PROTOCOL FOR BIOSIGNATURE IDENTIFICATION IN WET AEOLIAN DEPOSITS, USING µXRF ANALYSES THAT SIMULATE THE PIXL INSTRUMENT ONBOARD THE MARS 2020 ROVER. M. Nachon[1], R.C. Ewing[1], M.M. Tice[1]. [1]Texas A&M University, Department of Geology & Geophysics (mnachon@tamu.edu, marion.nach@gmail.com).

Introduction: The NASA *Mars 2020* rover key objective is to search for potential biosignatures **[1]**. Onboard the rover, the PIXL (Planetary Instrument for X-ray Lithochemistry) instrument will use the XRF (X-ray fluorescence) technique, coupled to a high-resolution imager, for examining fine scale chemical variations of Mars samples **[2]**.

We aim to define a protocol that guides the detection of potential biosignatures on Mars using PIXL. Here we focus on microbial biosignatures specifically in wet aeolian deposits, because wind-blown environments (1) are a recognized extreme habitable environment on Earth, (2) have also been identified in the modern and ancient geological record on Mars via the Opportunity and Curiosity rovers **[3,4]**, and (3) yet have received little attention as an environment of interest for recording microbial biosignatures.

Methodology and Data: This research project includes (1) field work in environments holding record of microbial mats and aeolian deposits, (2) compositional analyses in order to identify biosignatures, and (3) µXRF analyses analogous to the PIXL instrument.

Field work was conducted in the modern wet aeolian dune field of Padre Island National Seashore (PAIS), Texas **[5]**. To access the stratigraphy of aeolian deposits and buried microbial mats, we dug trenches (up to 65cm deep) and collected sediment peels. We performed compositional XRF analyses both on surface samples and on the different horizons exposed along the trenches **[6]**. Complementary mineralogical analyses were performed via X-ray diffraction **[6]**.

Field samples were analyzed in order to identify the criteria that correspond to biosignatures identification in these aeolian deposits **[6]**. The aim being to identify the characteristics exclusive to the microbially-related layers, and distinct from the ones of "non-biotic layers".

For µXRF analyses, a benchtop Horiba XGT7000 (from M. Tice Lab., at Texas A&M University) was operated with a 100µm probe head, on the sediment peels collected from the trenches in the field.

Results: Here we present and compare four PIXL-like µXRF analyses, performed onto a sediment peel that includes buried microbial crusts (area of interest 1) and aeolian horizons (area of interest 2) (Fig. 1). Each area of interest is analyzed using 2 types of PIXL-like µXRF "scans". Line scans correspond here to 3 contiguous lines of 20mm length, spaced apart by 2mm (Fig. 1B). Map scans correspond here to 24x24mm mapping areas (Fig. 1B,C).

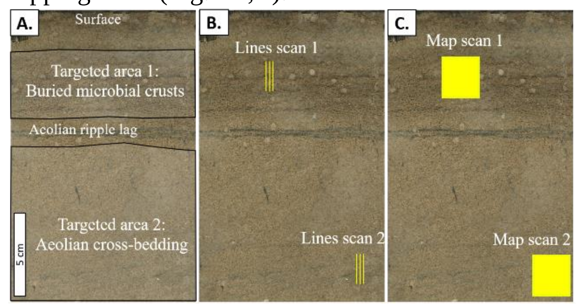

*Figure 1: Example of PIXL-like analyses footprints (**B.**,**C.**) onto areas of interest of a sediment peel (**A.**).*

Figures 2 and 3 show the two types of PIXL-like analyses performed on the buried microbial crusts horizon (area of interest 1). In Fig. 2, for each of the 3 lines scan (A,B,C) the corresponding µXRF peak intensities of Fe and Ti are plotted. This allows to visualize the variability in composition along the scan, and to identify where Fe and Ti are being co-detected.

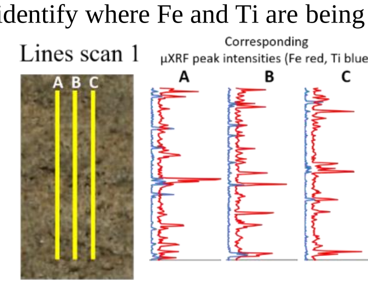

*Figure 2: Fe and Ti µXRF peak intensities of the three lines (A,B,C) of **Lines scan 1** (Fig. 1B).*

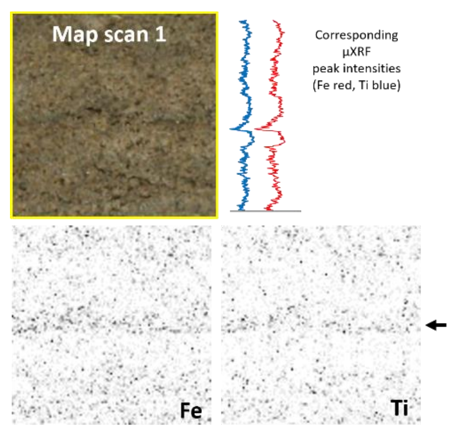

*Figure 3: Fe and Ti µXRF maps of **Map scan 1** (Fig. 1C) and corresponding µXRF peak intensities profile (average over the entire map).*

