PROTOCOL FOR BIOSIGNATURE IDENTIFICATION IN WET AEOLIAN DEPOSITS, USING MICRO-XRF ANALYSES THAT SIMULATE THE PIXL INSTRUMENT ONBOARD THE MARS 2020 ROVER. M. Nachon[1], R.C. Ewing[1], M.M. Tice[1], H.J. Patel[1], K. Cheffer[1], M. Coker[1]. [1]Texas A&M University, Department of Geology and Geophysics, College Station, TX. (marion.nach@gmail.com)

Introduction: A 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 biosignatures on Mars using PIXL. Specifically, we focus on identifying microbial biosignatures, via XRF, in wet aeolian deposits.

Methodology and Data: This research includes field work on aeolian and microbial deposits, XRF analyses, and participative "survey", in order to construct the PIXL for identifying biosignatures.

1) Field work and compositional analyses: Field work was conducted in the modern wet aeolian dune field of Padre Island National Seashore (PAIS), Texas **[3]**. To access the stratigraphy of aeolian deposits and buried microbial mats, we dug trenches up to 65 cm deep and exposed layers of aeolian cross-stratification and interdune deposits. We collected sediment peels, and performed compositional XRF and micro-XRF analyses analogous to the PIXL instrument **[4]**. Complementary mineralogical analyses were performed via X-ray diffraction **[4]**.

2) Biosignature identification criteria: Field samples were analyzed in order to identify the criteria that correspond to biosignatures identification in these aeolian deposits **[4]**. The aim was to pinpoint the characteristics exclusive to the microbially-related layers, and distinct from "non-biotic layers". In particular, we aimed to establish the morphological and compositional characteristics of the layers related to microbial organisms and determine changes in composition of these layers by burial.

3) Protocol construction: Based on the biosignature criteria, we constructed a protocol that guides the potential detection and identification of biosignatures. Our broad aim was to define the key observations and analyses that could be performed with PIXL in order to streamline decision making. At a more technical level, this protocol aims to provide guidance on the optimization of the PIXL's measurement modes themselves: based on the sequences pre-defined by the PIXL Team **[2]**, the goal is to determine optimal number, size, and distribution of PIXL analyses in order to asses biosignature identification.

4) Participative survey for biosignature seeking: We developed a survey that allows participants to "examine" our field samples by defining locations of interest for potential biosignatures and selecting PIXL-like measurements locations and types. The aim is both to study the scientists' approaches when searching for potential biosignature and provide feedback on the best protocol to use.

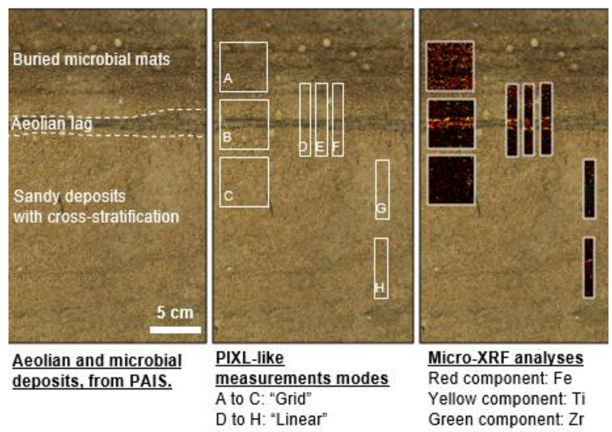

Figure 1: Micro-XRF analyses simulating PIXL measurement modes (see [2]), onto aeolian and microbial deposits from PAIS.

Results: For biosignature identification, criteria considered are both compositional (via XRF analyses) and morphological.

In our PAIS samples, XRF analyses indicate that geological horizons associated with microbial mats have a signature in Fe, Ti, Zr distinct than/from the "non-biotic" horizons **[4]** (Fig. 1). Specifically, buried microbial mats show an ilmenite content lower than the surface microbial crusts and other abiotic deposits **[4].** We hypothesize that ilmenite is altered in the initially oxidizing mat and Fe is leached as the mat is buried and degraded **[4]**. Morphologically, buried microbial mats appear as dark diffuse or cryptic laminations.

Based solely on imagery observation of PAIS trenches, participants of our survey tend to select those horizontal layers, distinct in color from the surrounding sandy layers (Fig. 2).

Based on preliminary results, the PIXL-like measurement modes that are more commonly picked are a combination of "linear" and "grid" analyses (see Fig. 1). Participants often locate them at the interface of layers, to capture compositional differences of different geological horizons. Also, some participants choose to favor replica analyses.

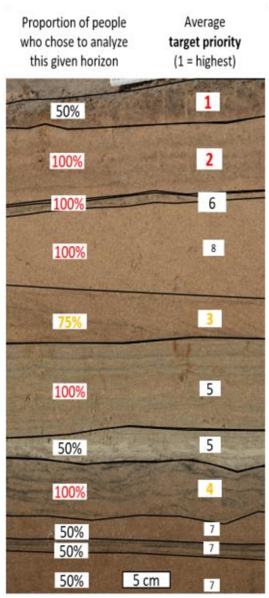

Figure 2: Example of survey results, for selection of geological horizon with biosignature-bearing potential (left column), and thus of interest to be characterized via PIXL-like analyses, and with which scientific priority (right column).

Perspectives: Based on the morphological and compositional criteria for biosignatures identification in some PAIS samples, we aim to study other aeolian environments with microbial mats, in order to test and optimize these criteria, and make them suitable for detection of microbial biosignatures in aeolian deposits, broadly defined. First, we will consider other locations in PAIS, to assess the regional variability of the deposits. Subsequently, we will consider ancient (Jurassic) aeolian rocks, which host microbial-related geological horizons.

Additionally, we will pursue the test of which PIXL-like measurement modes are the optimal. We will take into account technical rover mission constraints, such as the expected time and data volume of the distinct PIXL analyses.

We also plan to further develop the participative survey. We will circulate it to a broader community, in order to increase and diversify the expertise of participants. This will allow us to study the influence of scientific backgrounds present in the Mars 2020 Team on target selection.

Finally, we aim to develop a protocol that takes into account the broader context of the *Mars 2020* mission (Fig. 3), including coordination with other instruments, up to the influence of PIXL analyses to guide the ultimate goal of the *Mars 2020* rover: selection and collect of cached samples **[1]**, that will be brought back to Earth.

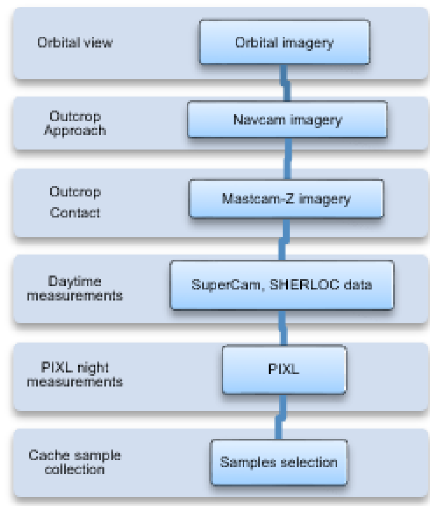

Figure 3: Global context of successive steps for PIXL decision making, when the Mars 2020 rover will be operated.

References: **[1]** Mars 2020 Report; Science Definition Team (2013). **[2]** Allwood et al., (2015). 10.1109/AERO.2015.7119099. **[3]** Ewing et al., (2018) https://colloque.inra.fr/icar2018/content/download/3917/40812/file/ewing_microbes_final.pdf. **[4]** Patel H. et al., (2019), this issue, Abstract #2113.
NASA SSW GRANT #80NSSC17K0763.