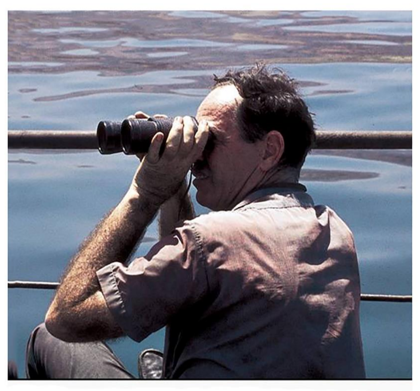

Neev Center for Geoinformatics

Dead Sea Stromatolite Reefs: A Testing Ground for Automated Detection of Life Forms and their Traces in Harsh Environments

Nuphar Gedulter, Amotz Agnon, Yaniv Darvasi (Neev Center, Institute of Earth Sciences, The Hebrew University, Jerusalem)
Noam Levin (Department of Geography, The Hebrew University, Jerusalem)
Nicolas Francos (The Remote Sensing Laboratory, Tel-Aviv University, Tel-Aviv)

nuphar.gedulter@mail.huji.ac.il

THE HEBREW UNIVERSITY OF JERUSALEM

Abstract

The Dead Sea is one of the most saline lakes on Earth, and only few organisms manage to survive in this harsh environment. However, at some locations near the current Dead Sea shore, active and diverse microbial communities flourish. In the geological past, similar microbial-rich environments had left their marks under the form of stromatolites. Stromatolites are thoroughly investigated to understand the appearance of life on Earth and potentially on Mars. Currently, the main practical attraction revolving around these stromatolite textures is possible analogies with potential microbialites and fossils on Mars: they may be the Martian equivalent of the ancient, heavily weathered and contentious Archean stromatolites on Earth.

Fig.1 Stromatolite dome at the Dead Sea

Fig.2 A rich microbial pond at the Dead Sea shoreline

The Research Objectives

Using integrated remote sensing and in-situ hyperspectral technologies for characterization of bio-signatures inherent to stromatolites, and developing spectral detection methods for automated mapping from airborne and satellite hyperspectral imaging.

Fig.3

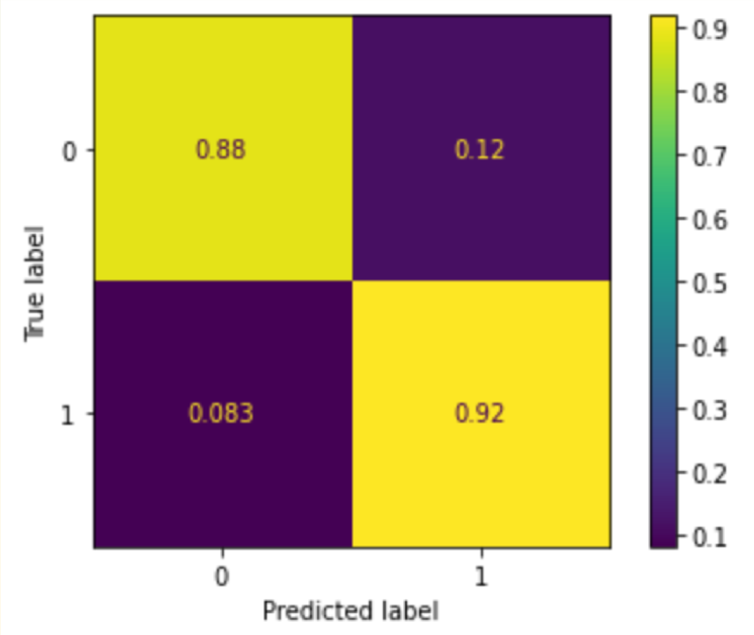
Fig.4

Methods

- Spectral analysis: Spectral characterization of stromatolites using a spectrometer (FieldSpec 4 with 2150 spectral bands in the 350-2500 nm range).
- Telops Hyper-cam, covering the 8.0-11.7 mm region with 122 bands.
- Image analysis using ENVI software's classification tools.
- Spectrum data analysis using machine learning algorithms such as XGBoost of the Scikit-Learn module in order to identify the most indicative wavelengths for distinguishing the targeted layers.

