Pursuing Life on Two Frontiers

Charles Darwin once speculated that life arose in "some warm little pond"—a quiet, nurturing environment where primitive biological molecules could mingle and evolve in peace. Two new reports suggest that the early history of life held far more excitement than Darwin ever imagined.

Rocks from Greenland harbor evidence that microorganisms populated Earth either during or just after a cataclysmic period when chunks of space debris were raining down on the planet. And new clues from a Martian meteorite add further hints that early life also colonized the Red Planet, a far cry from Darwin's earthbound backwater.

Both reports draw their evidence for ancient life from an unusual chemical fingerprint detected in the isotopic ratio of carbon atoms. Yet the differences between the two cases may outweigh their similarities. The Greenland study has passed through the peer-review process and calls for a plausible extension of life's record on Earth. The Martian data are preliminary, statistically less solid, and vastly more controversial in their implications.

If verified by future work, however, both findings suggest that life in the solar system is hardier, and perhaps more widespread, than we have long believed.

On Earth

Talk about a baptism by fire. The first living organisms on Earth apparently evolved in the midst of a cosmic bombardment, when giant asteroids were pummeling the planet and routinely incinerating its surface.

Improbable as it may sound, this scenario of a hellish birth is gaining support, thanks to a report that pushes the record of life on Earth back before 3.85 billion years ago, some 300 million years earlier than previously thought.

Evidence for the more ancient beginning comes in the form of minute carbon residues found in some of the oldest rocks on Earth, from Akilia Island near Greenland. These specks of carbon bear a chemical fingerprint that could only have come from a living organism, report Stephen J. Mojzsis of the Scripps Institution of Oceanography in La Jolla, Calif., and his colleagues in the Nov. 7 Nature.

Other researchers hail the new discovery yet remain cautious about interpreting these indirect hints of life. "It's a very strong indication that life existed back then, but it's not proof," says Heinrich D. Holland, a geochemist at Harvard University.

Mojzsis and his coworkers analyzed the ratio of two forms of carbon preserved within the Greenland rocks. As living organisms grow, chemical reactions in their cells alter the natural carbon ratio, slightly favoring the light isotope, carbon-12, over the heavier one, carbon-13. Isotopically light carbon can therefore serve as a chemofossil, or molecular remnant of life.

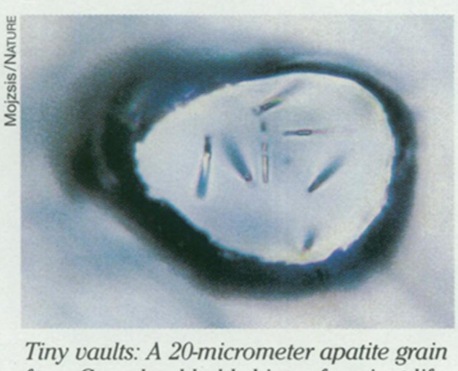
In previous studies of ancient Greenland rocks, researchers had found a ratio of carbon-13 to carbon-12 that is only 1 to 1.5 percent lower than an international standard. Because inorganic rocks sometimes have values almost as light, scientists did not consider the ratio a fingerprint of life.

Like all extremely old rocks, however, the Akilia rocks had endured a torturous history during which they had been heated and squeezed. Such metamorphism pushes a rock's carbon isotopic ratio toward heavier values, thus wiping out any signature of life.

Mojzsis and his colleagues suspected that unaltered information might lie hidden within the Greenland rocks. They found tiny amounts of undisturbed carbon locked within grains of the mineral apatite, which had served as a sort of safe-deposit box over the eons.

To gauge the carbon's isotopic ratio, the researchers used a tool called an ion microprobe, which can analyze minuscule samples. The technique revealed ratios of carbon-13 to carbon-12 that ranged from 2 to 5 percent lower than the standard. Because no known inorganic process can create such a skewed ratio, Mojzsis and his team declare it evidence of ancient microbial life.

Other scientists have their worries, though. John M. Hayes of the Woods Hole (Mass.) Oceanographic Institution wonders whether early Earth may have had unusual inorganic reactions that produced compounds with very light carbon ratios. Still, he says, "it's most likely that the new results are indeed evidence for life 3.85 billion years ago."



