RECOVERY OF ORGANICS AND BIOMARKERS FROM MARS ANALOGUES AND METEORITES: EXTRACTION AND QUANTITATIVE ANALYTICAL CHALLENGES. P. Ehrenfreund[1], R. Quinn[2], Z. Martins[3], S.O.L. Direito[4], B.H. Foing[4,5], M.J. Kotler[6],W.F.M. Röling[4]. [1]Space Policy Institute, Washington DC, USA (email: pehren@gwu.edu), [2]NASA Ames Research Center, Moffett Field, CA 94035, USA**,** [3]Dept. of Earth Science and Engineering, Imperial College London, London, UK, [4]Vrije University Amsterdam, NL, [5]ESTEC, SRE-S, Postbus 299, 2200 AG Noordwijk, NL, [6]Leiden Institute of Chemistry, Einsteinweg 55, 2333CC, Leiden, NL

Introduction: The analytical precision and accuracy obtainable in modern Earth-based laboratories exceeds that of any in-situ instrument onboard spacecraft. Therefore, a sample return mission to Mars has been identified as the highest priority for future Mars exploration. The Mars science community, in their inputs to MEPAG and the 2011 Planetary Decadal Survey, voiced that carefully selected samples from well-chosen sites would be the means to make the greatest progress in Mars planetary exploration and the search for life in the solar system. Compiled data from Mars orbiters and Mars rover surface operations help to define the best possible landing sites for future missions that will cache samples from regions that may harbor organic compounds (intrinsic or delivered). The landing sites for current and future missions target predominantly regions with a geological history facilitating the formation and preservation of organic molecules over long time scales. Therefore, environments that witness aqueous mineral processing, (e.g., phyllosilicate environments) are of particular interest. For future missions, the successful hunt for organic molecules and biomarkers will require consideration of several parameters including, deposition history and diagenesis, preservation potential, extractability and the instrument performance.

Challenges: The most sensitive techniques used to date to extract extraterrestrial organic matter from its host matrix use several extractions steps including water, solvents, heating cycles and chromatographic purifications. Extraterrestrial samples such as the Murchison CM2 meteorite contain amino acids at ppm concentrations; even 20 times larger concentrations of amino acids are recently found in Antarctic CR2 meteorites [1]. In comparison, concentrations of amino acids in samples from dry deserts such as Atacama are often devoid of recoverable amino acids or at the detection limit in Earth laboratories (< ppb concentrations). Tests in extreme environments on Earth have shown that even without restricted sample access, the recovery of organics in such materials is challenging [2]. Recent results from astrobiology field research have indicated that soil porosity and low clay-particle content seem to be correlated with extractability of organics and DNA. Even with access to analytical accuracy and sensitivity of Earth-based laboratory experiments that involve solvent extraction and amplification neither DNA nor amino acids could be detected in many samples [3,4]. In fact, clay material is known to strongly adsorb and bind organic molecules, often preventing extraction by even sophisticated laboratory methods. Additionally, our results show dramatically low DNA recovery from clay-rich Utah desert samples that were spiked with a PCR fragment of the yeast *Saccharomyces cerevisiae* hexokinase1 (YHXK1) gene. Furthermore, the analysis performed on deserts samples has shown that organics (e.g. amino acids) and microorganisms have patchy distributions, with concentrations either above or below detection limits for samples collected within several meters proximity [5].

These issues not only complicate future *in situ* searches for biomarkers and organic compounds on Mars, but also the selection of samples for return to Earth. The complexity of searching for life traces on Mars reinforces the continuing need for ground truth studies to enable the successful detection and characterization of organics on Mars. Ground truth studies must include Mars analogue field research in extreme environments, laboratory investigations of biota and biomarker chemistry under Mars conditions (e.g., radiation, temperature, oxidation, racemization) as well as supporting analytical methods (e.g., optimizing extraction procedures that can release adsorbed biological compounds) We provide a comparison of results from recent analogue field tests in the Atacama and Utah desert and meteoritic sample analysis as well as a discussion of amino acid extraction and DNA binding on Mars analogue samples.

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