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TRACE FOSSILS OF MICROBIAL COLONIZATION ON MARS: CRITERIA FOR SEARCH AND FOR SAMPLE RETURN; E. I. Friedmann, Polar Desert Research Center, Department of Biological Science, Florida State University, Tallahassee, FL 32306-2043.

The recent discovery of microbial trace-fossil formation in the frigid Ross Desert of Antarctica suggests that early primitive life on Mars may have left behind similar signatures[1]. These trace fossils are apparent as chemical or physical changes in rock (or sediment) structure (or chemistry) caused by the activity of organisms. Life on Mars, if it ever existed, almost certainly did not evolve above the level of microorganisms, and this should be considered in search for fossil life[2]. For the reasons detailed here, microbial trace fossils seem to be a better and more realistic target for search than would be "true" microbial fossils (remnants of cellular structures):

- Fossil preservation of cellular structures can occur only when a fortuitous combination of certain environmental factors is present. For this reason, fossilization in a cold desert environment such as in the modern Ross desert, or on early Mars, is unlikely to occur or have occurred. Yet, as we now know, trace fossils can be formed even under such conditions.

- There is no cogent reason to assume that biological evolution on Mars resulted in morphologies similar to those on Earth. Therefore, fossil Martian microorganisms may be difficult to recognize, while trace fossils leave simpler and easier recognizable signatures.

- If the size of primitive Martian microorganisms was of the same order of magnitude as their terrestrial counterparts, then the on-site search for fossils involves the recognition of microscopic patterns in the micrometer range, achievable only by highly complex instrumentation. Microbial trace fossils (like those in the Antarctic Ross desert), however, form patterns in the millimeter range and thus offer targets that can be recognized by less complex instrumentation.

- As trace fossils do not contain combustible carbon, the conditions for sample handling, storage, and return are probably less stringent than in the case of true fossils.

The model of the Ross desert trace fossils makes it possible to set concrete aims for the search for past microbial life on Mars. These can be defined as the recognition of chemical and/or physical discontinuities in rocks or sediments that appear to run against, or in no conformity with, apparent physical and chemical gradients and which cannot be explained by chemical and physical gradients.

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It is suggested that samples of Ross desert trace fossils be used for experimental studies on conditions of sample handling and storage, sample size, as well as for instrument design for collection and on-site recognition.

[1] Friedmann, E.I. and R. Weed. (1987). Microbial Trace-Fossil Formation, Biogenous, and Abiotic Weathering in the Antarctic Cold Desert. Science 236:645-752.

[2] Friedmann, E.I. (1987). The Antarctic Cold Desert and the Search for Traces of Life on Mars. Advances in Space Research 6:265-268.