towns along the line of railroad.

STATEHOOD.

Our people are a unit in favor of statehood.

In conclusion, I would say to the worker that Mohave County offers an unexcelled field. In no place is the labor of the farmer, mechanic, or miner better repaid than here. There are thousands of mines open to location in our mountains, while our valleys are rich and unsettled.

Assessed valuation of property in Mohave County.

Cultivated land	\$28,335.00
Uncultivated land (112,000 acres)	22,400.00
Railroad land (535.396 acres)	112,555.83
Patented mines (99)	38,674.56
Improvements on patented mines	87,205.00
Improvements on unpatented mines	27,715.00
Town and city lots	46,037.00
Horses :	
Range (1,181)	23,620.00
Work (330)	16,500.00
Saddle (1,001)	35,035.00
Stallions (2)	100.00
Mules (14)	490.00
Asses (85)	425.00
Cattle, range (22,257)	222,570.00
Milch cows (87)	1,740.00
Bulls (3)	75.00
Sheep (14,573)	29,146.00
Goats (800)	1,600.00
Swine (105)	368.00
Railroad, standard gauge (108,076 miles)	270,190.00
All other property	263,252.55
Total	1,228,033.94

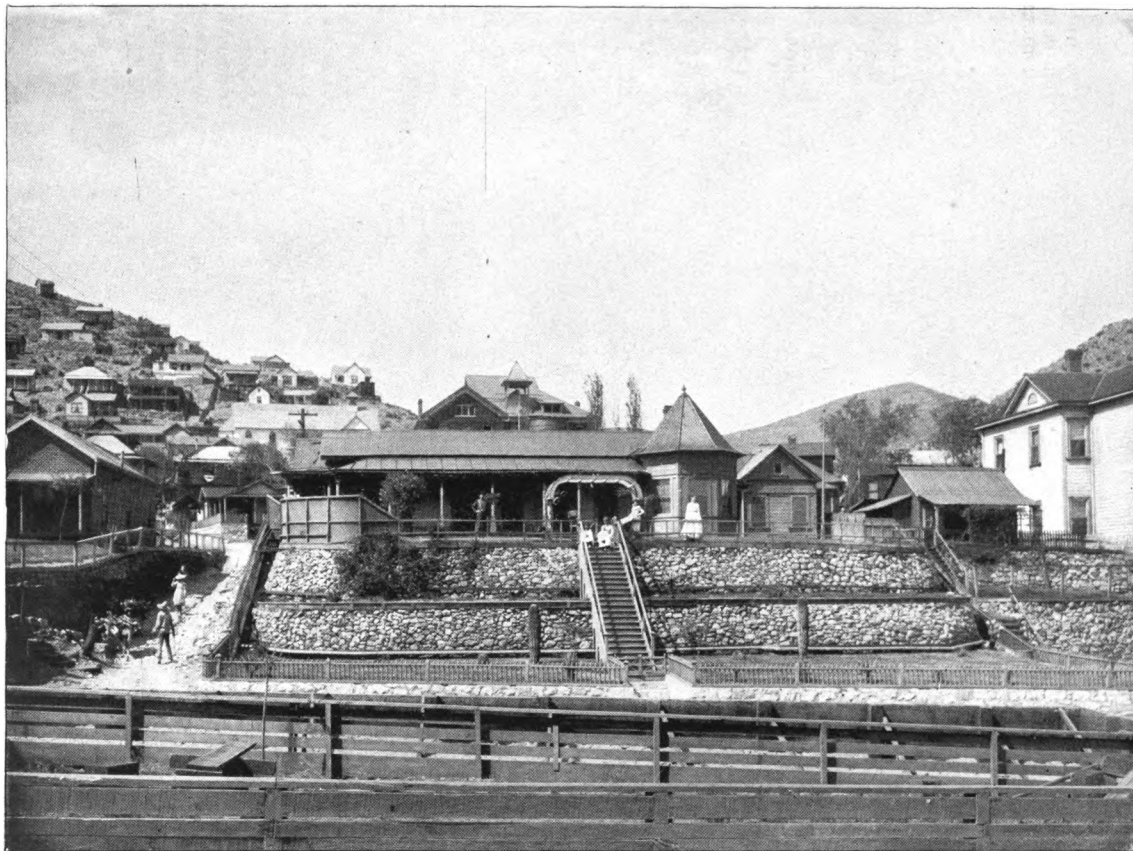
COCHISE COUNTY.

County seat, Tombstone.

