The feasibility of microbial iron reduction on Mars

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Mars today is seemingly inimicle to life. However, the planet was once habitable when life prospered on Earth. Given the lack of oxygen, and the high flux of damaging radiation at the surface, the most plausible life to operate on Mars is anaerobic redox-driven metabolisms. Mars is rich in ferric iron, hence microbial iron reduction (MIR) is a compelling candidate metabolism to operate in the subsurface, past or present. On Earth, MIR typically draws upon organic compounds as electron donors. Mars is expected to host large quantities of organic material, primarily from the infall of carbon-bearing meteorites, an assumption supported by the recent detection of organics by the Curiosity rover. These carbonaceous meteorites contain compounds known to serve as electron donors for MIR on Earth. However, there are many compounds in these meteorites that have not been tested for microbial use. Further, it is not clear whether organic matter in these meteorites is sufficiently abundant and accessible to microbes. Here I present data from experiments testing whether rare meteoritic amino acids, and kerogens (chemical analogs for carbonaceous chondrites), can serve as electron donors for MIR by a number of microorganisms. Results indicate that D-forms of some amino acids, and most kerogens tested, inhibit microbial activity. These results serve to highlight that not all organic carbon is potentially bioavailable, and habitability is greater than the sum of its parts.