Subsurface Hydrothermal Systems as Havens for Martian Life

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Hydrothermal systems are defined by hot (~50° to >500°C) fluids that are in chemical disequilibrium with their host rocks. Variations in the temperature (and density) of subsurface fluids drives convective circulation, producing large-scale transfers of dissolved materials and energy. On Earth, hydrothermal systems are believed to provide an expansive subsurface habitat for microbial life. Hydrothermal systems have been identified as important targets in the astrobiological exploration of Mars (Farmer and DesMarais 1999).

Studies of the SNC (Martian) meteorites, along with *in situ* investigations by the Pathfinder and Mars Exploration Rovers have provided valuable information about the composition of the Martian crust. Mars is dominated by mafic crustal compositions, somewhat enriched in iron and sulfur relative to Earth. By analogy with deep seafloor hydrothermal systems on Earth, a wide variety of subsurface metabolic strategies are plausible for Mars, including aerobic (e.g. metal and metal sulfide oxidation; sulfur and sulfide oxidation; hydrogen and methane oxidation, etc.) and anaerobic (e.g. reduction of iron and sulfur; sulfur respiration and methanogenesis, etc.) processes.

While liquid water is presently unstable at the surface of Mars today, extensive groundwater environments may exist at a depth of several km (Clifford 1993). In addition, subsurface zones of liquid water are also expected at shallow depths in association with young volcanic centers that have recently erupted through the cryosphere on the high northern plains of Mars. While access to the deep subsurface of Mars is presently limited by deep drilling capabilities, upwelling hydrothermal systems could provide a means for bringing a deep subsurface biota into the shallow (tens to hundreds of meters) subsurface crust, where organisms could be sequestered and cryopreserved in ground ice. Such sites are regarded as prime targets in the exploration for an extant Martian biosphere.

References

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