Microbes under Greenland Ice may be preview of what scientists find under Mars' surface

December 14 2005

A University of California, Berkeley, study of methane-producing bacteria frozen at the bottom of Greenland's two-mile thick ice sheet could help guide scientists searching for similar bacterial life on Mars.

Methane is a greenhouse gas present in the atmospheres of both Earth and Mars. If a class of ancient microbes called Archaea are the source of Mars' methane, as some scientists have proposed, then unmanned probes to the Martian surface should look for them at depths where the temperature is about 10 degrees Celsius (18 degrees Fahrenheit) warmer than that found at the base of the Greenland ice sheet, according to UC Berkeley lead researcher P. Buford Price, a professor of physics.

This would be several hundred meters - some 1,000 feet - underground, where the temperature is slightly warmer than freezing and such microbes should average about one every cubic centimeter, or about 16 per cubic inch.

While Price is not expecting any time soon a mission to Mars to drill several hundred meters beneath the surface, methanogens (methane-generating Archaea) could just as easily be detected around meteor craters where rock has been thrown up from deep underground.

"Detecting this concentration of microbes is within the ability of state-of-the-art instruments, if they could be flown to Mars and if the lander could drop down at a place where Mars orbiters have found the methane concentration highest," Price said. "There are oodles of craters on Mars from meteorites and small asteroids colliding with Mars and churning up material from a suitable depth, so if you looked around the rim of a crater and scooped up some dirt, you might find them if you land where the methane oozing out of the interior is highest."

Price and his colleagues published their findings last week in the Early Online edition of the journal Proceedings of the National Academy of Sciences, and presented their results at last week's meeting of the American Geophysical Union in San Francisco.

Variations in methane concentration in ice cores, such as the 3,053-meter-long (10,016-foot-long) core obtained by the Greenland Ice Sheet Project 2, have been used to gauge past climate. In that core, however, some segments within about 100 meters, or 300 feet, of the bottom registered levels of methane as much as 10 times higher than would be expected from trends over the past 110,000 years.

Price and his colleagues showed in their paper that these anomalous peaks can be explained by the presence in the ice of methanogens.

Methanogens are common on Earth in places devoid of oxygen, such as in the rumens of cows, and could easily have been scraped up by ice flowing over the swampy subglacial soil and incorporated into some of the bottom layers of ice.

Price and his colleagues found these methanogens in the same foot-thick segments of the core where the excess methane was measured in otherwise clear ice at depths 17, 35 and 100 meters (56, 115 and 328 feet) above bedrock. They calculated that the measured amount of Archaea, frozen and barely active, could have produced the observed amount of excess methane in the ice.

"We found methanogens at precisely those depths where excess methane had been found, and nowhere else," Price said. "I think everyone would agree that this is a smoking gun."

Biologists at Pennsylvania State University had earlier analyzed ice several meters above bedrock that was dark gray in appearance because of its high silt content, and identified dozens of types of both aerobic (oxygen-loving) and anaerobic (oxygen-phobic) microbes. They estimated that 80 percent of the microbes were still alive.

Though methane has been detected in Mars' atmosphere, ultraviolet light from the sun would have broken down the amount observed in about 300 years if some process was not replenishing the methane, Price noted. While interaction of carbon-bearing fluid with basaltic rock might be responsible, methanogens might instead take in subsurface hydrogen and carbon dioxide to make the methane, he said.

If methanogens are responsible, Price calculated that they would occur in a concentration of about one microbe per cubic centimeter at a depth of several hundred meters, where the temperature - about zero degrees Celsius (32 degrees Fahrenheit) or a bit warmer - would allow just enough metabolism for them to keep alive, just as the microbes in the Greenland ice sheet are doing.

Source: University of California - Berkeley