Hunting martian fossils best bet for locating Mars life, researcher says

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Hunting for traces of life on Mars calls for two radically different strategies, says Arizona State University professor Jack Farmer. Of the two, he says, with today's exploration technology we can most easily look for evidence for past life, preserved as fossil "biosignatures" in old rocks.

Farmer is a professor of geological sciences in ASU's School of Earth and Space Exploration, where he heads the astrobiology program. He is reporting on his work today (Feb. 16) at the annual meeting of the American Association for the Advancement of Science in San Francisco.

"Searching for extraterrestrial life must follow two alternative pathways, each requiring a different approach and tools," Farmer says. "If we're looking for living organisms, we are doing exobiology. But if we are seeking traces — biosignatures — of ancient life, it's better to call it exopaleontology."

Unfortunately, he notes, "for the next 10 or 15 years, technology limitations will force us down the exopaleontology path." The core issue is accessibility. "To find living organisms on Mars," says Farmer, "you need to find liquid water. Because liquid water is unstable on the Martian surface today, that means going deep into the subsurface."

Water saturates the ground in high latitudes north and south, and around both poles, only a few inches below the surface, Farmer explains. But this water remains frozen year round. "Environments with liquid water will likely lie far deeper, perhaps miles below the surface."

Organisms have been found living in fractured rock, thousands of feet underground on Earth, Farmer notes. "But with current robotic technology, we simply can't drill that deep on Mars."

Terrestrial deep drilling requires complex, heavy equipment, plus constant supervision and troubleshooting by human crews. Says Farmer, "We'll be lucky if, in the next decade or so, robotic drilling on Mars reaches a depth of a couple yards."

So where does that leave us in the search for life on Mars? Farmer says our best choice is to pursue the exopaleontology path.

"Finding the signatures of an ancient Martian biosphere means exploring old rocks that might preserve traces of life for millions or billions of years," Farmer notes. Among the best places to look on Mars, he says, are deposits left by springs and former lakes in the heavily cratered highlands. "The rocks there date from a period in Martian history when liquid water was common at the surface." In fact, says Farmer, conditions on Mars then were likely similar to those on the early Earth at the time when life began.

"Besides water, life also requires energy sources and organic chemical building blocks," Farmer explains. "The Mars Exploration Rover Opportunity found ample evidence for water in ancient rocks at Meridiani Planum, but the rovers’ instruments can’t detect organic materials." However, NASA’s next rover, the Mars Science Laboratory, will carry instruments to analyze traces of organic substances. It is due for launch in 2009.

Recognizing a Martian fossil may be difficult. "We’re not talking about stumbling over dinosaur bones," Farmer says.

Instead, the discovery may involve finding biologically formed structures in old sedimentary deposits, perhaps like stromatolites found here on Earth. Stromatolites are distinctive structures that form in shallow oceans, lakes, or streams where microbial colonies trap sediments to form thin repeating layers.

Stromatolites also contain microscopic cellular remains and chemical traces left by the microbes that formed them. Taken together, such structures comprise the primary record of life in ancient rocks on Earth.

For hunting Martian fossils, says Farmer, we will need robotic microscopic imagers capable of viewing rocks in many wavelengths as well as seeing details as small as a hundredth of a millimeter across. Also needed are organic chemistry laboratories to analyze promising rocks. "That will help us avoid mistaking non-biological features for biological ones," he says.

Farmer's fieldwork has taken him to extreme microbial habitats in

Iceland, New Zealand, Yellowstone National Park, and Mono Lake, Calif. He has sought to understand how modern microbial communities become preserved as fossils. Their environments, he notes, span physical and chemical conditions believed to be representative of early Mars.

"Studying how microbes become fossils is a key step in developing an effective strategy for exopaleontology," Farmer says. "It will help us find the best places to explore on Mars and how to look."

Source: Arizona State University

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