County officers.—Supervisors: R. W. Barr, M. C. Benton, John Montgomery; sheriff, Scott White; treasurer, A. Wentworth; recorder, Frank Hare; district attorney, Edward W. Land; probate judge, W. F. Bradley; clerk board of supervisors, A. H. Emanuel.

Cochise County is in the southeast corner of the Territory. It was named for one of the Indian chiefs who formerly ruled the Territory within its boundaries. It contains many historic spots connected with the early settlement of Arizona and the Indian wars connected with that period. One notable trace of pioneer methods is the old Butterfield Trail, over which mail, express, and passengers were carried in the ante-railroad days by the "pony express." Mail and express was carried over this route between St. Joseph, Mo., and San Diego, Cal.; 20,000 horses are said to have been employed on the line. The climate is equable. Most of the surface of the county is sufficiently elevated to make the climate cool in summer and not severe in winter. Like nearly all portions of Arizona, Cochise County is mountainous.

The Chiricahua Mountain district is one of the wildest sections in the United States. Bear, deer, lions, and other varieties of wild animals roam here and multiply almost undisturbed. The mountain slopes are covered with a good growth of timber, which furnishes lumber to the mill man, stulls and lagging to the miner, and fuel to all classes, thus greatly assisting all industries. The rugged folds of their great ridges store water, which finds its way to the surface in springs, or flows underground at a small depth, which enables stockmen to raise it easily to water their herds. Many pleasant retreats are found beneath their sheltering cliffs and groves for persons seeking refuge from summer's heat. The different



BISBEE—RESIDENCE PORTION OF TOWN.

ranges serve as condensers, thus causing throughout the county a fair rainfall. During the year 1899 most parts of the county have been well favored with rains, and good feed, fat stock, and a fair crop of hay is the result.

While the soil of Cochise County is fertile, still, for lack of water sufficient for irrigation, the great need of the entire Southwest, the county can not make large claims as a farming county. However, along the streams and in many canyons hardy husbandmen have taken advantage of the natural facilities and are raising excellent crops of hay, fruit, melons, vegetables, and grain, all of which crops thrive wonderfully where enough water can be had to irrigate them sufficiently. It is, however, as a mining and stock-raising county that Cochise can boast. A great variety of ores are mined, including gold, silver, copper, lead, and wolframite. Roofing slate and some valuable building stones are also a part of her wealth. The Copper Queen Mining Company at Bisbee is one the leading concerns of the world for the mining of copper. Its works are located at Bisbee, and a railroad reaches them, which forms a junction with the Southern Pacific at Benson. The Copper Queen Company employs a veritable army of men, and the trade resulting from its employment furnishes business to a great number of other people and industries. Bisbee is the largest city in the county, having a population of about 5,000.

The Commonwealth and other mines owned by the Commonwealth Mining and Milling Company at Pearce are bonanzas. The revenue to the owners, from a conservative estimate, is \$500,000 a year, although the company does not need to employ more than 100 men. The capacity of the mill on the company's property has been increased from 20 to 50 stamps during the year.

The wolframite mines, as well as mines of other metals near Dragoon, have attracted a great deal of attention, and some important deals affecting them have been accomplished. There are a number of companies operating in that district, besides several individuals.

A stamp mill for treating ores has been reconstructed during the year at Dos Cabezas. Some placers in that district are also exciting interest, and some work is being done on them. Dos Cabezas, located 15 miles from Willcox, is one of the oldest mining camps in the Territory. Gold is the principal ore mined there, although others are found in paying quantities. Some important deals in mining property have been made there during the year.

Tombstone mines, after many years of almost total inactivity, are lately taking another start under the operations of lessees, some of whom are said to be doing extra well, while all are doing well. The people there are hopeful that the plan above mentioned may prove a complete success, and that those fabulously productive mines may again be turning out their mints of the white metal.

Everywhere throughout the county there is great activity in mining. At Turquoise, Barrett Camp, Middlemarch, Golden Rule, and other properties in the Dragoon district, extensive work in the way of extracting ores and developing properties is being done. A smelter at Barrett Camp will soon be operating upon copper ores. A stamp mill to work the ores of the Golden Rule, and to do custom milling also, has been erected at Cochise, a small station on the Southern Pacific, during 1899.

That men have confidence in the ore supplies of the county throughout is evidenced by the amount of work and money that is at present being expended in developing property, and sinking to discover ore bodies. Greater activity than usual has been shown in this direction during the past year, and the inquiries have been more numerous for mining property than for some time.

