MAPPING MINERALOGY AND WET/DRY CYCLES IN ACIDIC SALINE LAKES IN WESTERN AUSTRALIA. T. A. Plattner[1], B. E. Schmidt[2], A. Baldridge[3], J. M. Weber[4], M. A. Birmingham[5], P. Doran[6], E. Ingall[1], J. Wray[1], F. Rivera-Hernandez[1], J. S. Bowman[7], S. Som[8], A. Schartup[7], S. Buessecker[9], E. Quartini[2], L. Fisher[7], E. Paris[9], B. Klempay[7], M. Weng[10], C. Sephus[7], C. Pozarycki[1], A. Odenheimer[11], the Esperance Tjaltjraak Native Title Aboriginal Corporation[12], M. Towner[13], and the OAST Team. [1]School of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta, GA (tplattner24@gatech.edu). [2]Department of Earth and Atmospheric Sciences, Cornell University (britneys@cornell.edu). [3]Saint Mary's College of California. [4]NASA Jet Propulsion Lab, California Institute of Technology. [5]University of Kansas. [6]Louisiana State University. [7]University of California, San Diego. [8]Blue Marble Space Institute of Science. [9]Stanford University. [10], Georgetown University. [11]University of California, Los Angeles. [12]Esperance, WA, Australia. [13]Curtin University, Perth, WA, Australia.

Introduction: The Western Australia Transient Lakes (WATL) located across the Yilgarn Craton change over time, fluctuating in depth due to varying wet/dry stages from the influx of groundwater and rainwater [1-3]. As these cycles occur, properties related to habitability and organic compound stability such as ionic composition, pH, salinity, and water activity can vary, influencing salt precipitation and biomarker preservation. The abundance of evaporative minerals such as halite and gypsum in the WATL and salt crusts along the WATL shorelines could provide a remotely observable indication of the environmental cycling and preservation potential.

Additionally, studying the geochemistry [4] and environmental parameters [5] in these lakes will provide insight to the starting bulk composition of the water column, which is needed to contextualize the remote sensing to fully understand what salts could precipitate out of the lakes when they go through evaporative stages. This will give context to where biomarkers are more likely to be found [6] and connect the features to the environment they are found in. Understanding the influence of varying ionic concentration and composition across multiple WATL field sites on these processes will allow me to connect between the orbital observations, environmental data, and preservation and extrapolate lessons learned to the history of environments on Mars and how these may have altered or preserved biomarkers.

Objective: To choose from the hundreds of shallow lakes within the Yilgarn Craton, we down selected lakes of interest using band indices [7] and were able to narrow down our list of 80 lakes to roughly 40 lakes for our 2022 field campaign to the WATL. During our fieldwork, we sampled 40 lakes and obtained *in situ* data of each lake environment with our suite of instruments similar to what is on many Mars rover missions: a portable spectrometer, LIBS, XRF, and Raman instruments. Additionally, we used spectral data from the Operational Land Imager (OLI) on the Landsat 8 & 9 spacecrafts to determine what type of evaporative minerals they contain and what wet/dry stages these lakes were in during the time of our fieldwork, and over the last year.

Methods: To do this analysis, we obtained Landsat 8 & 9 Collection 2 level-2 data from USGS. Using this data, we utilized Radwin and Bowen's 2021 method for identifying halite and gypsum with the use of band indices [8] to map the mineralogy in the WATL.

Preprocessing: First the removal of bedrock, water, and vegetation was done for each lake environment, so that each lake deposit was mapped accurately [8].

Band Indices: Then band indices [8] for gypsum and halite were completed, and an RGB image of those band indices and a classification image was produced to map the evaporites in each lake environment. The following band math indices were used to map halite and gypsum with Landsat 8 & 9 Collection 2 level-2 data:

- Halite: (Red – SWIR1)/(Red + SWIR1)
- Gypsum: (SWIR1 – SWIR2)

Additionally, using band indices [8] and through spectral classification we were able to map water in the lakes over time, which helped us get a clearer picture of what is happening with the water chemistry and the minerals as these lake environments go through wet/dry cycles.

Classification: Lastly, we classified our field sites using the Spectral Hourglass Wizard tool in ENVI, and we have further identification of the minerals in these environments through our *in situ* and lab-based analyses from the portable spectrometer, XRF, Raman, and LIBS instruments.

