

## Hatching a method of eggshell dating

When scientists at an archaeological site in the African nation of Botswana started probing the layers of sediment that were too old to date by the carbon-14 decay method, they turned instead to ostrich eggshells. Edward Hare of the Carnegie Institution in Washington, D.C., Julie Kokis of George Washington University in Washington, D.C., and co-workers found fragments of eggshells scattered throughout the stratigraphic record at the #Gi site in the northern Kalahari Desert. The researchers, who presented their findings last week at the Geological Society of America meeting in Reno, Nev., suspect that like the !Kung people today (SN: 7/30/77, p. 74), past tribes used the eggshells of the African ostrich (*Struthio camelus*) as water containers and for bead making.

Hare's group dates the layers containing eggshells by analyzing the amino acid content of the shells. Amino acid molecules can have either a right-handed (D) or left-handed (L) symmetry. In biological materials like skin and hair, he says, the amino acids are all of the L form. But neither the D nor the L form alone is stable; in a process called racemization, a completely left-handed sample will convert over time to a mixture of D and L. Hare's group has tracked this process in the laboratory and has shown that it can be accelerated by increasing the temperature. The ratio of the amount of the D form to the L form then gives scientists an indication of how long the eggshell has been around.

The researchers were most interested in pinpointing the endpoint and duration of the Middle Stone Age (MSA) at the Botswana site. At best, all that could be concluded using carbon-14, which has a half-life of about 5,700 years, was that the age of the MSA layers exceeded 40,000 years. The eggshell data suggest that the MSA ended at least 80,000 years ago. The technique also shows researchers that the MSA began later at the #Gi site than some archaeologists had previously thought; the amino acid ratios indicate that people occupied the region for only a few thousands of years during the Middle Stone Age.

While eggshell contains much less organic matter than do bone and other biological materials that might get buried at a site, it retains its protein for a longer time. Bone is very porous, and every time it comes in contact with water, the organic matter is flushed out. Hare's group tested the "tightness" of eggshell by putting samples in either water or water vapor for a week and heating them to speed up the decay process. The researchers found that water can percolate into the eggshells, but nothing comes out.

Hare says that for the temperatures typ-

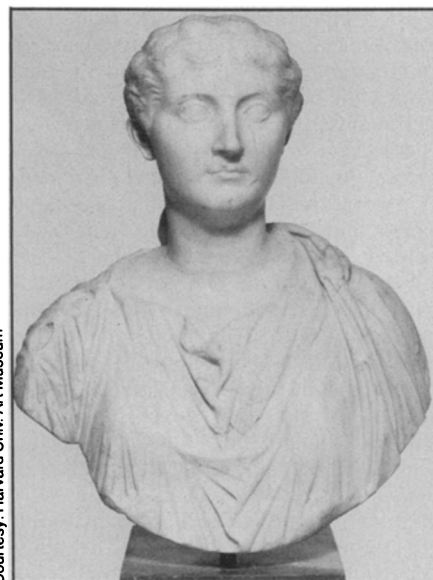
ical of the Kalahari, the racemization ratios can be used to date shells up to 150,000 years old. But he adds that there are still many amino acids involved in other reactions that could be used to date

shells even older. This technique might also be used for other materials, including clams and mussel shells. "There's a lot of potential we haven't tapped yet," he says.

—S. Weisburd

## Science for art's sake: Five easy pieces

One of the casualties of the sacking of Rome was a bust of Antonia Minor, the mother of Claudius Caesar. But by 1678, when the eighth Earl of Pembroke brought the statue to England, it had been reassembled, presumably from the original materials, and looked good as new. Three hundred years later, however, archaeologist Patricia Erhart Mottahedeh suggested that the bust wasn't all that it seemed. Some of the drapery pieces were forgeries, she claimed, because the tool that made them was used only during the Renaissance.



Antonia Minor

Courtesy: Harvard Univ. Art Museum

Upset, the curators of the Fogg Museum at Harvard University, which currently owns the statue, called on Norman Herz and co-workers, now at the Center for Archaeological Sciences at the University of Georgia in Athens. After a bit of scientific sleuthing, Herz's group showed that the bust had indeed been assembled from five pieces of marble that were originally unrelated. Herz concluded in a presentation last week at the Geological Society of America meeting in Reno, Nev., that in all probability only the head section is the genuine article.

The researchers used a technique first suggested in 1972 in which the abundance of stable isotopes, typically those of carbon and oxygen, are measured. Each quarry, with its own geological history, has a distinct signature given by ratios of carbon-13 to carbon-12, and oxygen-16 to oxygen-18. Herz and other scientists have analyzed the carbon and oxygen isotope content of 528 samples collected from 39

quarries in Turkey, Greece, Italy and Tunisia—all thought to have been sources of marble traded in ancient times. By treating these data statistically and comparing them to the isotope makeup of marble samples of unknown origin, Herz and William Hayes, also at the University of Georgia, can estimate the chances that the marble came from a particular quarry. However, they must first narrow down the number of quarries to those in the general region in which the statue is thought—on the basis of other archeological clues—to have originated.

As for Antonia Minor, the researchers found that her ponytail and lower right shoulder probably came from the Carrara quarry in Italy, although the two pieces did not come from the same chunk of marble. The left and right shoulders and the head are probably made from Parian marble (Greece)—the highest-class marble, typically used for emperors and their entourage—but the head appears to be unrelated to the other pieces. "The head is probably authentic, so the museum is very happy," says Herz. "For a museum it makes a piece more interesting actually."

Herz and Hayes tested the reliability of their analysis by applying it to samples of known origin. The confidence level depends on the quarry. For Carrara and Thasos (Greece), for example, 91 percent of the samples were correctly identified. In the atypical and worst case, 70 percent of Hymettos (Greece) samples were incorrectly assigned.

—S. Weisburd

## The zeta vanishes

In a famous story, *The Lady Vanishes*, a woman comes down with bubonic plague while traveling. The authorities, wishing to avoid a public panic, make her disappear and even alter the physical surroundings to convince witnesses that she never existed. Nature sometimes plays similar tricks. Last August, physicists working in Hamburg caused great excitement by reporting an unusual new particle they called zeta (SN: 8/11/84, p. 84). More recently, at the meeting in Santa Fe, N.M., of the Division of Particles and Fields of the American Physical Society, both the Crystal Ball group and a group working at the Cornell Electron Storage Rings in Ithaca, N.Y., reported that new searches could not find the zeta. Several theorists had come to Santa Fe prepared to tell what they thought the zeta was. Said one the next day: "I tore up the transparency on which I had written that part of my talk." □