Mojzsis/Nature

Tiny vaults: A 20-micrometer apatite grain from Greenland holds hints of ancient life.

The next-oldest signs of life come from 3.5-billion-year-old rocks in Australia and South Africa. These deposits contain true fossils of microorganisms, as well as isotopically light carbon.

By extending the biological record backward, the Greenland find moves life's start into an uncomfortable time in the solar system. From the age and size of craters on the moon, planetary scientists calculate that large asteroids continued hitting Earth from its origin 4.5 billion years ago until 3.85 billion years ago.

"I think this is telling us that life somehow evolved amid an impact-ridden chaos," says Christopher F. Chyba of the University of Arizona in Tucson.

Some of the impacts during this period would have been large enough to vaporize the upper layer of the oceans, according to estimates, but they may not have wiped out life. Emerging biological evidence suggests that all modern organisms descended from heat-loving microbes. If true, these so-called thermophiles may have been either the first creatures on Earth or simply the sole survivors of the planet's fiery childhood. *— R. Monastersky*

On Mars

Is the Red Planet alive with bacteria? Resurrecting findings from a 1989 report, British researchers announced last week that primitive life may have existed on Mars as recently as 600,000 years ago.

"It's a very small step from detecting life that could have originated sometime in the last 4 percent of [Martian] history to finding evidence of life there now," says Ian P. Wright of the Open University in Milton Keynes, England, who collaborated on the study with Colin T. Pillinger of the Open University and Monica M. Grady of the Open University and the Natural History Museum in London.

The reseachers base their finding on the high concentration and the carbon composition of organic compounds they detected in a young Martian meteorite.

The meteorite, discovered in Antarctica in 1979 and known as EETA79001, formed 180 million years ago and was ejected from Mars 600,000 years ago. The researchers argue that the organic matter in the meteorite was incorporated before the rock left Mars. Critics maintain that the organic compounds are terrestrial contaminants.

At a meeting last week in London on life in the solar system, the British scientists also presented new evidence that bolsters last summer's report that a much older Martian meteorite, ALH84001, harbors vestiges of ancient life on that planet (SN: 8/10/96, p. 84). The studies suggest that if life got a foothold on ancient Mars, it may have survived at least until very recently.

The researchers measured the ratio of carbon-12 and carbon-13 in the two meteorites. One of the carbonate-containing grains of ALH84001 has ratios of carbon-13 to carbon-12 that are 6 percent lower than the international standard. That's the same signature the team had found in terrestrial rocks that date from 2.8 billion years ago and contain fossil evidence of bacteria.

Some scientists question whether Martian organisms could have increased carbon-12 by this amount. They note that the Martian atmosphere today has a higher carbon-13 to carbon-12 ratio than Earth's and could well have had a similar ratio in the past.

"A lot of what we're trying to puzzle out here is based on an announcement, not a peer-reviewed, published article," cautions David Des Marais of NASA's Ames Research Center in Mountain View, Calif.

The British team reported 9 years ago that EETA79001 contains abundant organic material (SN: 7/22/89, p. 53). Present in a concentration of 1,000 parts per million, the material has a ratio of carbon-13 to carbon-12 about 2.5 percent lower than the standard. That is roughly the same isotopic ratio found in organic material on Earth today.

That's just the point, says Jeffrey L. Bada of the Scripps Institution of Oceanography in La Jolla, Calif., who contends that the material is a contaminant.

While the chemical identity of most of the organic material remains unknown, last year Bada and Gene D. McDonald of Cornell University reported finding amino acids in a sample of EETA79001. However, the acids have the same structural characteristics and composition as modern Antarctic samples. This suggests that the amino acids were inserted into the meteorite by Antarctic meltwater percolating through the rock.

Wright maintains that although the amino acids in the meteorite may well be contaminants, they account for only a tiny percentage of the organic material in EETA79001.

Even if the organic material in the 180-million-year-old rock did originate on Mars, it may simply represent material left over from a much earlier biological era on the planet, says exobiologist Christopher P. McKay of Ames.

