SUBSURFACE PROFILES OF ORGANICS OBTAINED BY CORE DRILLING IN JURASSIC SEDIMENTS AT A MARS ANALOG SITE IN UTAH.

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Introduction: Upcoming missions to Mars, including the en route Mars Science Laboratory and the planned ExoMars drilling rover, are targeted to find a history of habitable conditions including organic compounds that may indicate a record of life. Landing sites selected for these missions access deposits formed during an era on early Mars where liquid water occurred as suggested by the presence of phyllosilicate, sulfate, and carbonate minerals. The MSL rover carries a shallow (5 cm deep) drill with which to get unoxidized samples from beneath the surface of rocks. The ExoMars rover plans for a coring drill with 2 m depth access, in order to reach samples with potential pristine biology not sterilized by cosmic radiation. We are investigating the importance of and strategy for drilling on Mars to search for biological organic deposits by analyzing drilled samples from a Mars analog site in Utah [1,2].

Methods: We obtained core samples in two locations in Jurassic era (150 MY old) Morrison Formation sediments located near the Mars Desert Research Station in Utah (38°25'23.25" N, 110°47'30.85" W). The first drill site (Site 1) was located in a fossil soil developed on siltstones having evidence of bioturbation and insect burrows (Figure 1). The second drill site (Site 2) was located in a paleochannel deposit (Figure 2). Many such channel sandstones are found in the study area and often form inverted relief [3]. The deposit drilled was a flat-lying white sandstone with small orange concretions projecting from its surface that are morphologically similar to those found in the Burns formation at Sinus Meridiani.

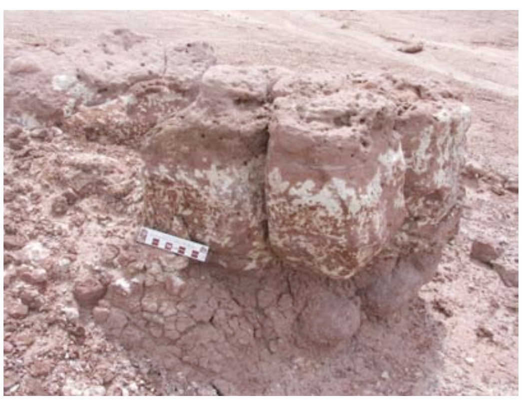

Figure 1. Fossil soil at drill Site 1

Figure 2. Flat lying concretion bearing sandstone at drill Site 2.

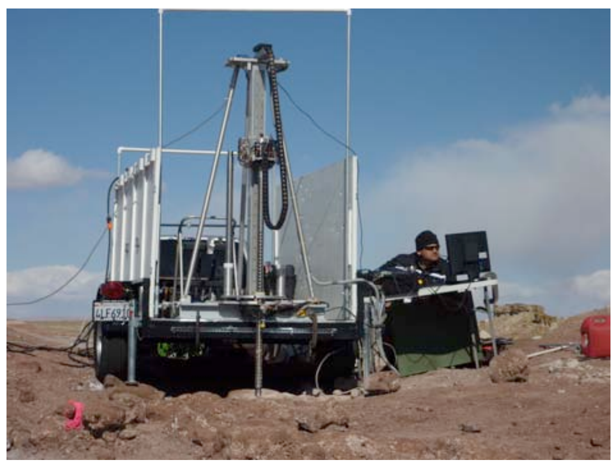

Figure 3. Drilling at Site 1 with the MARTE drill mounted in a towable trailer.