On the map scan analysis (Fig. 3) µXRF maps of both Fe and Ti (in grayscale intensity, where black corresponds to the strongest peak intensity and white corresponds to non-detection of the element) display a higher concentration along a disrupted lamination (highlighted by the black arrow). The Fe and Ti peak intensities profile (averaged over the entire map scan) show similar behavior along the profile, hence also suggesting that they are co-located, and present in the same mineral phases.

Figures 4 and 5 show the two types of PIXL-like analyses performed on the aeolian cross-bedding horizon (area of interest 2). On the map scan (Fig. 5) both Fe and Ti maps clearly highlight the cross-bedded structure (highlighted by the black arrows). The µXRF color composite image represents yet another way of identifying if and where chemical elements are co-located in the map.

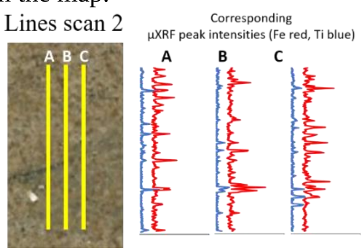

*Figure 4: Fe and Ti µXRF peak intensities of the three lines (A,B,C) of **Lines scan 2** (Fig. 1B).*

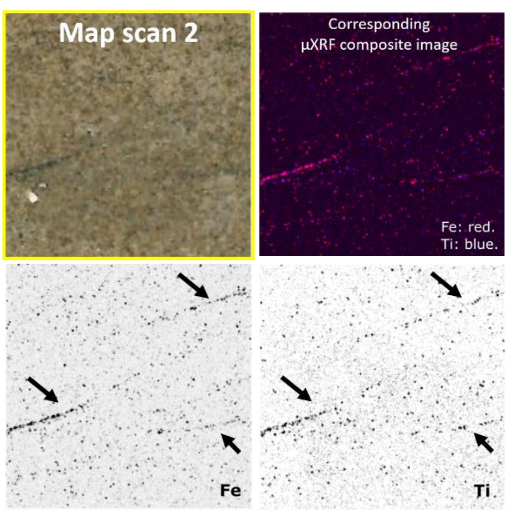

*Figure 5: Fe and Ti µXRF maps of **Map scan 2** (Fig. 1C) and corresponding µXRF color composite image.*

Discussion and ongoing work: These results allow to compare two types of PIXL-like analyses over two areas of interest: one biosignature-bearing, the other being purely aeolian in origin. The µXRF map scans appear particularly efficient at highlighting the presence of structures such as the disrupted laminations corresponding to the buried microbial crusts (Fig. 3), as well as the aeolian cross-bedding (Fig. 5). Such structures might also be identified using the Line scans. In particular, several line scans over a single horizon of interest seem to capture its lateral variability. This is particularly true when structures of interest are horizontal (such as the buried crusts). In both cases, the ability to compare the geochemical results with the imagery appears essential.

For identifying the horizon bearing the buried crusts, it seems that apart from targeting PIXL analyses on the area of interest 1 (Fig. 1A), a comparison with other horizons not bearing potential biosignatures is needed. This allows to identify the morphological and/or compositional criteria that are unique to the biosignature.

When operating on Mars, the choice of PIXL targets and analyses types will also depend on the time available in the Mars 2020 rover operations schedule. It is currently estimated that is would take from ~30 min for a single PIXL line scan, to ~16 hours for a 75mm^2 high-resolution map. Thus, in addition from determining the criterions that would streamline biosignature detection and identification by the PIXL Team, we are also working on determining optimal number, size, and distribution of PIXL analyses in order to asses biosignature identification.

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References: **[1]** Mars 2020 Report; Science Definition Team (2013). **[2]** Allwood A. et al., (2015). 10.1109/AERO.2015.7119099. **[3]** Grotzinger J. et al., (2005) Stratigraphy and sedimentology of a dry to wet eolian depositional system, Burns formation, Meridiani Planum, Mars, *EPSL*. **[4]** Banham S. et al., (2018) Ancient martian aeolian processes and palaeomorphology reconstructed from the Stimson formation on the lower slope of Aeolis Mons, Gale crater, Mars, *Sedimentology*. **[5]** Ewing R.C. et al., (2018) Distribution of mat biosignatures in a wet aeolian system, *ICAR abstract*. **[6]** Tice M. et al., (2019) Microbial Communities from Wet, Windy Environments on the Modern and Ancient Earth: Lessons for Astrobiology during the Mars 2020 Mission, *AbSciCon abstract*.