Results: From the analysis, various images (e.g. *Figures 1-2*) were produced for different months spanning the last year, including the time of our fieldwork in August 2022. Here we focus on the Landsat 9 image taken on January 3rd, 2022 of our F21 field site to show our methods clearly, since during our fieldwork the lakes were flooded and very little evaporites were seen along the shoreline. For each image acquired, a true color image (*Figure 1*) was produced along with monochromatic images of our band indices, an RGB image (*Figure 2*), and a classification image (*Figure 2*) were also produced. From these distinct images we estimated the distribution of gypsum and halite surrounding the lakes. Additionally, by comparing different months in a calendar year we characterized the seasonal variability in gypsum and halite, along with mapping how the water dried up over time during these wet/dry cycles. From the remote sensing, there is notably more halite and gypsum overall in the WATL during December - February relative to other months. consistent with undergoing a seasonal dry cycle at this time. We observe increased abundance of evaporate minerals visible near their shores during local summer.

Figure 1: This is a true color image of our F21 field site taken on January 3rd, 2022 and the Landsat reference number is LC09_L2SP_109083_20220103_20220122_02_T1. The red points represent the areas we sampled during our August 2022 fieldwork.

Furthermore, remote detection of mixtures of halite and gypsum within our field site, agrees with the field spectroscopy recorded at this lake environment with handheld sensors. *Figure 2* shows the salt mixture in yellow, and resolves variability in the surrounding geologic units, where sand and weathered rock are shown in cyan and orange that were confirmed *in situ* during our field campaign. These preliminary results suggest that spectral unmixing and further pixel-scale and spatial investigation may be fruitful for representing accurately what is present in these locations (e.g. diagenetic veins and clay minerals). Thus, in an environment such as our F21 field site, we can use a combination of *in situ* and remote sensing to connect the geochemistry, extremely weathered minerals, and evaporites to describe what is happening in the lakes as they continually go through wetting and drying cycles.

Future Work: We plan on continuing to map the minerology in these environments through the method [8] for all the field sites that we visited. We are currently working to analyze more of the *in situ* data from the Raman, LIBS, XRF, and spectrometer results. Finally, we will extend the environmental characterization surrounding the salt pan in *Figure 2* to disentangle the signals from salt pans, large outcroppings of weathered rock, and windblown salt from the lake, resulting in a spectrum from that area that is a mixture of various minerals.

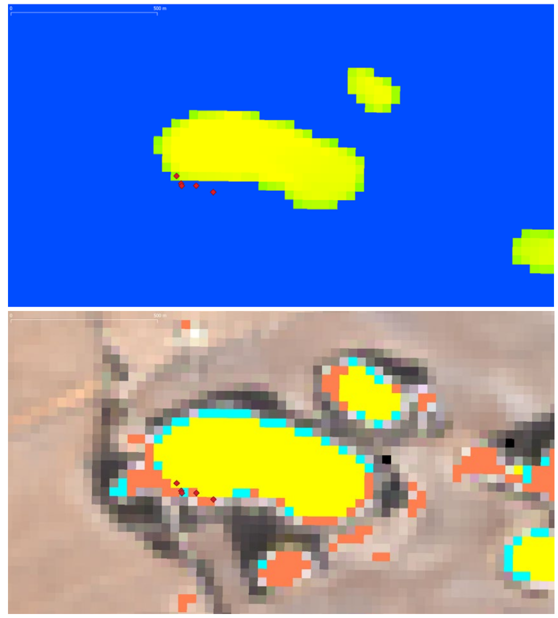

Figure 2: (Top image) This is an RGB image of the halite and gypsum band indices for our F21 field site, where R = halite, G = gypsum, and B = surrounding terrain that was masked. (Bottom image) This is a classification image of our F21 field site, where yellow = salt pan, orange and cyan = mixture of sand and weathered rock. This image was taken on January 3rd, 2022 and the Landsat reference number is LC09_L2SP_109083_20220103_20220122_02_T1.

Acknowledgements: This work was funded as part of the Oceans Across Space and Time program of the NASA Astrobiology program, grant 80NSSC22K1409, PI B.E. Schmidt. More information about OAST and its investigators can be found at: https://oast.eas.gatech.edu/. We thank David Guilfoyle and the Elders of the Esperance Tjaltjraak community, and Dr. Martin Towner, Dr. Phil Bland and their team at Curtin University for their hospitality. We thank the following WA Government and Native Title Corporations for their help: Ngadju Aboriginal Corporation, Esperance Tjaltjraak Aboriginal Corporation, DBCA, and DPLH.

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