Ancient American Text Gets New Reading

Workers building a riverside dock near the southeastern Mexico settlement of La Mojarra in November 1986 literally stumbled upon a huge rock that they dragged from its muddy bed. The roughly 6½-foot-high, 4½-foot-wide slab displays a carving of a standing man sporting an elaborate headdress and costume, bordered on the top and one side by 21 columns of hieroglyphic writing.

Two investigators now report that they have deciphered much of the story on the four-ton stone, making it the earliest known readable text in the Americas.

The language of the ancient inscription, which dates to A.D. 159, served as the ancestral tongue of four closely related languages now spoken in southern Mexico, the scientists assert. Moreover, the script bears a close relationship to Mayan hieroglyphics, which emerged after A.D. 250 in the vicinity of the Yucatan Peninsula, they contend.

"Tentatively, we think several conventions of Mayan hieroglyphics were already developed in the script portrayed on the La Mojarra stone, which the Maya adapted and then developed on their own," argues John S. Justeson, an anthropologist at the State University of New York at Albany. He and Terrence Kaufman, a linguist at the University of Pittsburgh, have deciphered about two-thirds of the La Mojarra text over the past two years.

Several other, less complete examples of writing by "epi-Olmec" cultures, which date from 150 B.C. to A.D. 450 in southern Mexico, have also been found. But only the La Mojarra stone contains enough legible script to allow full-scale decipherment, the investigators say.

Elements of Mayan and epi-Olmec scripts apparently descended from a common ancestor, perhaps the more rudimentary and poorly understood written symbols of the Olmec civilization, which existed from around 1200 B.C. to 500 B.C. in Mexico, Justeson maintains.

The new report, published in the March 19 SCIENCE, supports the view that the earliest scripts developed relatively gradually and challenges the notion that sudden bursts of innovation produced the first writing systems (SN: 3/6/93, p.152).

Justeson and Kaufman employed several tactics to understand the La Mojarra script. First, Kaufman reconstructed the ancestral tongues of the two groups of languages now spoken in the area of Mexico surrounding La Mojarra. Linguists base this work on shared vocabulary and placement of key sounds across languages (SN: 6/9/90, p.360). Kaufman determined that the inscriptions belonged to a language related to the modern Zoquean tongues. This allowed the scientists to decipher some signs for consonant-vowel sequences and better understand the script's grammatical structure, such as the placement of verbs relative to nouns.

They also relied on comparisons with a short text on a statuette discovered nearby that dates to A.D. 162.

Previously deciphered Mayan writing offered further clues to word meanings and stylistic practices in epi-Olmec script. Other lines of evidence included the repeated placement of specific signs that could be linked to certain words.

Of the approximately 150 hieroglyphic signs on the stone, Justeson and Kaufman provide translations for about 100. The meanings of the remaining signs, as well as some strings of signs that denote words, remain unknown, Kaufman says.

The La Mojarra text largely refers to an elite group that supported the king pictured on the stone, Justeson argues. At several points, however, the text – which covers a 15-year period – directly quotes the king.

An elaborate story of power politics emerges, in which the king's supporters help repel attempted usurpers of the throne from within the kingdom. The king's elite allies then describe punishment meted out to enemies, including the king's brother-in-law.

Maya stone monuments offer much less detail about kings and their activities, Justeson notes. "Epi-Olmec royal power seems much more dependent on prominent public involvement of key elite supporters, but this text will undoubtedly fuel much speculation," he says.

Some researchers who have examined the La Mojarra stone, such as archaeologist Sylvia Meluzin of California State University, Fullerton, argue that too little knowledge exists about Mayan writing and the nature of epi-Olmec signs to justify the amount of deciphering claimed by Justeson and Kaufman.

"We'll need time to see if their assumptions pan out," Meluzin contends.

