Soil gas analysis as a rapid resource and geological assessment tool at the Mars Desert Research Station in Utah

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The location and utilization of subsurface resources as part of an extended manned Mars surface visit will require rapid assessment of local resources and geologic indicators at and around the landing site. It is proposed that through the analysis of soil gas constituents, preliminary constraints can be placed on the location of geologic structures, resources such as water and methane, and the detection of magmatic volatiles indicative of nearby subsurface magmatic activity. This procedure emphasizes effective and rapid surface data collection, with its most significant implications in regards to shallow-surface resource mapping.

The presence of gases contained within soils is a direct result of diffusion of a gas from its source area (Liu et al., 2006)[1]. This proposal intends to assess the presence and concentration of a number of gases, namely water vapor ($H_2O_{(g)}$), sulphur dioxide (SO_2) and methane (CH_4). Carbon dioxide (CO_2) will also be measured as a baseline for comparing soil diffusion rates with atmospheric CO_2 levels. If equipment and time allow, it may also be possible to measure other gases considered important to Martian geochemistry, such as oxygen (O_2), argon (Ar) and nitrogen (N_2).

Increased water vapor levels may indicate the presence of liquid water aquifers accessible via specialized groundwater wells. Sulphur dioxide and methane may indicate nearby magmatic or hydrothermal activity, an important factor to consider in terms of modern-day geomorphic processes and resource location on the Martian surface. The presence and distribution of methane gas may help identify methane collection sites for use as an energy source. Additionally, the detection of methane may also indicate biologic activity that could be followed up upon by other crewmembers or as part of a longer surface stay needed to eliminate magma or volcanic outgassing as the sole source of methane.

Increases in soil gas concentrations may be due to the presence of significant or numerous geologic structures such as faults, which can serve as preferential gaseous flow pathways due to their associated high permeabilities. In terms of accessing subsurface resources and groundwater data, faults are important zones to focus upon and would therefore need to be delineated.

The survey would be performed in two phases. The first phase is a low-resolution high-coverage scheme whose primary goal is to map regional variations in soil gas concentrations by way of a large-scale sampling grid. The second phase seeks to identify the extent and character of any inferred resources by mapping the boundaries of any anomalies identified in the first phase.

Recording of field data during the first phase is straightforward and could be easily taught to skilled individuals. Numerous gas measurements can be made at once, further speeding the data collection process and maximizing the amount of area that can be covered. Data analysis between the first and second phases would be ongoing and would require some interpretation before the second phase can begin shortly thereafter.

1. Liu, G., Li, Baoguo, Hu, K. and van Genuchten, M.T. (2006) Simulating the Gas Diffusion Coefficient in Macropore Network Images: Influence of Soil Pore Morphology. *Soil Science Society of America*, **70**, 1252-1261.