MICROBIAL SURFACE ALTERATION IN MARS-ANALOG GLACIO-FLUVIAL SETTINGS: IMPLICATIONS FOR BIOSIGNATURE DETECTION IN RETURNED SAMPLES. C. Demirel-Floyd[1], G. S. Soreghan[1] and M. E. Elwood Madden[1], [1] *School of Geosciences, University of Oklahoma, 100 E Boyd St., Norman, OK 73019 USA.* cansu.demirel@ou.edu

Introduction: There are two trillion galaxies in the observable universe according to Hubble observations [1]. The most conservative models estimate ~300 million to 2.5 billion potentially habitable worlds in our galaxy [2]. Therefore, one of the primary goals of astrobiology research is to develop and test potential biomarker proxies that can help us determine if we are alone in the universe, and our first test is Mars [3].

Based on previous missions and analog experiments on Earth, the harsh conditions on Mars make extant life unlikely on the surface. Instead, astrobiologists have focused on seeking biosignatures in the Martian subsurface, where they have higher preservation potential [4]. These studies depend on terrestrial analogs to develop and test methods to detect molecular or inorganic biosignatures [3,5]. Permafrost and glacio-volcanic sediments are such analogs where biosignatures can be preserved over geological time [6].

Here we investigate microbial surface alteration via silicate bioweathering experiments on Icelandic and Antarctic glacio-fluvial sediments to determine putative inorganic biosignatures (biominerals and patterns of leached solutes) formed in glacio-volcanic terrains and permafrost soils.

Methods: We obtained the fine (<63μm) silicate fraction of Icelandic (Eyjafjallajökull outwash, mafic) and Antarctic (Onyx River, mostly felsic) meltwater stream sediments by wet sieving and treating them with acetic acid and hydrogen peroxide to remove the secondary carbonates and organic matter, respectively [7-9]. We compared biological and chemical weathering processes using UV-sterilized sediments in 0.1X BG11 medium with and without the Antarctic cyanobacteria *Leptolyngbya glacialis* (ULC073), respectively, at the culture's optimum growth temperature-12°C, analogous to warming permafrost temperatures in Antarctica [7,10]. We collected samples weekly over four weeks and analyzed the water chemistry (pH, solutes), chlorophyll-a in the microbial mat. We looked for mineral biosignatures and weathering textures via Scanning Electron Microscopy (SEM), coupled with Electron Dispersive Spectroscopy (EDS) measurements. We used t-tests, Pearson's Correlation, Principal Component Analysis (PCA) and ANOVA statistical analyses to identify significant differences between the parallel experiments.

Preliminary Results and Implications for Biosignatures on Mars: Silicate weathering rates were up to 3-folds higher in the presence of microbes in both Antarctic and Icelandic experiments. Given that alkalinity was also 4-fold higher, and pH increased up to 8 in the biotic reactors, we conclude that photosynthesis caused the most significant changes in the aqueous environment, accompanied by increasing Al and Si concentrations, which are highly correlated in the biological experiments, but are only weakly or not correlated in the abiotic experiments. We observed decreasing macro- and micro-nutrient (Ca, Mg, Mn, P, N) concentrations, potentially due to utilization for photosystems in the biological experiments; however, these were almost constant in the abiotic ones.

SEM-EDS analysis on Iceland experiments revealed potentially neoformed clays, nano-phase Fe-(oxy)hydroxide minerals in association with biofilms and cell surfaces, and filament-shaped etch pits that we did not detect in abiotic chemical weathering experiments. Importantly, we also observed similar Fe nanominerals on biofilm-etched surfaces in Antarctic drift deposits from Taylor Valley, where cyanobacterial mats are common [10]. These results indicate that microbes can change surface chemistry via weathering under biofilms, producing secondary minerals, while remaining protected from harsher surface conditions.

We propose to search for such inorganic biosignatures that may be indicative of biofilms in samples returned by the Mars 2020 mission and the future missions. As biofilms could degrade in extreme environments, our future directions will include determining preserved organic and inorganic tracers of biofilms at various Mars-analog extremes via Raman spectroscopy to aid rovers and future extraterrestrial cave explorers to detect mineral biosignatures in-situ.

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References:[1] Conselice C. J. et al. (2016) arXiv:1607.03909v2 [2] Bryson S. et al. (2020) *AJ, 161,* 36. [3] MEPAG (2020) [4] Phillips-Lander C. et al. (2020) *38th MEPAG* [5] Banfield J. F. et al. (2001) *Astrobiology, 1(4),* 447-465. [6] Hays L. E. et al. (2017) *Astrobiology, 17(40),*363-400. [7] Demirel-Floyd C. et al. (2020) *51st LPSC*, Abstract #2238 [8] Demirel C. et al. (2018) *49th LPSC*, Abstract #1542 [9] Marra K. et al. (2017) *Geomorphology, 281,* 13-30. [10] Dolgikh A. V. et al. (2015) in *The Soils of Antarctica,* 45–63.