Drilling was performed using the MARTE drill [4] a coring drill originally developed under ASTEP funding as a prototype for future Mars drilling missions. Figure 3 shows the MARTE drill operated in the field. Core samples were acquired using clean and sterile coring equipment, without the use of aqueous drilling fluids, although compressed air was used to aid clearing cuttings from the auger flights of the drill. Labile organic carbon (LOC) in the core samples was determined by titration with the oxidation of permanganate and acid hydrolysis [5]. This method has demonstrated high reproducibility and sensitivity in hyper-arid soils of the Atacama desert where recalcitrant organic matter is mostly, if not completely, absent. The advantage of the acid hydrolysis is that it isolates the biologically active labile fraction of organic carbon from the mineral matrix before the potassium permanganate oxidation, and eliminates the complications associated with the Walkley–Black method of permanganate oxidation directly in the soil matrix. Importantly, labile organic carbon is more susceptible to geochemical oxidation such as oxidant minerals and/or atmospheric radiation, which are expected on Mars surface and near subsurface. Mineralogy of the core samples was analyzed using an **In Xitu** Terra field portable X-ray Diffractometer, a commercial version of the CHEMIN instrument carried by the MSL mission.

Results: Figure 4 shows the vertical profiles of LOC for each drill site.

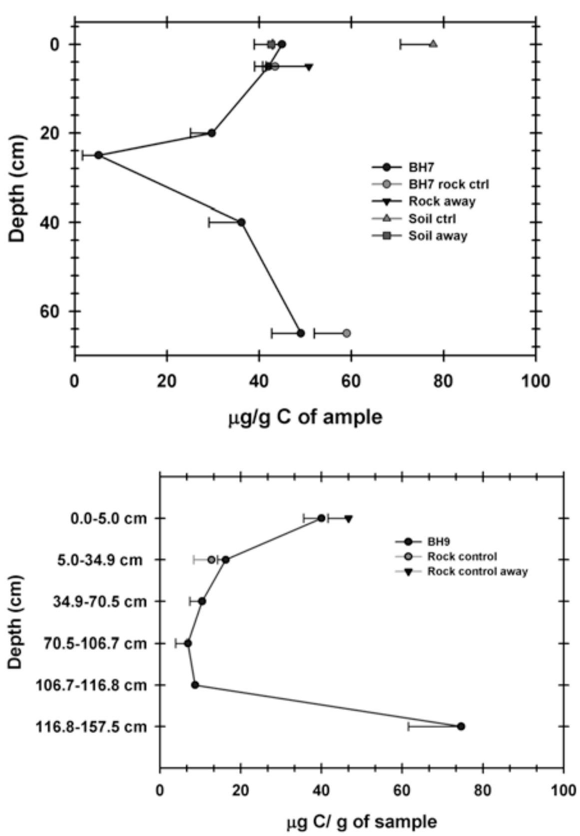

Figure 4. Vertical profile of organics from drill site 1 (top) and 2 (bottom).

At both sites the organics decrease from the surface to reach a minimum value in the subsurface and then increase thereafter. We interpret the decrease from the surface to subsurface to a combination of modern organic input at the surface and oxidation processes that destroy the ancient subsurface organics to some depth. Similar profiles are expected to occur on Mars, absent the modern input of organics at the surface.

Conclusions: Drilling allows samples to be obtained from depths below surface influences. This minimizes surface contamination and maximizes biogeochemical signatures that are destroyed or modified by surface processes. Our drilling shows that in slightly weathered surface rocks the effect of surface contamination and weathering to the organic geochemistry can be differentiated from that of the original lithology.

On Mars, surface samples will likely have any biogeochemical signatures modified or destroyed by surface processes, including UV exposure and surface-derived oxidants [6]. Our results from drilling into ancient sediments in Utah show that detailed sampling down the length of core allows both the detection of original biogeochemical signatures and the quantification of surface-derived modification. We emphasize the importance of such detailed depth profiles in any analyses of drill samples on Mars.

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References: [1] Stoker et al., *Icarus*, Submitted, 2011. [2] Stoker et al., *Int. J. Astrobiology* 10, 269-289, 2011. [3] Clarke and Stoker, *Int. J. Astrobiology* 10, 16-175, 2011. [4] Stoker et al., *Astrobiology 2008* DOI:10.1089/ast.2007.0217. [5] Valdivia-Silva et al., *Geochim. Cosmochim. Acta* 75 (7), 1975-1991, 2011. [6] Bullock et al., *Icarus* 107, 142-154, 1994.