PRESERVATION OF ORGANICS AT THE PAINTED DESERT: LESSONS FOR MSL AND BEYOND.

E.Z. Noe Dobrea[1,2], A.C. McAdam[3], C. Freissinet[3], H. Franz[3], I. Belmahdi[3], M.R. Hamersley[4], C.R. Stoker[2], W.G. Parker[5], D.P. Glavin[3], F. Calef[6], and A.D. Aubrey[6]. [1]Planetary Science Institute (eldar@psi.edu), [2]NASA/ARC, [3]NASA/GSFC, [4] Soka University of America, [5]Petrified Forest National Park, [6]NASA/JPL.

Introduction: One of the foci of the Mars exploration program is the search for organics and evidence for past life. Phyllosilicate and sulfate deposits are widely observed on Noachian and Early Hesperian terrains on Mars, and the association of similar ancient terrestrial deposits with high concentrations of organics makes these martian deposits viable and attractive targets. Here, we examine sediments from a Mars-analog material, the Painted Desert sediments, to investigate the mechanisms of organic preservation in fluvio-lacustrine systems.

The Painted Desert of northern Arizona consists of 215 My old, interbedded layers of mudstones, sandstones, and limestone deposited in a fluvio-lacustrine and deltaic environment [1]. Trapped in some of these layers is biogenic organic carbon that was rapidly buried in the prograding beds and floodplains of the system [2,3].

The spectral and morphological character of the Painted Desert appears analogous in many ways to that of the Al-phyllosilicate-bearing units at Mawrth Vallis, Mars. Both regions present evidence for fluvial activity and have thick Al-phyllosilicate sequences containing Al-smectites, kaolins, hydrated silica, and jarosite [*e.g.* 4]. These similarities make the Painted Desert a potential geological and compositional martian analog. We seek to understand how the chemistry and textural character of these units play a role in the preservation of organic compounds.

Previous Work: In a previous study, we focused on relationships between organic content, rock-type, and color of the host rock [5]. We found typical concentrations of a few tens of mg C/kg in smectite deposits and C:N ratios between 1 and 10. The latter are lower than would be expected for terrestrial flora, indicating either diagenetic loss of C or allochthonous sources of N during diagenesis. We also found organic-rich (>300 mg C/kg) pieces of dark calcite (interpreted as calcified wood) coated by a jarosite rind and embedded in the clay beds. We noted the contrast with silicified logs that were embedded in sandstone-rich layers.

In the present study, we tested new hypotheses:

H1. The calcite nodules are calcified trees.

H2. Silicification occurs preferentially in highly permeable sandstone beds, whereas calcification occurs in the lower permeability mudstone beds.

H3. Silicification does not preserve organic carbon as effectively as calcification in these beds.

H4. A correlation exists between organic carbon content and the presence of jarosite in these rocks.

Current Results: High organic carbon concentrations (500-1500 mg C/kg) were found in jarosite-bearing mudstones targeted via remote sensing, in dark calcite nodules, in jarosite precipitates coating the calcite, and in sandstones encasing these nodules. Low organic carbon content (ca.30 mg C/kg) was found in the jarosite-free clay beds and in the silicified wood. In general, we found neither host rock tonality nor grain size to be a good predictor of organic content.

Unexpectedly, we also found dark calcite nodules and jarosite precipitates in the same sandstone layer as the silicified wood and only a few tens of meters away from it. Hence, the mechanism by which organics are calcified, rather than silicified, remains unknown. Further sampling and analysis of this layer will be one of the objectives of future study.

GCMS and EGA analyses provided greater insight into the presence and distribution of organics. Organic fragments evolved at the same temperatures of gas releases (SO_2, H_2O, CO_2) that result from mineral decomposition at high temperatures, suggesting that some organics were trapped within sample minerals. Data from GCMS flash pyrolysis to 900ºC indicated the presence of aromatics with up to three rings. Subsequent water/isopropanol extraction of the organic content of the sample followed by MTBSTFA derivatization, allowed measurement of the most refractory organic molecules present in the samples: numerous amino acids were detected, in addition to carboxylic and dicarboxylic acids, alcohols, aliphatics and other complex molecules.

Discussion: Although the identification of organics in these rocks is not necessarily surprising, the apparent lack of correlation in organic carbon concentration and rock type is somewhat perplexing, as one expects organics to be better preserved in mudstones than in sandstones. This suggests that additional parameters must be taken into account when considering the preservation of organics. The detection of organics in association with jarosite precipitates points to a mechanism of preservation that should be of high interest to MSL and future missions. These results are especially compelling in light of the recent identification of organics by MSL/SAM in the Murray mudstones [6,7].

References: [1] Allen (1930). *Amer. J. Sci.* doi:10.2475/ajs.s5-19.112.283 [2] Demko *et al.* (1998) G*eology*. [3] Ash and Creber (2003) *Paleontology* 43. [4] Noe Dobrea *et al.*, (2011) *Mars Journal*, 6. [5] Noe Dobrea *et al.*, (2011) *MSL 5th Landing Site Workshop*. [6] Eigenbrode et al. (2015) AGU. [7] Freissinet et al. (2016) *LPS XLVII*.