EARTH SCIENCE

In Ancient Climate, Orbital Chaos?

Paul Olsen has found an unusual place to study the evolution of the solar system: central New Jersey. Specifically, he is examining a set of boreholes in the sedimentary rocks of the Newark Basin. By looking at patterns of banding in thousands of feet of drill cores, the paleontologist can read the history of lakes that filled the Newark Basin more than 200 million years ago. And in the climate cycles responsible for the banding, he thinks he can see a trace of the changing orbital dynamics of Earth and Mars.

The climate cycles themselves are no great surprise. Researchers have long known that periodic variations in the shape of Earth's orbit and the orientation of its spin axis can alter climate by affecting the quantity and distribution of the sunlight reaching the planet. The 22,500 feet of shales Olsen, Dennis Kent, and colleagues from Columbia University's Lamont-Doherty Earth Observatory recovered from the boreholes show that most of the cycles in recent geologic history were also operating 200 million years ago, along with others that have so far only been calculated (*Science*, 31 May 1991, p. 1254).

What is surprising, however, is that one of the longest cycles, lasting about 2 million years, doesn't fit the predictions. At least one cyclical change in Earth's orbit happened on a different schedule then than it does now, Olsen suspects, probably because of a slightly different gravitational interplay between Earth and Mars. Says Olsen, "It appears from the rock record that Earth and Mars...were acting a little bit differently."

Though other researchers aren't yet convinced by Olsen's preliminary analysis, which he presented in a talk last fall at Lamont, they are intrigued by the prospect of learning about the evolution of the solar system from ancient climates. Says paleoclimatologist Andre Berger of the Catholic University of Louvain, Belgium, "I strongly support the initiative of having past climates telling us something about the astronomy of the past."

There are few better places to study ancient climates than the Newark Basin, where the Lamont workers drilled their cores in 1991. When the rocks there were formed, more than 200 million years ago, the basin resided in the tropics. As astronomical cycles influenced sunlight, monsoon rainfall waxed and waned. During wet periods, the deep lakes would have yielded black, organic-rich sediments. In dry periods, the lakes would have been shallow and intermittent, with reddish sediments that are poor in organic residues.

The result was a 25-million-year climate diary written in sediment color. Mathematical analysis of the banding shows that the lakes filled and shrank over periods of about 20,000 and 100,000 years—roughly the cycles known from recent climate records. The Newark Basin record also captured a 400,000-year cycle of change in the eccentricity of Earth's orbit, which is hard to see in more recent climate records. And it revealed a much longer eccentricity cycle, thought to arise from the gravitational interplay of Earth and Mars, that intensified the shorter cycles of wet and dry every 2 million years or so. "It's never been shown to exist before," says Olsen, "which isn't too surprising since most drilling records aren't that long."

The surprise is that this longer cycle in the Newark record doesn't have the period called for by calculations based on current solar system dynamics: 2.3 million years. Instead, says Olsen, "When you do a Fourier analysis you get 1.8 million to 1.9 million years."

Olsen ascribes the discrepancy to the evolution of the solar system, a slow, chaotic process that astronomer Jacques Laskar of the Bureau des Longitudes in Paris and others have explored through large-scale computer simulations of how the planets tug on one another. "We know from [Laskar's] analysis that [the orbital variations] can be chaotic, but we don't know how to constrain them," says Olsen. He thinks his record could yield the first real data on how the orbits have evolved. "I think we really have to go from the geological constraints," he says.

Berger, however, thinks it's too early to draw firm astronomical conclusions from the rock. "Nobody knows how the climate system responded back then," he says. "Perhaps 2.3 [million] was still 2.3, but the climate system output this as 1.8," possibly because it didn't respond linearly to the orbital changes. What's more, he says, "Laskar's integration of the past 200 million years shows indeed that these [orbital] frequencies have varied in time but the variation is very small," nothing like what Olsen is claiming.

On the other hand, Berger is not ready to throw stones at Olsen's long rock record. "Maybe these changes are in reality larger than what Laskar has seen."

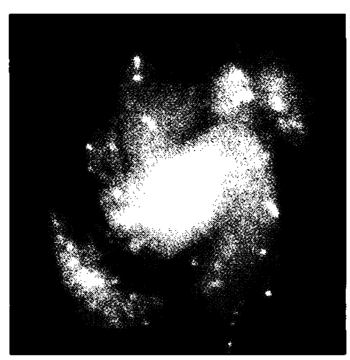
–Larry Krumenaker

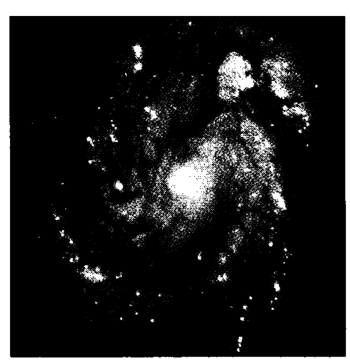
Larry Krumenaker is a free-lance science writer living in—where else—New Jersey.

ASTRONOMY

New Images Highlight Hubble Fix

Last week, just a month after the delicate space repair of the Hubble Space Telescope, the National Aeronautics and Space Administration (NASA) released dramatic before and after pictures to confirm what astronomers had hoped. The telescope now sees as well as it was ever supposed to, say NASA scientists. Until the repair, Hubble's misshapen mirror had shrouded the cores of distant galaxies like M100 in haze (upper image). Now the telescope details spectacular cloud structure and pinpoint stars (lower image).





PHOTOS BY NASA

The images shown here and others released by NASA testify to the success of one part of the repair: the replacement of the main camera—the Wide Field Planetary Camera—with a new one containing built-in corrective mirrors. The astronauts also installed an array of mirrors, known as COSTAR, designed to refocus light as it bounces into the Hubble's other three instruments—the Faint Object Camera and two spectrometers. And other images suggested that, at least for the Faint Object Camera, that fix succeeded as well.

Besides delighting astronomers, these images may go far to repair another image: NASA's own, sullied by the loss of the Mars Observer and other disappointments. At the NASA press conference, Senator Barbara Mikulski (D–MD) called the repair "a major step in restoring confidence in NASA." In what may be the only negative note for astronomers, White House science adviser Jack Gibbons added that the impressive repair mission will bolster support for the proposed $30 billion space station—an endeavor many astronomers oppose because they would rather see NASA's money spent on other astronomy satellites.

–Faye Flam