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THE ANTARCTIC DRY VALLEY LAKES: RELEVANCE TO MARS

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The similarity of the early environments of Mars and Earth, and the biological evolution which occurred on early Earth, motivates exobiologists to seriously consider the possibility of an early Martian biota. Our research is aimed at identifying environments which could have contained Martian life and areas which may presently contain evidence of this former life. Sediments which are thought to have been deposited in large ice-covered lakes are present on Mars. Such localities have been identified within some of the canyons of the Valles Marineris and more recently in the ancient terrain in the southern hemisphere. We are currently studying perennially ice-covered Antarctic lakes in order to develop quantitative models that relate environmental factors to the nature of the biological community and sediment forming processes. These models will be applied to the Mars paleolakes to establish the scientific rationale for the exobiological study of ancient Martian sediments. One biologically important feature of an ice cover is its capacity to thermally buffer the underlying water from the relatively cold external temperature. The mean annual temperature in the Antarctic dry valleys is –20° C, yet the water in the lake does not cool below 0° C. Consequently, microorganisms are capable of thriving in these thermally stable lakes in spite of the cold external environment. By analogy, it is possible that ice-covered lakes on early Mars provided a relatively warm, liquid water environment for early Martian biota. Another feature of perennially ice-covered lakes is their ability to concentrate atmospheric gases in the water column. For example, we have shown that Lake Hoare, Antarctica, has about 300% more oxygen and 160% more nitrogen than would be in equilibrium with the atmosphere. In Antarctica, both biological and abiological processes contribute to the enhanced gas concentrations. Sedimentation and loss through the ice cover of organic carbon produced through photosynthesis represents a biological source of oxygen. Also, the incoming meltstreams carry air in solution into the lake which is concentrated when the water freezes to the bottom of the ice cover. Both of these processes are effective in controlling the gas concentration in the lake water. These concentration mechanisms may have operated in the ice-covered Martian paleolakes, possibly enhancing the concentrations of biologically important gases (e.g., CO_2, N_2) from the thin Martian atmosphere.