Ancient tidal fossils unlock lunar secrets

Like a small white dog on an invisible leash, the moon has tagged along with Earth on its celestial stroll since at least the time that microscopic bacteria ruled the globe. From basic physics, astronomers know that the gravitational leash should be stretching because of tides on Earth — a theory confirmed by measurements made since the Apollo landings.

Geologists now report discovering the fossilized remnants of tides in 1-billion-year-old rocks, enabling the scientists to track how fast the moon has slipped away from Earth during the last eon. These rocks push back the record of lunar evolution by several hundred million years. Marjorie A. Chan of the University of Utah in Salt Lake City and her colleagues describe their find in the September GEOLOGY.

"The Earth is spinning, and because of the tidal friction of the moon on the Earth, it slows the spin down, so then the moon has to move away to compensate for that. What's amazing to me is that we can actually see those changes in the rock," says one of the study's coauthors, Erik P. Kvale of the Indiana Geological Survey in Bloomington.

"It's a marvelous statement of the ingenuity of mankind," comments geologist Rudy L. Slingerland of Pennsylvania State University in University Park.

Chan and her coworkers found the tidal fossils in a series of unusual siltstones preserved in the mountains outside Salt Lake City. The rocks have a pin-striped appearance, alternating between light and dark bands.

The scientists believe that the bands formed from daily or semidaily tides, which carried coarse sediment into what may have been a marine estuary.

In support of their theory, they note that the bands thicken and thin in a fashion that matches the neap-spring tidal cycle. When the moon is full or new, its alignment with Earth and the sun causes a stronger tug on the oceans, generating a spring, or extra-high, tide. Neap tides occur when the orbital arrangement weakens the pull on Earth's oceans.

"We know of no other mechanism that can produce laminae that progressively thicken and thin on such a regular time interval. The only thing we know of that can do this is tides," Kvale says.

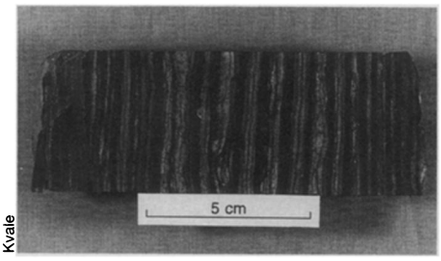
Penn State's Slingerland says he did not believe the claim at first. But after reviewing the data, Slingerland says, "it's difficult to attribute them to any other origin but tides."

In the last 15 years, geologists have discovered several other deposits of tidal fossils, or "tidal rhythmites." Until now, the oldest documented rhythmites dated to 650 million years ago and hailed from southeast Australia. The Utah rocks fall between 800 million and 1 billion years in age.

By counting the number of neap-spring cycles per year, geologists can determine the length of the lunar month back in time. From that value, they can calculate the Earth-moon distance. While modern measurements show that the moon is retreating at 3.5 centimeters per year, calculations based on the Australian rocks indicate that the rate was only 2.5 centimeters per year 650 million years ago.

Astronomers would like to look even further back to see how the rate has changed with time. Some scientists speculate that the amount of friction changes as the continents shift position, altering the shape of the ocean basins.

Chan and her colleagues drilled new cores of the Utah rhythmites this summer, and their preliminary calculations appear to match the astronomical theory — showing a shorter lunar month and a day of only 21 or 22 hours at the time the rocks formed. — *R. Monastersky*



Kvale

Calendar circa 1 billion years ago: Daily tides formed individual stripes in sedimentary rocks from Utah. Variations in the thickness of the bands reflects semi-monthly neap-spring tidal cycle. Photo shows several months of daily tides.

T cells cure leukemic mice

A new treatment based on a type of white blood cell eradicates or slows an aggressive leukemia in mice. The finding holds out the hope that a similar therapy might aid humans with leukemia or other cancers.

T lymphocytes form the basis of the experimental therapy. Daniela Santoli of the Wistar Institute in Philadelphia and her colleagues harvested some of these small immune system cells from the blood of a child with acute T lymphoblastic leukemia. Then they allowed the cells to proliferate in culture. When these lymphocytes proved potent killers of a variety of test-tube-grown cancer cells, the researchers decided to test them against cancer cells proliferating in mice lacking an immune system. These mice have no T cells of their own to defend against a variety of diseases, including leukemia.

First, Santoli's team irradiated the human-derived T cells to ensure that these lymphocytes died soon after completing their cancer-killing mission. Next, they treated the T cells with a substance known to rev up the cells' destructive potential. When injected with the cells, immunologically deficient mice with an early form of leukemia remained cancerfree for at least 2 months. This suggests the rodents "were essentially cured," Santoli says.

The same treatment also fought advanced leukemia, according to her group's report in the September JOURNAL OF CLINICAL INVESTIGATION. Among mice with severe disease that receive multiple injections of the revved-up T cells, half remained free of leukemia for at least 6 months. Though the rest continued to show symptoms of the cancer, they survived significantly longer than untreated mice.

Santoli hopes that, for humans, the treatment may be useful for mopping up any cancer cells that escape the surgeon's knife. — *K. A. Fackelmann*

Siblings get boost in mental knowledge

Brothers and sisters do far more than torment one another and vie for parental affection. A new study suggests that 3- to 5-year-old siblings, perhaps through their cooperative play, inadvertently help each other grasp a mental concept that sets the stage for understanding deception and making moral distinctions.

Children with two siblings achieve an understanding of false belief — the knowledge that someone can be misled or misinformed about the nature of an object or situation — earlier than those with one or no siblings, a team of British psychologists reports in the August CHILD DEVELOPMENT. Older and younger siblings in the 3- to 5-year-old range display comparable skills at detecting false beliefs, they assert.

"Children engage more frequently in creative social role-taking with siblings than with anyone else," write Josef Perner of the University of Sussex in Brighton and his coworkers. "Pretend play is perhaps our best candidate for a cooperative activity that furthers the eventual understanding of false belief."

Much research now indicates that a major shift in understanding beliefs,