week in *Nature*, the team again used oocytes from newborn mice carrying an *H19* mutation. This time, however, the mutation was larger—and apparently more effective at blocking *H19* expression. The researchers constructed 598 eggs, each carrying one set of chromosomes from a normal mouse and another from the mutant. They transferred 371 surviving embryos to 26 mice. To their surprise, when they checked the progress of the pregnancies at day 19, they found 28 pups, 10 alive and 18 dead. Two of the 10 seemed relatively normal, and one, Kaguya, survived to adulthood. She has since given birth to a litter of healthy pups.

Although they call the work interesting, some scientists such as developmental biologist Azim Surani of the University of Cambridge, U.K., question whether Kaguya can really be called a parthenote, because she has two genetic parents, albeit both female. The experiment is a "proof of principle" that a mammal can be born without contribution from sperm, says Patrick Tam of the Children's Medical Research Institute in Sydney, Australia. But he says lines of female-descended mammals are unlikely to become commonplace. The technique "is amazingly complex," he says. "There are not more than two or three labs in the world capable of pulling this off."

Indeed, why Kaguya survived is still a mystery. Given that just two of nearly 600 tries succeeded, says Davor Solter of the Max Planck Institute for Immunobiology in Freiburg, Germany, it is possible that Kaguya and the other survivor developed from immature oocytes that carried either an incomplete erasure of the paternal imprints or a lucky combination of genes that allowed them to overcome their imprinting abnormalities.

–GRETCHEN VOGEL

PALEONTOLOGY

New Biomarker Proposed for Earliest Life on Earth

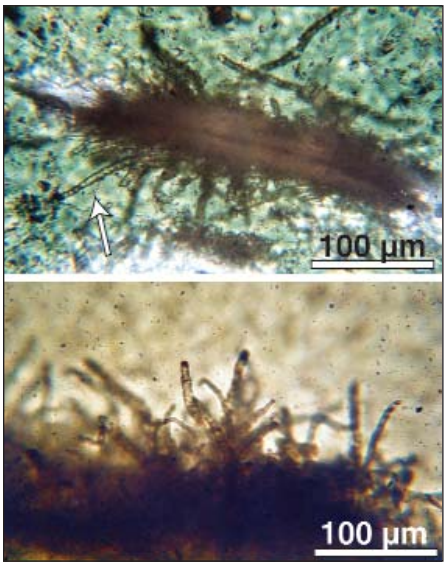
Recognizing life's remains becomes increasingly difficult as they shrink in size and increase in age. Little wonder paleontologists and astrobiologists have taken to tussling over what was and wasn't alive billions of years ago on Earth or on Mars.

Now, on page 578, a group of geoscientists takes a newly developed marker of recently past life and applies it to some of the oldest rocks on the planet. The researchers report the discovery of microscopic tubules in 3.5-billion-year-old sea-floor rock that strongly resemble microtubules apparently bored in modern sea-floor rock by microorganisms. If the ancient borings indeed had a biological origin, life was firmly established just a few hundred million years after the end of the rain of giant impacts that had repeatedly sterilized the young Earth. But, true to the field's recent history, the first application of the microtubule biomarker to ancient rocks is getting a mixed reception.

This new contender for oldest biomarker on Earth comes from South African rock that formed as lava oozed across a sea floor 3.5 billion years ago. Geologists Harald Furnes and Neil Banerjee of the University of Bergen, Norway, and their colleagues have found tubular structures sprouting from mineral-filled fractures in what was once the glassy rind of submarine lavas resembling a pile of pillows. These ancient microtubules, which average 4 micrometers in width and 50 micrometers in length, bear a striking resemblance to microtubules in modern sea-floor pillow basalts.

In the past decade, Furnes and other researchers have built a case for modern microtubules, at least, being the tracks of rock-eating microorganisms. These geologically young microtubules have the right size and shape to have been formed by micrometer-scale organisms. They can contain lingering organic remains and nucleic acids or just enhanced amounts of carbon and nitrogen, building blocks of life. The carbon is isotopically lighter, which could be life's doing. And in the lab, particular microbes have been shown to eat their way into rock and glass, taking up essential nutrients stored there such as phosphorus and iron. Still, yearlong experiments produce only shallow pits.

Furnes and his colleagues found most of those characteristics—similar size and shape, signs of organic matter, and light carbon isotopes—in the microtubules from the South African rocks, convincing them that that they have found a "3.48-billion-year-old biomarker." Others agree. "I've looked at hundreds of rocks" while studying modern microtubules, says petrologist Martin Fisk of Oregon State University in Corvallis. "To me, it's unequivocal that the textures they see were created by microorganisms. I think they've got the best evidence I've seen for life at that time." Other equally ancient signs of life have all come in for criticism lately (*Science*, 24 May 2002, p. 1384).



Same old? Tubules in ancient rock (arrow, *top*) resemble modern microbe borings (*bottom*).

CREDIT: H. FURNES *ET AL.*

Others are a bit more cautious. The South African microtubules "do look just like modern analogs in deep-sea glasses," says microbial geochemist Jennifer Roberts of the University of Kansas in Lawrence. But although compelling, the evidence "isn't a smoking gun," she adds. Abiotic chemical reactions, she notes, might move a few elements and isotopes around while carving out tubules in glass.

Paleontologist Martin Brasier and his colleagues at the University of Oxford, U.K., think they have an example of just such ancient abiotic borings. Unaware of Furnes's latest work, they were pursuing microtubules in Australian sea-floor lavas of the same age. "There's no doubt theirs and ours are the same sort of thing," says Brasier, but "we have a completely different interpretation of what's going on." In analogy to examples previously reported by others, Brasier believes that decomposition—possibly of organic matter—produced fluids that drove a mineral grain into the glass as chemical reactions at the grain ate into the glass, sort of like a corrosive-tipped pile driver. "We still do not know whether life is needed," says Brasier.

With the inevitable uncertainties inherent in any one biomarker, "we're really going to need to look at a number of pieces of biological evidence," says Roberts. That's the approach—still unsuccessful after 8 years—that proponents of biomarkers in martian meteorite ALH84001 have followed. In the meantime, Fisk is upping the ante a tad. At last month's Lunar and Planetary Science Conference in Houston, Texas, he and his colleagues presented examples of microtubules in the mineral olivine that resemble those in volcanic glass. Then he made a planetary connection by showing similar "tubelike alteration" in Nakhla and Lafayette, two martian meteorites.

–RICHARD A. KERR