the asteroid belt between Mars and Jupiter—the source of the twilight sky's "zodiacal light"—and from the extended Kuiper belt of cold, primitive objects beyond Neptune. SIRTF will spot faint wisps from such tenuous bands even around stars nearly as old as our sun, Meyer notes.

Meanwhile, another team led by astronomer Neal Evans of the University of Texas, Austin, will use SIRTF to examine newborn stars still tucked in their dusty nests or just fledging from them. Out to a distance of about 1000 light-years from Earth, says Evans, "we'll see anything forming a star, as well as substellar objects," such as brown dwarfs. "However the energy is getting out, we'll be able to study very small amounts of it."

Resolving the controversial origins of brown dwarfs (*Science*, 4 January, p. 64) is one aim of the survey, Evans says. The other key goal is to learn how long the gas and fluff girdling a new star remain available for planet formation. Planetary scientists disagree over the time scales and mechanisms needed for objects such as Jupiter to arise (*Science*, 29 November, p. 1698). By tracing the waxings and wanings of infrared patterns around a range of ordinary stars, SIRTF might steer that debate.

Some of SIRTF's science will hit closer to home. With part of its guaranteed observing time, Rieke's instrument team at Arizona will scrutinize scores of objects in the Kuiper belt. Astronomers have a poor grasp of the sizes of these icy bodies, because they must make assumptions about how much sunlight the objects reflect. SIRTF will detect their heat emissions directly; when combined with optical images, the data will pin down the objects' sizes and hint at their compositions. Leaders of a proposed mission to Pluto and the Kuiper belt will fine-tune their observing strategies based on SIRTF's results.

Observations from the telescope's major legacy programs will flow directly into a public archive after the SIRTF Science Center processes the data. In that way, astronomers may analyze images as they see fit, perhaps finding surprises that mission planners couldn't envision. This rapid public access—an aspect of SIRTF that all of the project's astronomers praise—will help scientists devise follow-up studies quickly enough to be conducted during the mission's second year in flight. After SIRTF's first 9 months in space, most of the observing time will be open to peer-reviewed proposals from all U.S. astronomers.

High-flying partners

SIRTF will have an active partner during its third year in 2005: the Stratospheric Observatory for Infrared Astronomy (SOFIA). Based at NASA's Ames Research Center in Mountain View, California, SOFIA consists of a Boeing 747 equipped to carry a 2.5-meter infrared telescope at high altitudes for 10 hours at a time. Chief scientist Eric Becklin of the University of California, Los Angeles, expects SOFIA to follow up on SIRTF's most compelling objects by using its large instruments to measure velocities, temperatures, compositions, and other properties in detail. The European Space Agency plans to launch its own advanced mission into deep space in 2007, a 3.5-meter telescope called Herschel. That instrument will focus on longer wavelengths of infrared light, which penetrate even deeper into dusty clouds.

The SIRTF team realizes that its work sets the stage for two of NASA's highest-profile space endeavors for the next decade: Hubble's successor, called the James Webb Space Telescope, and the Terrestrial Planet Finder. Both observatories will rely heavily on near-infrared vision. In that sense, says Carnegie's Dressler, SIRTF is not so much the denouement of NASA's Great Observatory program as the most logical prologue to the next act—a progression that probably wasn't foreseen when the Infrared Astronomy Satellite first scanned the sky 2 decades ago.

A final transformation awaits SIRTF: After launch, NASA will announce a new and presumably more graceful name, chosen from a national contest. If there's any justice, the name will honor someone as resilient as the oft-threatened telescope itself has been.

–ROBERT IRION

ARCHAEOLOGY

Oldest New World Writing Suggests Olmec Innovation

Inscribed characters that resemble those used in the later Maya script and calendar suggest that the Olmec were the first American scribes, boosting the theory that they heavily influenced later cultures

In A.D. 738, a minor lord in what is now Guatemala pulled off a staggering victory: Cauac Sky of Quirigua captured a powerful king, known as "18 Rabbit," beheaded him, and overran Copán, a major city in the Maya empire. Chronicled in inscriptions on numerous stone monuments at Quirigua, that upset is just one saga in a sweeping history recorded by the Maya in stone carvings for 7 centuries. Yet despite archaeologists' phenomenal success in deciphering Maya hieroglyphs, a fundamental aspect of this sophisticated civilization and its copious writings has always been a puzzle: their origins.

