From Iceland to Mars: characterizing potential regolith analogs with reflectance FTIR spectroscopy

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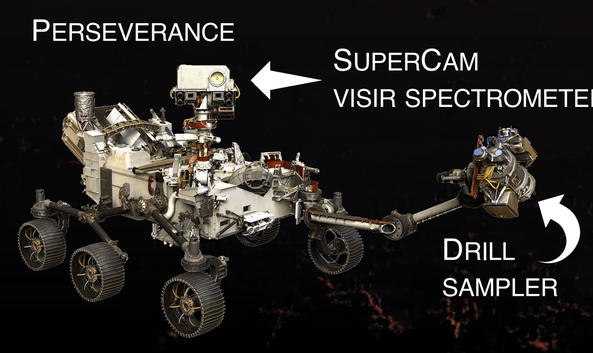
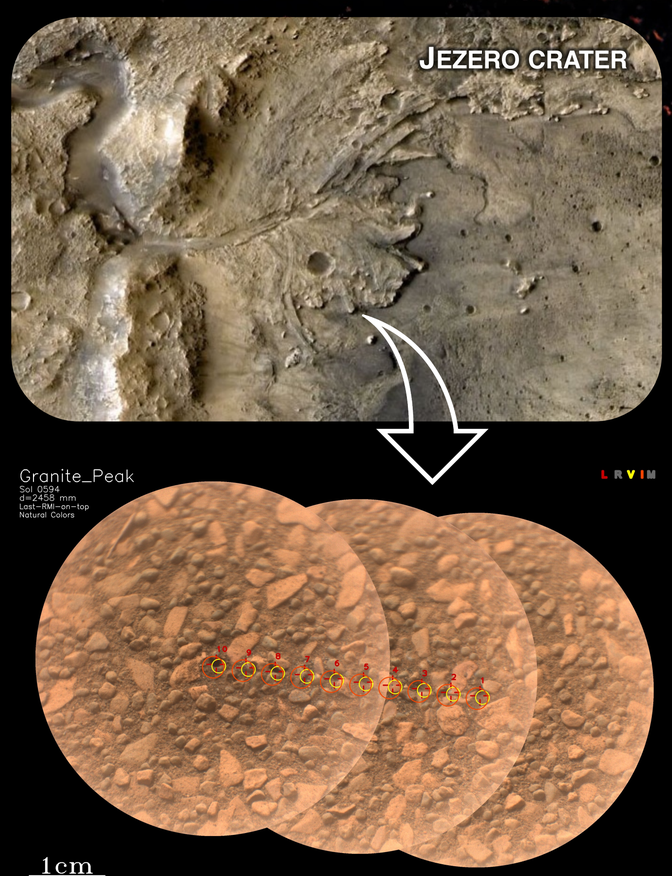
Mars 2020 and Mars Sample Return



- Investigate the geology of Jezero crater and beyond
- Search for fossil traces of past life on the Martian surface
- Collect samples from Jezero Crater and return them to Earth for detailed analyses
- Prepare for human exploration

Project Aims

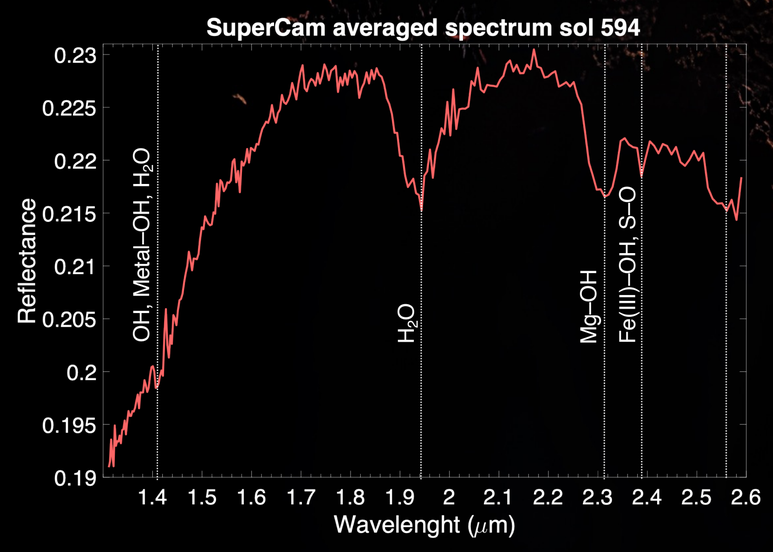
- Characterize a potential regolith analog collected at Lambahraun, Iceland
- Support in-situ analyses and future sample return missions



Martian Geological Setting — Jezero Crater

We analyzed SuperCam data acquired on the *Observation Mountain*, on the delta front, located in the contact zone between the Jezero Floor unit and the Jezero Fan unit 1. The region is dated between the late Noachian and early Hesperian eras.

