## BUGS OR BUMPS AND THE SEARCH FOR BIOSIGNATURES

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Biological processes can affect geochemical reactions by affecting acidity, by controlling redox chemistry, by producing organic ligands or by controlling geochemistry of micro-environments. As a result, biological processes can produce mineral phases whose mineralogy, chemistry, composition, isotope composition or morphology is different than expected from abiotic reactions. There are both direct and indirect mechanisms of mineralization. For boundary organized biomineralization (BOB), inorganic particles are grown within or on some organic matrix produced by the organism, resulting in well defined mineral morphology such as shells, phytoliths or magnetosomes. Their biogenic origin is rarely in doubt. In biologically induced mineralization (BIM), an organism modifies its local microenvironment creating conditions suitable for the chemical precipitation mineral phases, or the organism itself serves as a template for mineral precipitation. This processes produces minerals with variable morphology, such as ‘clay hutches’, ‘zinc balls’ and ‘iron wiggles’, or with a geochemical composition that is unexpected based on bulk geochemical composition. Though there is a continuum between these processes, which makes the interpretation of biogenicity based on morphology ambiguous.

## MARS ROCK OR MARTIAN? THE BIOMORPH PROBLEM

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Near-surface Mars provides a range of pressure-temperature environments which overlap considerably with those of near-surface Earth, and which can provide congenial niches for microbes. This would have been even more the case in the past, given the thicker atmosphere and greater abundance of liquid water. It follows that the most likely evidence of life on Mars would take the form of microfossils. However, unambiguous interpretation of small features in rock as microfossils presents problems even on Earth. Early Archean “microfossils” from the Pilbara craton of N.W. Australia bear a morphological resemblance to completely abiotic “biomorphs”: highly structured silica-carbonate composite nanostructures which can be grown easily in the laboratory. “Microfossil” morphology and also the presence of kerogen are both shown to be unsafe criteria for identification of microfossils. In the Pilbara, even the inorganic chemistry of the nearby is compatible with that of the laboratory biomorphs. The same is true of the fossil-like structures in the Allan Hills 84001 meteorite. Similar ambiguities of interpretation can be expected for structures found *in situ* on Mars.

## NOTES