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.

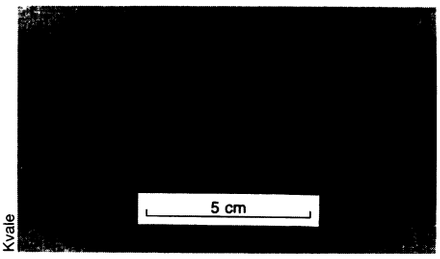
Penn State's Slingerland says he did not believe the claim at first. But after reviewing the data, Slingerland says, "it's difficult to attribute them to any other origin but tides."

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,

intentions, and other aspects of mental life occurs in the preschool years. Some investigators, including Perner, suspect that children construct "theories of mind," much as scientists fashion theories to account for natural phenomena (SN: 7/17/93, p.40).

One school of thought views children's comprehension of mental states as an innate capacity; another sees it as the by-product of a maturing general ability to reason in healthy kids.

The sibling findings of Perner's group suggest that, if an innate tendency to theorize about mental states exists, it gets triggered at different times in children, depending on the number of siblings in the home.

The researchers first studied 76 children, half between 3 and 4 years old, half between 4 and 5 years old. Of that number, 22 were only children, 42 had one brother or sister, 11 had two siblings, and 1 had three siblings.

An experimenter told each child a false-belief story enacted with dolls. Half the youngsters heard about a character named Max, who puts some chocolate in a cupboard and goes outside to play. His mother then puts the chocolate in a different cupboard. When Max decides to come in and eat the chocolate, the researcher asked the children, "Where will Max look for the chocolate?"

The remaining children heard a similar version of this story, in which Max leaves the house and tells his brother Sam where he mistakenly thinks the chocolate can be retrieved. An experimenter then asked, "Where will Sam look for the chocolate?"

About three-quarters of the 4-year-olds in the study answered these questions correctly, compared to 40 percent of the 3-year-olds. Three-quarters of those with two or more siblings also answered the questions correctly, regardless of age; the proportion of correct responses dropped to 60 percent for those with one sibling and 40 percent for only children.

In a second study, 42 children were asked questions about another false-belief story. Each of the 3- to 5-year-olds had only one sibling; 15 had an older sibling (the oldest of whom was 11) and 27 had a younger sibling.

Two-thirds of both older and younger children understood false belief, the researchers report. Thus, family size makes a specific impact on children's belief reasoning rather than on more general intellectual capacities, the psychologists suggest.

Other researchers have found that false-belief understanding rises in children who make more attempts to interact cooperatively with an older sibling. Belief and pretense are closely related concepts, leading Perner's group to offer pretend play among siblings as a way to enhance understanding of false belief. — *B. Bower*

Taking the temperature of the far cosmos

Score another point for the Big Bang. In a celebrated confirmation of cosmology's most popular theory, a spacecraft 4 years ago measured the temperature of the cosmic microwave background (SN: 1/20/90, p.36). Astronomers believe this faint glow represents radiation left over from the fireball that spawned the expanding cosmos. The universe has cooled considerably since its birth, and the temperature of the relic radiation in nearby regions of space, 2.73 kelvins, exactly matches the predicted cooling.

But scientists have tried for years, with little success, to examine a related facet of the microwave background: Probing more distant reaches of the universe, which reveals the way the cosmos looked at earlier, presumably warmer times, should yield a higher temperature for the microwave glow.

According to the Big Bang, the temperature of the microwave background increases linearly with redshift, a measure of the distance to faraway objects.

Using a high-resolution spectrograph and the 10-meter W.M. Keck Telescope atop Hawaii's Mauna Kea, researchers have now taken the temperature of two distant gas clouds observed as they appeared at 25 percent of the cosmos' current age. Antoinette Songaila and Lennox L. Cowie of the University of Hawaii in Honolulu and their colleagues report their work in the Sept. 1 NATURE.

The measurements "are strikingly consistent with the Big Bang theory," comments David M. Meyer of Northwestern University in Evanston, Ill.

The two clouds studied lie directly in the path of light from a quasar and contain carbon atoms. Analyzing the quasar light absorbed by these atoms, the team calculated the relative number of carbon atoms occupying either of two closely spaced energy levels. The atoms in each level serve as a sensitive probe of the energy imparted to them by the microwave background, providing a measure of its temperature.

Within experimental errors, the team found that one cloud— at 7.58 kelvins — matches the temperature predicted for the microwave background at that distance. The other cloud has a temperature some 3 kelvins higher. Cowie notes that the numbers give only an upper limit on the microwave background. Local effects also contribute to the excitation of carbon atoms in each cloud, and this may explain the higher temperature in the second cloud. — *R. Cowen*

Calif. Assoc. for Research in Astronomy

W.M. Keck telescope.

Source of withdrawal pangs found in brain

It's a cruel punishment for drug dependency. Those who finally decide to kick the habit or who simply can't get hold of any drugs may experience withdrawal, complete with shaking and sweating. Many addicts have no doubt wondered what could be making them feel so bad.

According to Glenda C. Harris and Gary Aston-Jones of Hahnemann University in Philadelphia, it's dopamine, a chemical messenger, in the brain's nucleus accumbens that helps impose this harsh sentence. Researchers disagree, however, on the finding's clinical implications.

Their new results, reported in the Sept. 8 LANCET, further support dopamine's good guy–bad guy image: This chemical helps provide the high and then turns against users when they fail to deliver the goods — more drugs (SN: 6/30/90, p.406).

Uncovering the role of the nucleus accumbens in withdrawal "is an important finding...[that] will stimulate a lot of new research," says Roy A. Wise of Concordia University in Montreal.

Other experiments had shown that dopamine concentrations in the accumbens can crash when addicted animals go off drugs. When animals get drugs that ward off the symptoms of withdrawal, dopamine concentrations in the accumbens don't decrease. But these findings demonstrated only an association between