- Primary mafic composition, possibly modified by lacustrine activity, Fe- and Ti-oxides and quartz
- Secondary Fe-Mg phyllosilicates, sulfates and carbonates



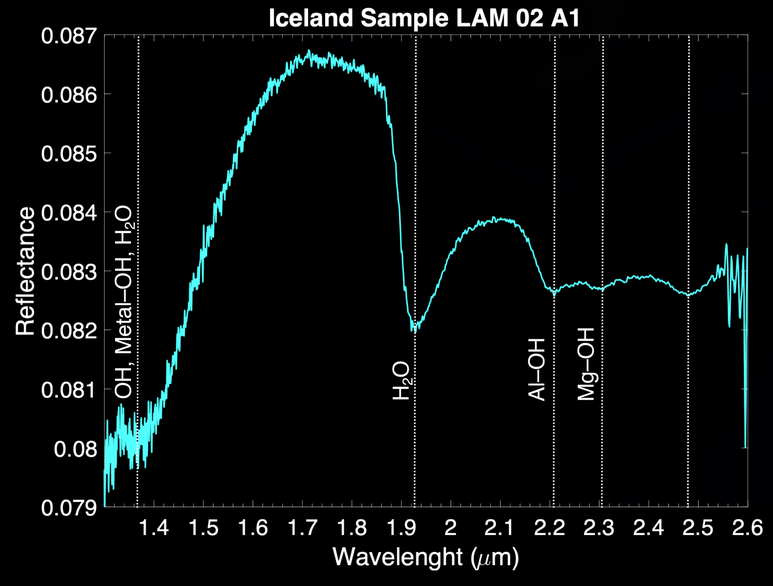
Martian spectra analysis

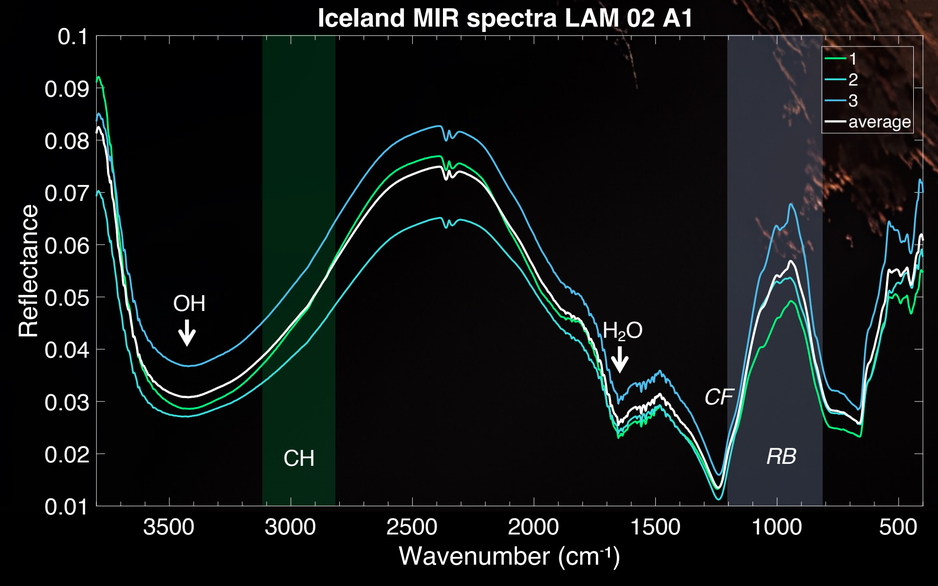
One of the spectra is shown, selected for its prominent spectral features and regolith similarities.

Slopes: (1.3 – 1.8) μm **+**
(2.1 – 2.5) μm **0** $^-$ → **Water-bearing minerals**

Dominated by **hydrated silicates** with Mg and Fe(III) metal cations bound to the OH [1][2]

A possible **carbonate** signature detected at 2.56 μm [3]





Icelandic Geological Setting — Lambahraun Lava Flows

Analogs were collected during a NASA–ESA field trip in a sand sheet on Lambahraun lava field, formed 4000 years ago [4][5]

- Basaltic lithic fragments
- Traces of glass, olivine and volcanic pumice

Icelandic spectra analysis

NIR

Slopes: (1.3 – 1.8) μm **+**
(2.1 – 2.5) μm **0** $^-$ → **Water-bearing minerals**

Clear similarities with the martian spectrum, revealing **hydrated silicates** with different metal cations bound to the OH [1][2]

A possible **carbonate** or **chlorite** signature is detected at 2.483 μm [3]

MIR

The position of the Christiansen Feature (CF) and of the Reststrahlen Bands (RB) reveal the **basaltic** nature of the sand [6][7][8]

Al-, Mg- and Fe-rich silicates signatures were detected between 600 cm^{-1} and 400 cm^{-1} [3][9]

Faint CH bands, suggesting the presence of organics around 2900 cm^{-1}

Conclusions

- FTIR characterization of the Icelandic regolith confirmed its basaltic nature, with bands typical of plagioclases, pyroxenes and olivines.
- The detection of hydrated silicates in the Icelandic samples was not confirmed by XRD analysis, so they could be present below 0.5 wt.% (XRD detection limit).

→ Our samples could be used as analogs for a basaltic Martian regolith that is poor in water-bearing minerals and rich in plagioclase.

What's coming next?

- Continue the mineral analyses of the samples with other techniques (e.g. Raman) and compare to the Martian results.
- Characterize the detected organics and use the analogs to study organic-mineral-radiation interactions.

[1] Ehlmann et al. 2012
[2] Wiens et al. 2022
[3] NASA RELAB facility
[4] Baratoux et al. 2011
[5] Mangold et al. 2011
[6] Lucey et al. 2021
[7] Cooper et al. 2002
[8] Weber et al. 2023
[9] Michalski et al. 2005

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