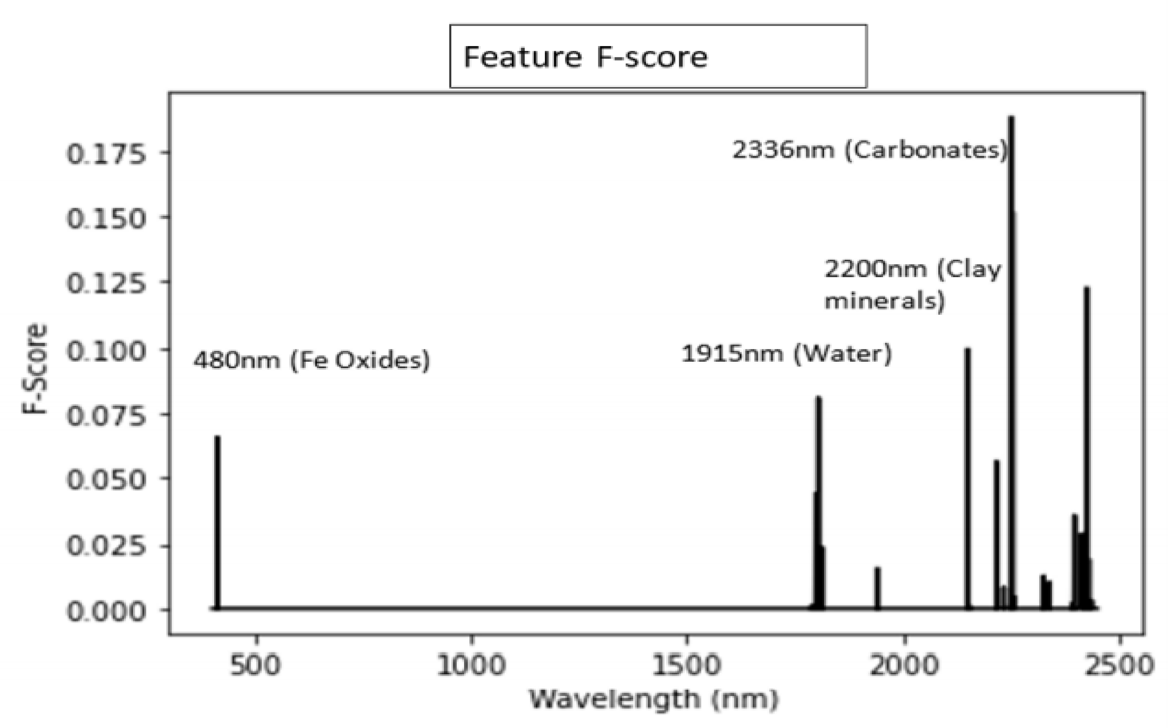
Results

Fig.5 Confusion Matrix



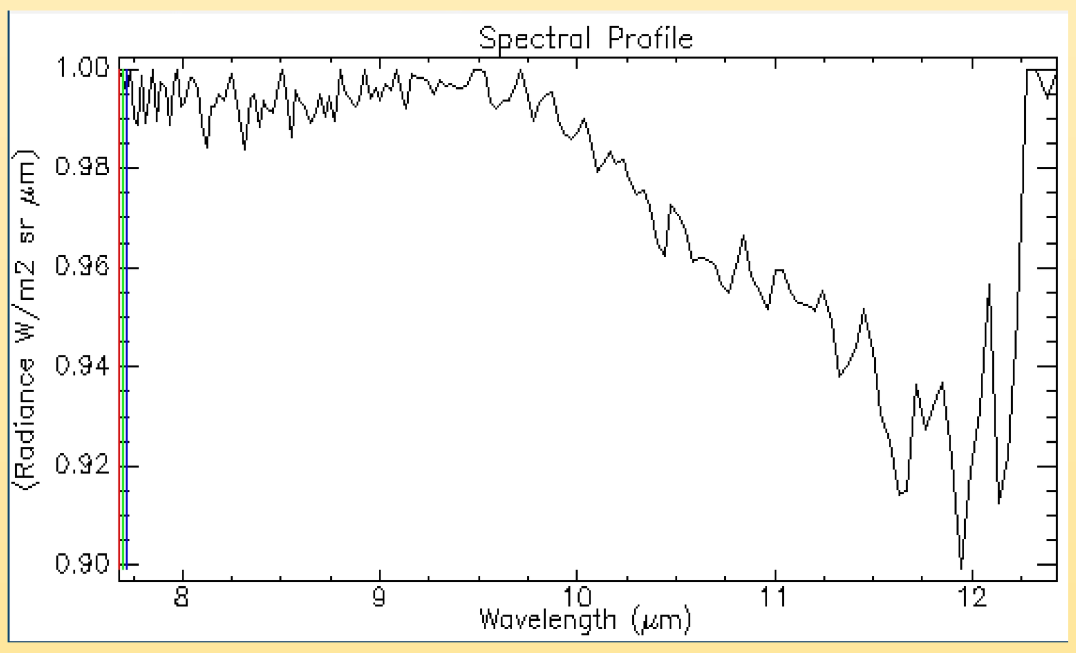
The model has successfully distinguished the target layer (1) from the background layer (0)

