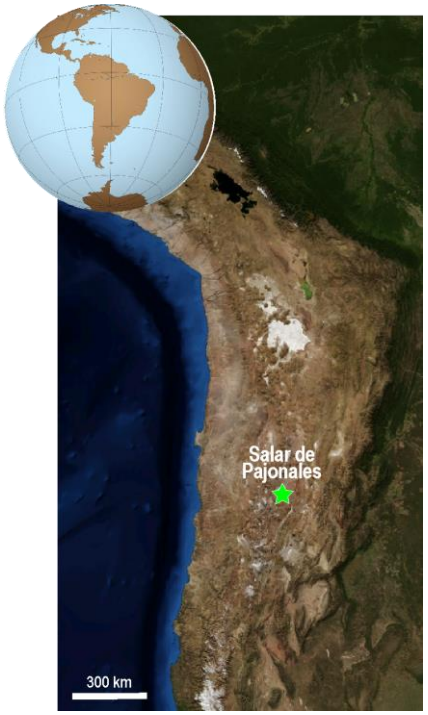
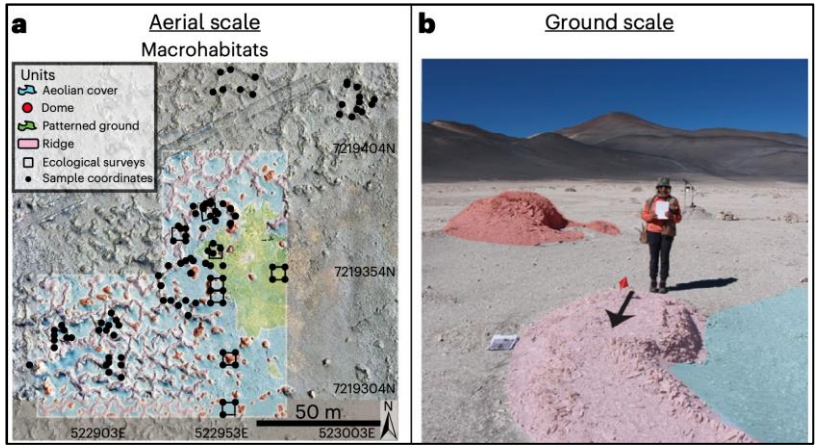
Orbit-to-ground framework to decode and predict biosignature patterns in terrestrial analogues

Warren-Rhodes et al. (2023) Nature Astronomy

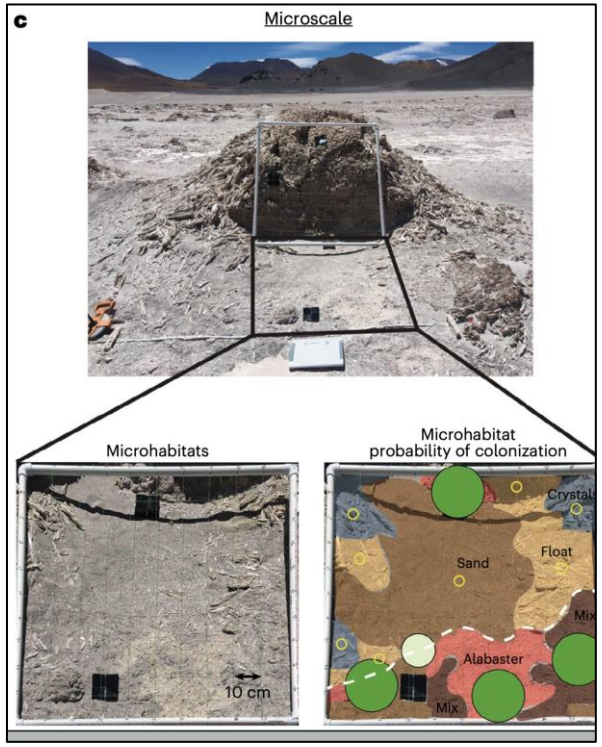


Background: Finding life on Mars is constrained by the technology we are capable of sending to Mars. How scientists can creatively utilize current technology to identify signs of life, and guide future targeted life detection missions is an exciting area of current life detection efforts. A team at the SETI Institute (Search for Extraterrestrial Intelligence) investigated potential biosignatures at Salar de Pajonales, an extremely arid region in the Atacama Desert (northern Chile) analogous to evaporitic environments on Mars. This site was analyzed using predictive models and machine learning on a variety of spatial scales to improve life detection strategies on Mars.

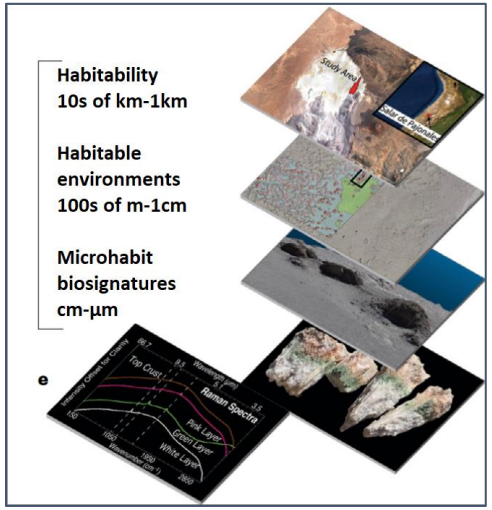
Experiments: A 2.78 km^2 area was systematically categorized by satellites, UAV drones, and researchers on the ground. Four different microenvironments were sampled for microbial communities. Samples were categorized using visible assessments, Raman and visible short-wave infrared spectroscopy, X-ray diffraction, and 16S ribosomal RNA gene sequencing. Based on these results, the likelihood of finding life in each microenvironment was calculated and used to train a machine learning model.



Pictures of research area from the sky and from the ground



Example observation area with mineral classification



Scale of habitability observations

Results & Significance: With the artificial intelligence-machine learning models, there was an 56.9-87.5% chance of finding life at the site, while a random search had a 9.2% probability over the same area, reducing the physical search space by 85-97%. These results significantly improve life detection efforts at the scale of microbial habitats, an equivalent scale to current Mars rovers, helping to optimize current and future search efforts on other terrestrial planets.

Warren-Rhodes K, et al, Nature Astronomy, 2023	https://doi.org/10.1038/s41550-022-01882-x	Nugget design: K Harrison, B Burcar, and A Davila