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NEWS FOCUS

GEOLOGICAL SOCIETY OF AMERICA MEETING:
Geology Near, Far, and Long Ago

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DENVER, COLORADO--Late last month, geologists and paleontologists gathered for the annual meeting of the Geological Society of America, which is headquartered here in the central part of the continent. Topics wandered out to an asteroid of uncertain parentage and back in time to geologic clocks and the death of the dinosaurs.

Measure for Measure in The March of Time

When your wristwatch and a wall clock disagree about the time, one (or both) of them is wrong. Geochronologists have a similar problem, but the potential consequences are more grave. In the limestone pinnacles of northern Italy's Dolomite mountains, a technique that marks time by counting sedimentary layers much the way tree rings are counted gives one answer for how long it took the rocks to form roughly 240 million years ago in the Triassic period. The uranium-lead radiometric technique--a pillar of geochronology--gives a very different answer.

"There's going to be a lot of work figuring out how much time is involved," says sedimentologist Bruce Wilkinson of the University of Michigan, Ann Arbor. Geologists and paleontologists are anxious to know which method they can trust to gauge the pace of evolution's Cambrian explosion, say, or the timing of huge volcanic eruptions relative to mass extinctions that they may have triggered.

Time is made visible, and perhaps even measured out, in the majestic Latemar limestones of the Dolomites. These rocks are a 600-meter-high pile of carbonate skeletons of marine animals laid down layer by layer on an ancient ocean floor. It all took 8 million years, sedimentologist Linda Hinnov of The Johns Hopkins University calculated by counting the meter-thick layers and making one crucial assumption: The clocklike orbital behavior of the planet controlled their deposition.

Astronomers know that Earth's tilt, the direction of its axis, and the shape of its orbit vary with periods of 20,000, 40,000, and 100,000 years, respectively, under the gravitational influence of other solar system bodies. During the past few millions of years, these orbital or Milankovitch cycles have driven climate changes and probably even set the pace for the comings and goings of the ice ages, leaving vivid records in deep-sea sediments. Like many other researchers trying to measure time in ancient sedimentary rocks, which generally can't be dated by radioactive decay, Hinnov assumed that the cycles had similar effects at earlier times in Earth history. So she looked for the fingerprint of the cycles in the pattern of the layers in the Dolomite limestones.

In the Latemar sequence, for example, the layers seem to form bundles of five, with a thick layer at the bottom of each bundle and the four above it progressively thinning. In the 1980s, researchers theorized that, if orbital cycles somehow varied the productivity of the carbonate-yielding marine animals, each layer could be the product of 20,000 years of sedimentation under the influence of one cycle in Earth's axial orientation. The bundles of five would form the 100,000-year cycle; later work seemed to identify the 40,000-year cycle as well in the layered rock.

At the meeting, however, geochronologist Roland Mundil of the Berkeley Geochronology Center in Berkeley, California, and his colleagues presented evidence that the Latemar layers have nothing to do with orbital cycles. Using the radioactive decay of uranium-238 to lead-206, they dated two thin layers of volcanic ash sandwiched in the limestone, separated by 420 supposedly 20,000-year layers. If orbital cycles really had ticked off the limestone layers like a clock, the dated interval should amount to 8.4 million years; Mundil measured an age difference of only 2.1 million years between the ash layers. Even under the most generous assumptions, says Mundil, "you would never get the time span you need for Milankovitch."

Determining which clock is right will take some more work. The orbital method "is a very seductive hypothesis," says paleontologist Paul Olsen of the Lamont-Doherty Earth Observatory in Palisades, New York, who has used it to date other Triassic beds. "Sometimes the criteria for recognizing Milankovitch [cycles] are so loose you can see it anywhere." Yet the uranium-lead method has its difficulties as well. "The more you dig into the method," says Olsen, "the clearer it becomes that getting dependable results is not a trivial matter."

For example, rock containing zircon crystals that hold the uranium and its decay product can partially melt, millions of years after their formation in a volcanic eruption, in a new volcanic outpouring. The zircon can survive the melting and then grow a new layer of crystal over its old core. When the whole crystal is analyzed, the apparent age will be older than the age of the eruption that laid down the ash layer. Some geochronologists, including Mundil, say they address such problems in their standard methods, screening out zircons with old cores through inspection under the microscope. But others aren't so sure. They look to other techniques that can pick out chemically distinct cores that would otherwise be invisible. Telling which clock, if any, is right will obviously take more effort than dialing up the time lady.