Think big. The Olmec were the first in Central America to build large cities. Pyramids, such as this one at La Venta, and monuments demonstrated their rulers' power.

CREDIT: CHRISTOPHER VON NAGY

Scarce finds from pre-Maya times have left archaeologists arguing whether key features of Maya civilization, such as writing and the sacred calendar, stemmed from a nearby culture called the Olmec or whether several early cultures contributed. Now on page 1984, a team of archaeologists describes two artifacts that preserve signs of script: fragments of stone plaques and a cylindrical seal that bear symbols known as glyphs. Dated to about 650 B.C., these are potentially the oldest evidence of writing in the Americas. Mary Pohl of Florida State University, Tallahassee, and her co-authors argue that one fragment names a king and a date, indicating that, as with the Maya, early writing was intricately involved with both royalty and the calendar.

For many archaeologists, the discovery, together with findings from new digs in even older Olmec sites, reinforces the notion that the Olmec was a "mother culture" and the primary influence on the later Maya and Aztec. "When the Olmec area was flourishing, there was nothing else like it," says archaeologist Michael Coe of Yale University. "This is the place where everything was innovated." The new glyphs add solid evidence to this longstanding theory, Olmec boosters say. "This is the oldest writing," says archaeologist Richard Diehl of the University of Alabama, Tuscaloosa. "It's the mother and father of all later Mesoamerican writing systems."

But other experts counter that the new artifacts are too fragmentary to resolve the enduring question of Olmec influence, or even how writing developed in Mesoamerica. Some question the fragments' age and whether they meet strict definitions of writing. Those who favor a model of "sister cultures," in which the Olmec were just one of a network of interacting cultures that all contributed to the development of key innovations, remain unswayed. "We strongly reject Olmec 'influence' on the ancient cultures of central Mexico," says archaeologist David Grove of the University of Florida, Gainesville.

Important date. The dotted symbol on this fist-sized seal, which is spoken by a bird, might be the oldest evidence for the Mesoamerican calendar.

The Olmec world

Several clues have long suggested that the Olmec were the first to develop crucial aspects of Mayan culture, including writing. "The mother-culture thesis is that the glories of the Maya are directly derivative of cultural attainments of the earlier Olmec," explains John Clark of Brigham Young University in Provo, Utah. According to this view, the large-scale Olmec architecture and monumental sculpture suggest that these people were the first in Mesoamerica to concentrate broad political power in the hands of a few. Linguistically, other Mesoamerican regions have apparently borrowed words related to writing and the sacred calendar from the precursor to the language now spoken in the Isthmus of Tehuantepec, the Olmec heartland.

But hard evidence of Olmec scribes is scant. In the major Olmec city of La Venta in the Gulf Coast region of what is now southern Mexico, researchers have uncovered two monuments containing a linear sequence of glyphs. But their age is unclear. They could be anywhere from 600 B.C. to 400 B.C., so they don't settle the question of when and where writing began.

Then in 1997, Pohl and her co-authors—Kevin Pope of Geo Eco Arc Research in Aquasco, Maryland, and Christopher von Nagy of Tulane University in New Orleans, Louisiana—began to dig at a smaller site known as San Andrés, 5 kilometers from La Venta. They uncovered a stratified deposit of floors, hearths, and trash heaps (*Science*, 18 May 2001, p. 1370). The layers of refuse contained many sherds of pottery, plus some real showstoppers: a fist-sized cylinder seal and engraved chips of greenstone a bit smaller than a thumbnail. Radiocarbon dating allowed the researchers to come up with a date, 650 B.C., for the engraved objects—an "amazing" achievement, says Clark.

