Devil's Hole Fires Ice Age Debate

For a couple of years in the early 1980s, it seemed scientists had built a strong case supporting the idea that cyclic changes in the Earth's orbit were the driving force behind the most recent ice ages. But recent work has complicated the picture, leading some to question the importance of orbital influences. Geologists now report evidence that could force the once well-accepted orbital theory to go the way of the woolly mammoth.

The new finds come in the form of calcium carbonate layers that have built up over hundreds of thousands of years on the walls of an underwater cave called Devil's Hole in the southern Nevada desert. After retrieving a sample of the mineral, investigators from the U.S. Geological Survey (USGS) analyzed oxygen-isotope ratios within the calcium carbonate. The isotopes provide a record of surface temperatures in the Devil's Hole area for times between 50,000 and 300,000 years ago, according to the researchers.

As one of the longest uninterrupted climate histories for a continent, the Devil's Hole evidence directly conflicts with marine records that support the orbital theory. "Our record would suggest that they [orbital changes] are not influencing the timing of the glacial cycles," says USGS researcher Isaac J. Winograd. Winograd and Tyler B. Coplen from Reston, Va. worked with Denver colleagues Barney J. Szabo and Alan C. Riggs. They report their findings in the Dec. 2 SCIENCE.

This record does not rule out the possibility that orbital shifts, which alter where sunlight strikes Earth, play some secondary role in driving the ice age cycle, Winograd says. "It means that they are not the pacemaker that has been claimed in the last decade."

During the last 700,000 years, Earth's climate has swung episodically between relatively warm times like the present and generally colder periods when thick ice sheets spread over the northern parts of America, Europe and Asia. While scientists from various disciplines have tried for 150 years to explain the climate cycle through changes in the Earth's orientation, the orbital theory is often credited to Milutin Milankovitch, a Serbian mathematician from the early 20th century.

In the last two decades, researchers have compiled detailed chronologies of the climate from isotopes in deep-sea sediments, which record global sea levels and hence the amount of ice on Earth. Some of these records placed great weight behind the Milankovitch theory by revealing that the growth and death of ice sheets corresponded extremely well with cyclic orbital changes. For example, the sea record shows the second to last ice age ended about 127,000 to 130,000 years ago when Earth's orbit and spin allowed the greatest amount of summer sunlight to reach northern latitudes.

The Devil's Hole chronology, however, dates this climate warming at least 17,000 years earlier—a time out of sync with the orbital theory, says Winograd.

"If they are correct, then the evidence for the Milankovitch theory is greatly diminished," admits John Imbrie of Brown University in Providence, R.I., one of those who developed the marine record that supports the orbital theory. Yet he adds that interpretation of the Devil's Hole climate record will require much more work. "Their evidence is for events in Nevada and one obvious question is how do the events in Nevada relate to sea level and global climate."

The USGS group believes the Nevada temperatures have global significance because the shape of their climate curve closely parallels the contours of the two other long-term records: the marine sea-level chronology and a temperature record for Antarctica derived from oxygen isotopes in ice cores (SN: 9/17/88, p.184). Although all three show roughly the same swings in climate, the Devil's Hole record just dates them earlier, says Winograd. The USGS team claims the most accurate dating, having used two different sets of radioactive elements in the calcium carbonate to establish the timing of climate changes.

– R. Monastersky

Cadmium may speed bone loss in women

Cadmium exposure may speed bone loss in postmenopausal women and may be one factor leading to osteoporosis, a porous bone disease that afflicts about 20 million Americans. The new research may help explain the increased risk of osteoporosis faced by older, female smokers exposed to cigarette smoke, which contains cadmium.

Many factors contribute to osteoporosis, which frequently strikes women who experience a drop in estrogen due to menopause. Estrogen is the female sex hormone that, among other things, protects against bone loss. The body is constantly tearing down and rebuilding bone. Victims of osteoporosis lose more bone than they replace and eventually have such porous bones that normal activities can lead to a fracture.

Cadmium has been linked to postmenopausal bone disease in Japan, where women living in the Jintsu River basin developed a painful bone disease known as Itai-Itai (which means Ouch-Ouch). Epidemiologic studies in the 1960s pointed to cadmium as a causative factor. The women lived downstream from a zinc and lead mine that had dumped cadmium into the river water, which was used for drinking and irrigating rice paddies. Even though men, young women and children were exposed to the cadmium, 95 percent of Itai-Itai cases developed in post-menopausal Japanese women.

Maryka H. Bhattacharyya, a biochemist at the Argonne (Ill.) National Laboratory, and colleagues speculated that cadmium may accelerate bone loss in menopausal women who lack estrogen's protective effect. To test their theory, the research team developed an animal model. They fed female mice diets containing cadmium chloride at either 0.25, 5.0, or 50 parts per million (ppm). The 0.25 group received an amount of cadmium that is biologically equivalent to human environmental exposure. The 5.0 ppm mice got amounts roughly equal to that ingested by the Itai-Itai victims. Mice getting 50 ppm cadmium got 10 times the Japanese exposure. After one year, the mice either had their ovaries surgically removed to mimic the onset of menopause, or got a sham procedure in which the ovaries were left in place.

In the November PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES (Vol. 85, No. 22), the researchers report the 50 ppm cadmium diet caused "significant" bone loss in mice without ovaries. Calcium contents of the femurs and vertebrae of these mice were "strikingly lower than those of nearly all other groups," the authors report.

In a separate part of the study, the team bathed fetal rat bone in a medium that contained cadmium in amounts similar to that found in smokers' blood. The cadmium cultures showed a 70 percent loss of bone as compared with a 25 percent loss for control samples. The finding suggests cadmium directly stimulates bone loss.

The new finding provides a plausible explanation for the fact that female smokers experience more bone fractures and tooth loss than nonsmokers. Smoking is known to boost bone loss by decreasing estrogen levels, but Bhattacharyya's work suggests the cadmium in smoke enhances that effect.

– K.A. Fackelmann