Such debate will probably continue, says Bada, "until we catch a Martian meteorite as it's falling to Earth or if we go to Mars and get samples." — *R. Cowen*

Boning up on postmenopausal hormones

Postmenopausal hormone supplements fight a woman's risk of osteoporosis—a potentially crippling, age-related embrittlement of the bones—better than had been expected, two new studies find. A related study concludes, however, that maintaining sturdy bones beyond a woman's childbearing years may require a troubling trade-off: an elevated risk of breast cancer.

All three studies appear in the Nov. 6 Journal of the American Medical Association (JAMA).

At menopause, a woman's body dramatically cuts its production of estrogen. Besides launching an uncomfortable period of physical adjustment, this change accelerates bone loss and triggers changes in the blood's lipids that heighten the risk of heart disease. The federally funded Postmenopausal Estrogen-Progestin Interventions (PEPI) trial was designed to assess in nearly 900 women age 45 to 64 how well hormone supplements arrest bone loss.

One group received tablets with no active agents. The rest received estrogens—alone or with a progestin, another female sex hormone, in one of three common formulations.

Designers of PEPI hoped the 3-year treatments would halt the rapid bone loss that occurs early in menopause, notes Joan McGowan of the National Institute of Arthritis and Musculoskeletal Diseases in Bethesda, Md. "But PEPI showed that you more than stabilize bone loss," notes McGowan, a coauthor of one of the JAMA reports. "There is actually an increase in the bone at the spine and the hip," she says—the areas most vulnerable to debilitating fractures.

All four hormone treatments increased bone density in the spine by 3.5 to 5 percent and in the hip by 1.7 percent. Smokers derived the most benefit. Untreated smokers lost 3.5 percent of their spinal bone, about twice as much as untreated nonsmokers, but both smokers and nonsmokers on the hormonal therapy gained the same amount of bone.

In a related study, physicians financed by the Parke-Davis Pharmaceutical Research Division of Warner-Lambert tested various doses of an experimental postmenopausal estrogen-progestin mix. They found that low doses of the same two hormones found in most oral contraceptives increased bone at least as well as the available drugs used in PEPI. However, notes study leader Leon Speroff of the Oregon Health Sciences University in Portland, unlike most postmenopausal therapies, the experimental combo does not cause menseslike bleeding in users. He says this drug pair could be marketed next year.

Researchers following almost 7,000 women age 65 and older as part of a fracture risk study decided to look at breast cancer incidence. In the third JAMA article, they report that cancer risk increased in lockstep with bone density. Women who had the most bone in hip or spine showed 2.5 times the risk of women with the least bone.

Though the women were not taking supplemental hormones during the study, the researchers worry that hormone therapy might elevate breast cancer risk, which has been associated with lifetime estrogen exposure (SN: 8/5/95, p. 94).

However, cautions Karl Insogna of the Yale University School of Medicine, coauthor of a commentary in JAMA, "we should not jump to the conclusion that it is estrogen" that links bone density and cancer risk. Until this hypothesis is tested directly, one can't rule out other possibilities, he says.

With the link between hormone therapy and breast cancer unproven, he told Science News, "the take-home message for women on standard hormone-replacement therapy is not to quit." — *J. Raloff*

Lens gets X rays to a point

Researchers have designed a simple, inexpensive lens for X rays that can focus a high-energy beam down to a spot just 8 micrometers wide. Such concentrated X rays could be used to probe the structure of individual grains of materials or to make images of single cells.

The compound lens, described in the Nov. 7 Nature, is a block of aluminum with a row of 30 cylindrical holes, each 0.6 millimeter in diameter, bored into it. The slivers of metal between the holes form a series of concave strips that can act as simple lenses. An X-ray beam directed at the end of the block passes through each strip of aluminum. Each successive strip bends the X ray slightly, gradually focusing the beam to a point.

This device—unlike those using mirrors, diffractive lenses, or glass tubes to collimate beams (SN: 6/27/92, p. 422)—actually refracts X rays, just as a glass lens refracts visible light. Because most materials bend X rays only slightly, a single lens is not practical. The multiple-lens design overcomes that limitation.

Other low-density materials could work, but "aluminum is the most suitable," says coauthor Anatoly Snigirev of the European Synchrotron Radiation Facility in Grenoble, France. "It has relatively low absorption for hard X rays, and you can easily drill holes into it." — *C. Wu*