The cattle business has also been unusually and gratifyingly profitable. Good rains have fallen and prices have been excellent, and as a consequence stockmen feel like princes. Willcox still holds its place at the head of the list of cattle-shipping towns, having shipped 31,794 head to September 1; and still stockmen aver the number shipped can scarcely be missed off the ranges, so abundant are the stocks in Sulphur Spring Valley and on adjacent ranges. A great impetus has been given to the stock business by the excellent prices which have prevailed during the year. Extensive and valuable improvements in the way of increasing water supplies and improving ranch property have been made.

Although cattle raising takes the lead, still the raising of sheep, horses, and mules ought not to pass without mention in an article treating of the resources of the county. Valuable herds of sheep are grazed here, and the excellent prices obtained for wool and mutton swell the accounts of their owners.

A great many horses roam on the ranges as free as nature itself. Their chief use has been as saddle horses in handling all kinds of stock. However, horse owners are hopeful that the causes now influencing prices may make the breeding and raising of good, clean-limbed, hardy horses a paying business.

Cochise can claim first rank in stock raising. Her broad plains and great mountain areas, her wells and springs, creeks and rivers, her free grass and semi-tropical climate, all combine to make Cochise an ideal place for breeding and raising stock. Many of her best citizens are engaged in this industry and vast amounts of capital are invested in it. Many ranches and ranges, comparatively deserted for years, have been reclaimed during this year.

The county is as well governed as any other. As much vigilance is shown by officials in the pursuit of criminals as in any of the other counties, and as much moral reprehension is measured out to crime and immorality as anywhere else within Arizona. The county supports its public schools well, the expense of their maintenance for the coming year being estimated at over \$30,000. Churches are also recognized as a necessity to civic as well as religious life, and several different denominations receive the support of the people. It was thought that Cochise would be able this year to take rank again as a first-class county, but her hopes were disappointed, as the assessment fell a few thousand dollars short of the amount required to give her that rank. However, there has never been a year in the history of the county when there has been such an even and general advance in all substantial respects in the industries of the county.

Property has enhanced in value. The merchandise business has been profitable and enlarged in almost every case. Willcox has added electric lights and an ice and cold-storage plant. Benson has acquired a newspaper, the Benson Breeze by name.

Men who want employment are seldom turned away. A large hay crop will be harvested this year. The calf crop is large.

There are few, if any, counties in Arizona which present any greater variety of enterprises, a better opportunity for employment, or more flattering inducements to that class of home seekers who are willing to work for what they get and wait a reasonable time for results.

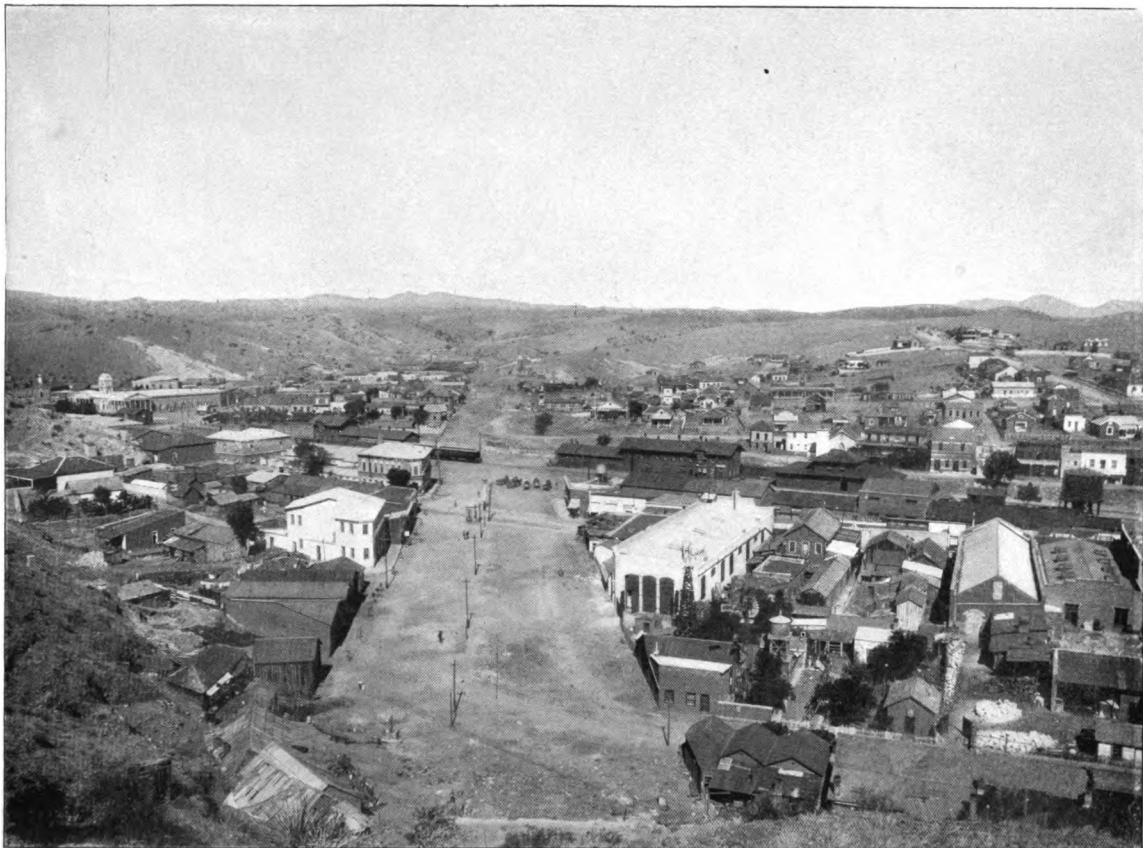
Assessed valuation of property in Cochise County.

