Developing a Robust Criteria for Mars Life Detection with Sample Analysis at Mars data

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Introduction: It can be argued that terrestrial basalts are possibly one of the most habitable environments on Earth. From the Hawaiian islands, Indonesia, Iceland, or Italy, volcanic slopes teem with a diversity of life and reveal that even in cold environments, recent lava flows harbor a diversity of bacterial species that are unique (1). While the same cannot be said of the Martian meteorites, several studies have shown that terrestrial life will readily inhabit these rocks. Whether these are Antarctic actinomycetes in ALH 84001 (2), or fungi and filamentous organisms growing and dying in Nakhla (3), or lichens on the Los Angeles meteorite (Haskin and Wang unpublished data), terrestrial life will use meteorites as a habitat. Glavin *et al.* (1999) concluded that most of the amino acids in Nakhla were derived from terrestrial sources, probably bacteria (4). Toporski and Steele (2004) showed the presence of terrestrial organisms throughout a depth profile of the Nakhla meteorite growing over a four-year measurement period (3). These findings support the idea that Martian basaltic meteorites are similar to terrestrial basalts in that they are very suitable habitats for terrestrial life (with the caveat that Martian basaltic meteorites have been subjected to terrestrial weathering to include addition of terrestrial contaminants).

To develop a strategy for detection of Martian life, one must first identify a set of robust criteria for life detection that form a testable hypothesis. Preferably two competing hypotheses; "Mars does not contain evidence of life" and "Mars does contain evidence of life", the so called red team, blue team approach that McKay et al., (1996) adopted to ALH 84001. This strategy depends on several key points for implementation.

1) An understanding of possible abiotic chemistry undertaken in Mars environments (including meteoritic infall) and the preservation / diagenesis of that signal with time.
2) A clear understanding of the geological context in which measurements are made.
3) A multidisciplinary and multi-measurement approach with convergent data sets from each measurement.
4) Commitment to both null hypotheses and to the process of peer review of results and data. It is the collective body of the community, not a single investigator or measurement, that will ultimately define a positive "Life Detected" result.

We will review published Sample Analysis at Mars instrument data that includes mineralogical, isotopic, organic and atmospheric measurements in terms of the two competing hypotheses. We will also include Mars meteorite data where applicable to define both competing hypotheses and stimulate debate on the most robust interpretation of these data.

References

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