These artifacts have features that the researchers interpret as symbols indicating words. For example, the greenstone fragments bear two inscribed oval glyphs that might be part of a columnar text, as are later inscriptions from the region. Inscribed on the cylinder is a single glyph and a bird's beak spewing two diverging lines. Pohl says that in later inscriptions from outside the Olmec heartland, human mouths also emit lines, in symbols called speech scrolls. At the end of the bird's scroll are U-shapes, a common ingredient in later Mesoamerican writing.

The speech scroll indicates that the inscriptions on the cylinder are more than just representational art, say Pohl and others. "The implication is that they are representing words or sounds of a language," says Martha Macri, a linguistic anthropologist at the University of California, Davis. The symbols are also not iconographic—they don't look like what they are supposed to mean—so they must be learned, Macri points out. "That's one of the hallmarks of writing," she says.

San Andrés treasure. The oval glyphs on these thumbnail-sized plaques arranged in a column on the righthand piece might be fragments of text.

The glyph on the cylinder is a U surrounded by an oval and next to three small circles. It resembles a Maya symbol with three dots called "3 Ajaw," a date in the Mesoamerican calendar. "I think it's definitely the day sign 'ajaw,' " says Coe, although others aren't so sure. If correct, this day sign coupled with a number are the first archaeological hints of the all-important 260-day Maya sacred calendar. And in Maya writing, ajaw means king as well as a date. Thus, Pohl reads the Olmec cylinder seal as the name "King 3 Ajaw," which makes sense because Mesoamericans were often named for the day of their birth. The San Andrés seal could have been used to print a royal message, the team says.

But some researchers question the age and meaning of the fragments. Radiocarbon dates for this period always have wide margins of error; thus, by radiocarbon dating alone, the San Andrés glyphs may range from 792 B.C. to 409 B.C. Von Nagy, the team's ceramist, says that associated pottery fragments helped narrow the range to between 700 B.C. and 600 B.C. And although Pohl argues that a glyph that was "spoken" is evidence of writing, linguists and epigraphers tend to have a stricter definition. They want to see columns or rows of glyphs with word order and syntax—far more than these fragments can reveal. "A few isolated emblems … fall well below the standard for first writing," says epigrapher Stephen Houston of Brigham Young University. "Show me a real text with sequent elements, and I'll be more convinced."

All the same, many researchers agree that even if these fragments aren't full-fledged writing, they document steps toward it. Pohl suggests, for example, that formatted rows and columns came later. "It's at the cusp between iconography and writing," agrees archaeologist Chris Poole of the University of Kentucky in Lexington.

The mother culture?

To Poole, all this fits with other emerging evidence that the Olmec played "a special role … in the development and dissemination of many cultural traits important for Mesoamerica." New data are making it clear that large populations and political structures developed first in the Olmec, he and others say.

For example, over the past decade, Ann Cyphers of the National Autonomous University of Mexico, Mexico City, and her colleagues have discovered that the early Olmec center of San Lorenzo in Veracruz, active from 1200 B.C. to 900 B.C., is much more sophisticated than previously thought. The main site, replete with monumental sculp-

CREDITS: (TOP TO BOTTOM) M. POHL *ET AL.*

tures of humans and felines, also featured an aqueduct that delivered spring water, plus a 100-square-meter "palace" with basalt drains. This might have been a seat of government, says archaeologist Kent Reilly of Southwest Texas State University in San Marcos. A survey of sites in the surrounding 800 square kilometers suggests that Olmec power extended far beyond the capital. For example, a site strategically located near the confluence of two rivers has thrones that are smaller than those at San Lorenzo but decorated in a similar fashion. "The way the settlement works on a regional level, we really think it was an incipient state," says Cyphers.

Despite this apparent concentration of political power, opinions remain divided on the Olmec share of influence. Scholars who favor the "sister culture" view note that the Olmec borrowed pottery styles from elsewhere, and that there was a bustling trade in goods such as obsidian tools and jade ornaments throughout ancient Mesoamerica. Grove of the University of Florida agrees that many cultures were active. And the new writing fragments are not enough to change the views of these scholars. Even if the glyphs are ancient, Grove, for one, isn't convinced that the La Venta area was necessarily the first site of writing. "I don't think it shows the Olmec invented it. It could have originated anywhere around that southern region," he says, especially because the seal and plaques were easy to transport.