Land (23,977 acres)	\$54, 657. 00
Improvements	79, 020. 00
Land grants (72,918 acres)	76, 417. 00
Improvements	310. 00
Patented mines (236)	17, 050. 00
Improvements	72, 874. 00
City and town lots (1,407)	27, 727. 00
Improvements	344, 369. 00
Horses :	
Range (1,858)	18, 620. 00
Work (956)	24, 856. 00
Saddle (1,096)	20, 091. 00
Stallions (19)	990. 00
Mules (119)	2, 975. 00
Asses (191)	1, 018. 00
Cattle :	
Range (66,477)	665, 620. 00
Graded (125)	3, 750. 00
Milch cows (123)	1, 935. 00
Bulls (55)	1, 039. 00
Sheep (6, 710)	13, 420. 00
Goats (427)	854. 00
Swine (90)	325. 00
Railroad, standard gauge (177.85 miles)	991, 948. 50
Pullman Palace Car Company	381. 20
All other property	555, 251. 00
Total	2, 974, 897. 70

SANTA CRUZ COUNTY.

County seat, Nogales.

County officers.—Supervisors, A. H. Noon, A. L. Peck, R. E. Rey; probate judge, Eb. Williams; sheriff, T. F. Broderick; treasurer, Fred Herrera; recorder, W. N. Cummings; assessor, Frank J. Duffy; surveyor, Charles E. Perkins; clerk board of supervisors, W. N. Cummings; district attorney, W. P. Harlow.



NOGALES, SANTA CRUZ COUNTY. SHOWING BOUNDARY LINE BETWEEN ARIZONA AND MEXICO.

Santa Cruz, the thirteenth and last county organized in the Territory, was created by act of the twentieth legislative assembly, approved March 15, last. It is also the smallest county, the area being approximately 1,200 square miles, and was formed by detaching the southern portion of Pima County, lying along the Mexican border.

The chief industries of the new county are mining and stock raising, the moderate amount of farming conducted being mostly confined to the lands immediately adjacent to the Santa Cruz River, which traverses the county from north to south. It is possible, however, to develop water so as to make a substantial increase in the agricultural area.

The county starts off under favorable auspices. The people are generally prosperous. As in all other portions of the Territory, the live-stock industry is in a splendid condition. In mining, the revival of interest is pronounced in all the districts. Nogales, the county seat, is growing steadily, and all the leading branches of business are prosperous.

The county is rich in mineral resources, and offers a tempting field for the prospector. There are many districts in which practically no development has been done, while indications are very promising. The districts in which the most development has been done are the Harshaw, Washington Camp, Lochiel, and Oro Blanco.

THE CITY OF NOGALES.

The modern history of Nogales dates from the construction of the New Mexico and Arizona Railroad from Benson to Nogales, in 1892. After that line was extended to Guaymas, on the Gulf of California, Nogales became an important port of entry and has steadily grown in importance.

Nogales—of which there are two, one in the United States, the other in Mexico, the dividing line passing along the center of a broad street—is unique and interesting in more ways than one. As a point of contact between two great nations, the “line city,” as it (or they) is familiarly termed, presents salient features and all the habits and customs of both nationalities. Citizens of both republics dwell there together in the closest accord and amity, and engage in social and business connection with an ease and facility which are pleasing to note and gratifying to the patriotic citizens of both countries.