Further study of modern languages spoken in southern Mexico – and continued archaeological finds – will contribute to a better understanding of epi-Olmec script, Kaufman asserts. *– B. Bower*

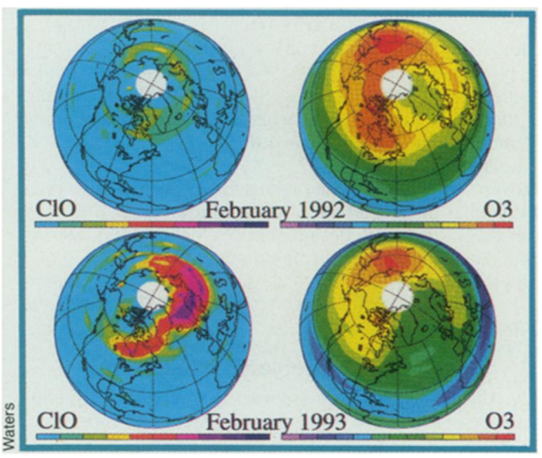
Northern hemisphere ozone hits record low

The north has taken center stage in the fast-moving global ozone drama. Six months ago, world attention focused on the extreme south when atmospheric scientists reported that the yearly ozone hole over Antarctica had expanded over a record area. Now the spotlight has shifted to the opposite end of the Earth as researchers announce finding substantially less than normal ozone over much of the northern hemisphere during the last three months.

Rumen D. Bojkov, an atmospheric scientist with the United Nations' World Meteorological Organization in Geneva, reports that concentrations of stratospheric ozone measured 9 to 20 percent below average in the middle and high latitudes of the northern hemisphere during December, January, and February. Ozone concentrations were even lower this year than last, when they also measured well below the average for the last 30 years, says Bojkov, who analyzed ground-based measurements as well as some data from U.S. satellites.

"To have two years in a row that hit [such] values is clearly extraordinary," Bojkov says.

The recent northern thinning is the latest chink to appear in the stratospheric ozone armor, which protects Earth's surface from harmful ultraviolet radiation from the sun. British scientists reported



In the left column, maps of chlorine monoxide (ClO) measured by the UARS satellite show the Arctic had much more of the ozone-destroying chemical in February 1993 than in February 1992. Right figures compare average ozone concentrations from February 15 through March 6 in both years, with red and orange indicating greatest amounts. Concentrations for 1993 were lower than those for 1992.

the first signs of weakness in 1985, after discovering that the stratosphere above Antarctica loses a large fraction of its ozone each year during September and October, a phenomenon dubbed the "ozone hole."

After several expeditions to Antarctica, scientists gathered proof linking the ozone hole to chlorofluorocarbons and other pollutants that carry destructive chlorine and bromine high into the stratosphere. In the frigid Antarctic, these chemicals eat away half the ozone in the sky during the southern hemisphere's springtime.

In 1987, researchers discovered a less obvious but more pervasive ozone thinning around the globe. The stratosphere over all regions except the tropics has lost a few percent of its ozone since 1979—a trend also attributed by scientists to chlorine and bromine compounds.

Bojkov thinks that such chemicals caused much of the dramatic ozone thinning over the northern hemisphere this winter, but other factors also contributed, he says. Meteorological data suggest that air movement played a role in setting up the ozone pattern. Masses of tropical air, naturally low in ozone, spread north during winter, lowering ozone concentrations above Europe and other regions, Bojkov says.

U.S. scientists who monitor ozone-sensing instruments on several satellites confirm that northern hemisphere ozone concentrations, which normally increase in winter, did not rise as much as in previous years. Measurements made by the Upper Atmosphere Research Satellite (UARS) also support the idea that destructive chemicals helped thin this winter's ozone. From December through late February, the craft observed extremely high concentrations of ozone-eating chlorine monoxide over much of the Arctic and surrounding regions, says UARS scientist Joe W. Waters of NASA's Jet Propulsion Laboratory in Pasadena, Calif.

From past studies, atmospheric researchers have come to know chlorine monoxide as the chief villain that attacks ozone in the Antarctic. Normally, chlorine in the stratosphere is bound in inactive molecules that cannot destroy ozone. But the cold Antarctic stratosphere contains icy particles that provide a surface on which inactive chlorine compounds can convert to harmful chlorine monoxide.

In early February of last year, scientists involved in a major research project expressed dismay at finding extremely high concentrations of chlorine monoxide in the Arctic stratosphere—an indication that the atmosphere of the north was primed to destroy ozone. If temperatures were to remain cold for several weeks, they predicted, sunlight and chlorine monoxide could combine to munch away a significant fraction of the Arctic ozone, perhaps even generating an ozone "hole" in the north. Soon afterwards, however, the atmosphere warmed, saving the Arctic from major ozone loss at that time.

The events of this winter apparently vindicate predictions made last year. Temperatures in the polar stratosphere stayed cold a month longer than last year, and high concentrations of chlorine monoxide persisted longer as well. As if on cue, ozone levels remained well below normal, hitting record lows for the month of February.