There's also evidence that other Mesoamerican cultures were experimenting with writing, possibly at about the same time. Joyce Marcus and Kent Flannery of the University of Michigan, Ann Arbor, excavated a monument from San José Mogote, made by the Zapotec culture centered in Oaxaca, about 300 kilometers from La Venta. But although Marcus dates this monument at 600 B.C. to 500 B.C., Pohl and others are skeptical of that age. Archaeologist Javier Urcid of Brandeis University in Waltham, Massachusetts, says the Zapotec monument contains a day-name glyph, which he considers writing. He thinks the greenstone plaques from San Andrés are writing too, and they might have been invented independently. "Even if writing did originate in a single spot, I don't think we'll ever be able to find it," he says.

Whatever its origins, Mesoamerican writing flourished in the centuries after these early inscriptions began to appear. Even defeat did not stop the scribes, at least for long. Eleven years after the defeat of 18 Rabbit, for example, a new ruler of Copán tried to wipe away the bitter memory with a grand history of his city's warrior kings—the longest hieroglyphic text known from the New World.

–ERIK STOKSTAD

DIGITAL INFORMATION SYSTEMS

Mapping the Future

With its topographic maps falling rapidly out of date, the U.S. Geological Survey has begun drafting an ambitious National Map—online

It wouldn't have stopped the wildfires that swept the western United States last fall. And it certainly wouldn't have prevented the crash of United Airlines Flight 93 into a Pennsylvania field on 11 September 2001. But a digital topographic map of the United States would have given firefighters fresh information about new neighborhoods threatened by the blazes, and it would have helped relief workers identify the plane crash site more quickly. That's the idea behind the fledgling National Map program at the U.S. Geological Survey (USGS), which aims to put such up-to-date, high-quality topographical data at the fingertips of anyone who wants it.

An online National Map promises to deliver continuously updated data—from elevations to rivers to geographic boundaries—for all the roughly 3000 counties across the United States. So far, eight pilot projects are under way; USGS officials hope to assemble the entire map with local partners over the next decade.

But although industry insiders say that the map is a smart idea, collecting and maintaining all these data are daunting tasks. "The real challenge is doing this in any extensive way, in a country as large and diverse and changing as the U.S.," says James Plasker, a former USGS executive and now executive director of the American Society for Photogrammetry and Remote Sensing in Bethesda, Maryland. "That's a huge organizational challenge," says Plasker, who is not alone in wondering if USGS can pull it off.

A new direction

USGS is an old hand at topography. Soon after its founding in 1879, pioneering cartographers fanned across a rugged landscape, mapping the horizon on portable drawing boards called plane tables. Over the years, the survey incorporated the latest mapmaking tools, such as aerial photography.

Surveying the scene. Early USGS mappers used plane tables and alidades to get the lay of the land.

CREDIT: USGS

By the late 1980s, when USGS finished mapping the entire country at an estimated cost of $1.6 billion and 33 million work hours, the survey's 55,000 "topo maps" had become standard tools for hikers, urban planners, and relief workers such as the Red Cross, among other consumers. As USGS's priorities shifted toward scientific research, however, its mapping program languished. As a result, while towns went boom and bust and landmarks such as airports, buildings, and parks spread and dwindled, the topo maps lagged further and further behind the landscape they represented. Today, the maps are only sporadically updated, and some are 57 years old.

"We just don't have the money to maintain a robust revision program," says William Flynn, chief of USGS's Mapping Partnership Office in Austin, Texas. In the early 1990s, USGS tried a foray into electronic mapping, with a project to collect basic geographic information for governments and land developers to share, but the computer networks then available weren't up to the job. "They've been wandering in the desert for a decade or so, trying stuff that didn't quite work," says Donald Cooke, founder of Geographic Data Technology Inc., a map database developer in Lebanon, New Hampshire. "Now, somehow