Both governments have there the headquarters of districts in the collection of customs and important consulates. It is a division station upon the through line of railway from the Southern Pacific at Benson and the Gulf of California at Guaymas. The Arizona city is the seat of government of the newly created county of Santa Cruz, and there is a movement on the Sonora side of the line to remove from Magdalena to Nogales the government of the district of the same name. Besides the business naturally caused by being the gateway for an international and trans-continental traffic, Nogales is a very important and flourishing commercial point, the merchants of the place drawing trade from the rich and rapidly developing districts of Altar, Magdalena, and Arizpe, in the State of Sonora, Mexico, and from the equally rich and important regions of Oro Blanco, Duquesne, Harshaw, and Washington Camp, in Arizona. Many of the stores carry extensive stocks of goods, and the enterprise and push of the merchants are known and appreciated all over southern Arizona and northern Sonora. The country tributary is not only very rich in natural mineral resources, but the cattle ranges are among the best and most valuable in the Southwest, and Nogales is the seat of a large import trade in stock from the interior of the State of Sonora. The joint population of the two municipalities is nearly 5,000 souls, and in each there are fine graded schools with large attendance and thoroughly competent teachers, under whose tuition pupils make very rapid progress.

Situated at an altitude of about 4,000 feet, the climate is mild and equable, avoiding the excessive heat of summer in lower altitudes and experiencing but little really cold weather in winter. Bright and pleasant days follow each other in an almost endless succession, and the invalid and health seeker finds the climate unparalleled. Many of the leading citizens and officials in the State of Sonora and their families reside there several months in the year through the heated term. Many Americans operating or employed in mines and business in Sonora have their homes in Nogales, residing there for the educational and climatic advantages presented. Roads ramify in various directions, drawing a heavy trade, and the enterprising business men of the two cities are doing everything possible to improve, extend, and shorten the highways they now have and to construct new ones.

Some years ago the rich and productive Oro Blanco mining region was brought into close relation with the city by the construction of a wagon road, and now

money is being liberally subscribed to construct a good highway to the Cananea Mountains, about 50 miles to the southeast, where very rich copper and silver mines are producing abundantly. A survey for a railway is being made to connect Washington Camp and Duquesne with Nogales. Should the development of coal, now assured in Sonora, prove all that is anticipated, the rich copper mines in those two camps will consume great quantities of the fuel. Nogales will be the best place to transfer it from the line of the Sonora railway to the new line, and in that event the line city will be the junction point of the two roads.

Besides excellent schools, the line cities have 4 churches—2 Catholic, 1 Methodist, 1 Congregational—and the various fraternal societies have strong and flourishing organizations. The Masonic order has a handsome temple, the first erected in Arizona, and the Odd Fellows now have one in course of erection. The Masonic building is a two-story stone structure, and that of the Odd Fellows is likewise two stories, of brick. The Montezuma Hotel and several of the business blocks are imposing structures of brick and stone, and many private residences are very elegant in appearance and finish.

Like Phoenix, Tucson, and many more towns in Arizona, Nogales began as an "adobe town," afterwards changing to a brick and stone. It is now in the transitory stage, as was Phoenix a dozen years ago, and ere many years "adobes" will go out of use as building material. On the Sonora side of the line the Mexican custom-house and municipal palace are imposing structures. The Mexican municipal authorities have recently walled the arroyo running through the town and thrown across it two very fine iron bridges.

Recently the United States issued a patent for the town site on the Arizona side of the line, which has settled finally and completely all questions of title to property. This, in connection with the creation of the new county and location of the county seat, has given the town an impetus which is speedily bringing it to the front rank among Arizona cities.

Crittenden, Harshaw, and Washington Camp are small but prosperous communities.

Assessed valuation of property in Santa Cruz County.

Land (16,909 acres)	\$31,619
Improvements	15,580
Land grants (42,318 acres)	10,580
Patented mines (40)	35,000
Improvements	1,935
City and town lots	63,317
Improvements	170,130
Horses (1,933)	26,780
Mules (139)	5,060
Asses (39)	274
Cattle (14,394)	143,727
Sheep (20)	40
Goats (10)	20
Swine (81)	293
Railroad, standard gauge (52.04 miles)	195,976
All other property	237,655
Total	937,986

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LIST OF CONTRIBUTIONS TO THE GEOLOGY OF ARIZONA.

[Arranged chronologically from the catalogue and index by N. H. Darton, in Bulletin No. 127 of the United States Geological Survey.]

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1853. Geologic map of the United States, etc., Marcou, J.
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1863. Silver Mines of Arizona, Pumpelly.
1865. Iron Regions of Arizona, Blake.
1866. Some Mining Districts of Arizona, Silliman.
1868. Iron Ore in Northern Arizona, Blake, W. P.
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