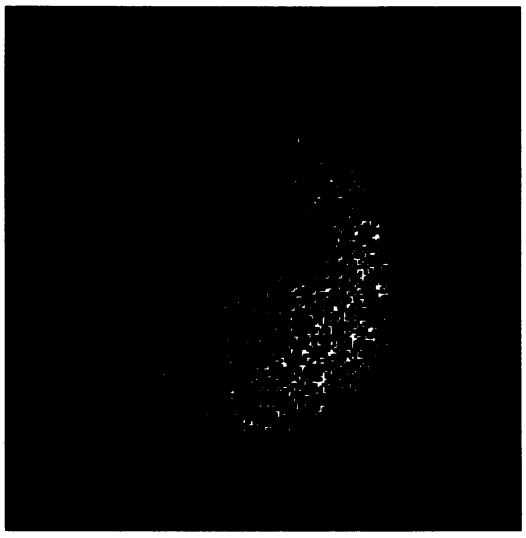
"Last year was the warning; this year it happened," says Mark R. Schoeberl of NASA's Goddard Space Flight Center in Greenbelt, Md.

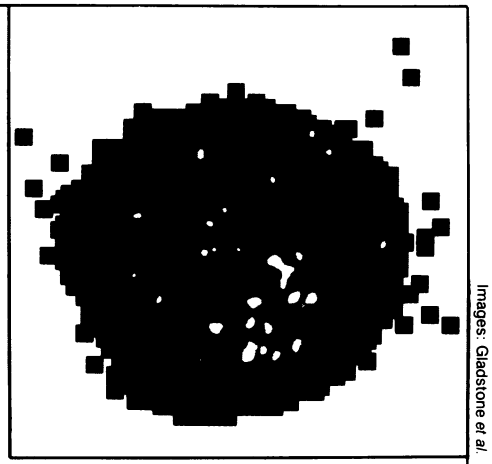
The combination of destructive chemicals and meteorology, however, did not create an Arctic ozone hole, because ozone is normally quite abundant in the higher latitudes of the northern hemisphere during winter. Even with concentrations well below average for this time of year, ozone remained plentiful in the sky during the last few months, providing what was probably adequate protection against the weak winter sunlight, scientists say.

But the current deficit could leave ozone levels lower than normal later in the year, when more ultraviolet radiation streams through the northern hemisphere skies, Schoeberl says. —*R. Monastersky*

The moon beams in extreme ultraviolet

Scanning the cosmos for emissions in an elusive part of the electromagnetic spectrum, a U.S. spacecraft has captured the first images of the moon aglow in the extreme ultraviolet. Astronomers presented the images this week at the annual Lunar and Planetary Science Conference in Houston.





Images: Gladstone *et al.*

The Extreme Ultraviolet Explorer (EUVE), launched last June, detects this band of radiation, which can't penetrate Earth's atmosphere and is intermediate in energy between the near ultraviolet and X-rays (SN: 5/23/92, p.344). While the craft devotes most of its time to studying the atmospheres of stars many tens of light-years beyond the solar system, it has cast its eye on an object closer to home.

In August, the EUVE recorded extreme-ultraviolet light reflected from the first-quarter moon (see left image above). And in December, the Earth-orbiting craft recorded extreme-ultraviolet light reflected from the full moon (right). In both of these false-color images, yellow denotes the highest intensity, blue the lowest. In the full-moon image, the brightest areas coincide roughly with lunar highlands, while the dark areas align with lava-covered plains known as maria.

Randy Gladstone, a member of the EUVE research team at the University of California, Berkeley, notes that the extreme-ultraviolet glow stems from solar radiation striking the lunar surface.

The glow consists primarily of extreme-ultraviolet photons from the sun that bounce off the moon, he says. But some of the emissions might result from solar X-rays that are absorbed by atoms on the moon's surface, causing them to fluoresce at the lower energies associated with specific wavelengths in the extreme ultraviolet.

Gladstone says that spectra of the moon's ultraviolet emissions, already taken by the EUVE but not yet analyzed, should indicate how much of the moonglow comes from reflected light and how much from fluorescence. If fluorescence contributes significantly to the moon's ultraviolet emissions, then such images would provide a new tool for uncovering the relative abundance of elements on the lunar surface, Gladstone says. —*R. Cowen*