Fig.6 Machine Learning Model



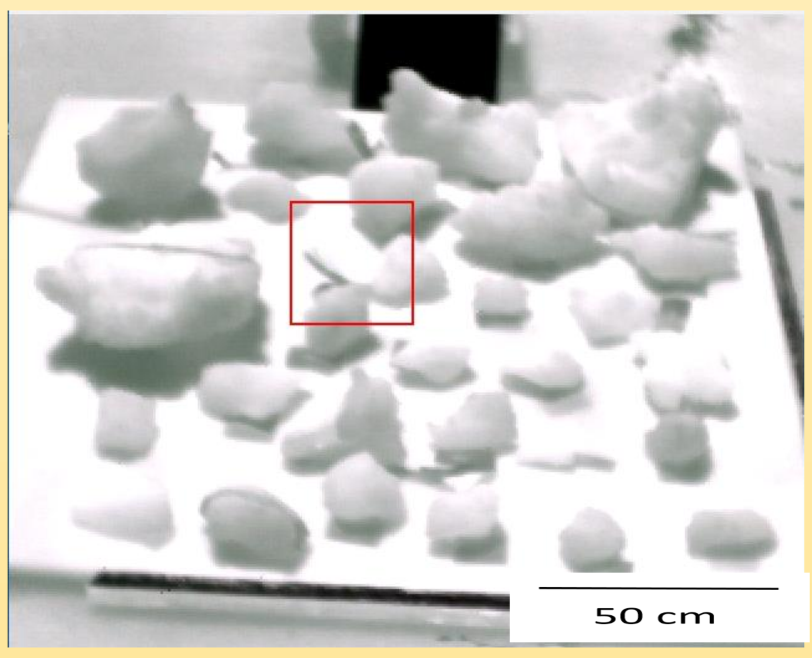
The absorption of principal constituents*

Fig.7 Continuum Removal



The advantage of the technique: absorption feature depth with respect to the hull, remains constant over the entire wavelength range.

Fig.8 Hyperspectral Camera



Spectral measurements for the LWIR spectral region, were acquired with the Telops Hyper-cam, covering the 8.0-11.7 mm region with 122 bands.

Future work

Sampling at a new site, at the Dead Sea, as a testing ground for the analysis of the Machine Learning model.

Acknowledgements

We thank Camille Thomas and Daniel Ariztegui for useful discussions regarding Dead Sea living analogs (Thomas et al., 2021)**

references

*Rossel, R. V., & Behrens, T. (2010). Using data mining to model and interpret soil diffuse reflectance spectra. Geoderma, 158(1-2), 46-54.
**Thomas, C., Vogel, H., and Ariztegui, D.: Unlocking the power of lake multiproxy analyses by understanding subsurface biosphere processes, EGU General Assembly 2021, online, 19–30 Apr 2021, EGU21-8379, https://doi.org/10.5194/egusphere-egu21-8379, 2021.