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Detection of Trace Biomarkers in the Atacama Desert with the UREY *in situ* Organic Compound Analysis Instrument

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Successful *in situ* Mars exploration requires the development of instrument suites advanced enough to operate in relevant field environments and the demonstration that they have the analytical capability and sensitivity to detect very low levels of biomarker compounds. We have developed the UREY instrument suite consisting of a subcritical water extraction (SCWE) and sublimation system called the Mars Organic Detector (MOD) for extraction of biomarker compounds from soil, together with a portable microchip capillary electrophoresis (CE) system for analysis of the fluorescently-labeled biomarker compounds. The CE instrument provides high resolution analysis of amino acid composition and chirality with ppb to part-per-trillion sensitivity (1). The CE instrument can also analyze amines, di-amines, amino sugars and nucleobase derivatives.

In June 2005 we studied Hill 3547 in the Yungay region of the Atacama Desert, Chile, an extremely dry, oxidized environment that is an excellent Mars analog site. We performed detailed sampling at various sites with different topographies, slopes, and exposures. Samples were extracted in the field using the SCWE and the effluent was fluorescamine- labeled and then analyzed on the portable CE system. Samples taken from the exposed surface typically produced low levels (4-8 ppb) of amines and amino acids that were at the level of the solvent blank. Samples taken from a shielded surface site or from areas of past water flows had 10-fold higher concentrations of amines

and amino acids. Chiral analysis of two of these samples gave D/L = 0.4 for ala/ser, indicating that the amino acids are of biological origin. Post-field work analysis of the Atacama soil subset showed the average organic carbon and nitrogen to be 0.015% and 0.009%, respectively. One particularly interesting location, 'site 60', showed anomalously light stable carbon isotopes (δ^{13}C = -54 per mil) indicating microbial reworking of organic matter. We will also report the results of further laboratory analyses of these samples designed to validate the field measurements of amino acid concentrations, their chiralities, to analyze for culturable bacteria, and to determine phospholipid fatty acid composition.

This work demonstrates the successful and robust operation of the UREY instrument suite in the Atacama Desert. The instruments were subjected to over 30 ^{o}C temperature variations during a typical day of operation and the CE microchip system was used to perform 340 separate electrophoretic analyses on only 3 microchips over the course of one week. The successful operation of our instrument suite in the Atacama Desert demonstrates both its technology readiness for *in situ* Mars exploration and its ability to detect the low ppt levels of biomarker compounds that may exist on Mars. UREY has been selected to be a part of the analytical package in the ESA Pasteur ExoMars mission.

1. Skelley, A.M. *et al.,* (2005) *Proc. Natl. Acad. Sci. U.S.A.* **102,** 1041-1046.