National Aeronautics and Space Administration

Postdoc Research

Global Distribution of Serpentine on Mars

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Background

Deciphering the distribution and origin of the mineral serpentine on Mars has both geologic and astrobiological significance. Hydrogen (H_2) and methane (CH_4) gases are produced during the production of serpentine via the oxidation of olivine and pyroxene by water. Since chemolithotrophic microbial communities rely on H_2 and CH_4 nutrient sources at and surrounding sites of active serpentine production, serpentinized rocks on the red planet are a compelling astrobiology target.

Objectives

- ❑ Generation of a global map of Mg-rich serpentine deposits on Mars using CRISM, HiRISE, and CTX data.
- ❑ Constrain the mechanism(s) that controlled serpentinization on Mars from the results of geologic context, terrain age, and stratigraphic context.

Approach and Results

- ❑ Apply the dynamic aperture factor analysis/target transformation (DAFA/TT) to 15,760 of CRISM Targeted Reduced Data Record (TRDR) images to localize serpentine spectra at near-infrared (NIR) wavelengths.
- ❑ Employ the I/F and radiance ratio validation techniques to eliminate the possible impact of a known artifact present in ~90% of CRISM images that overlaps with serpentine's characteristic 2.12 µm band.

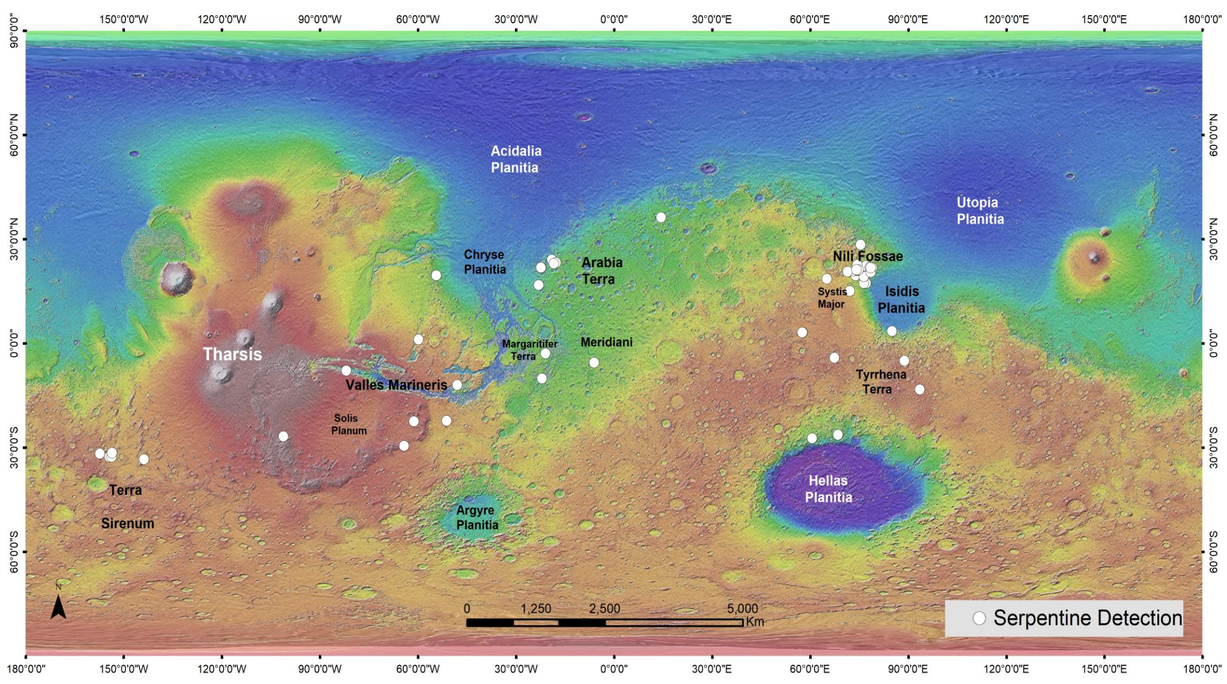

Figure 1: Global distribution of detected serpentine overlaid on MOLA elevation map. The serpentine detected locations of CRISM images are indicated as the white circles.

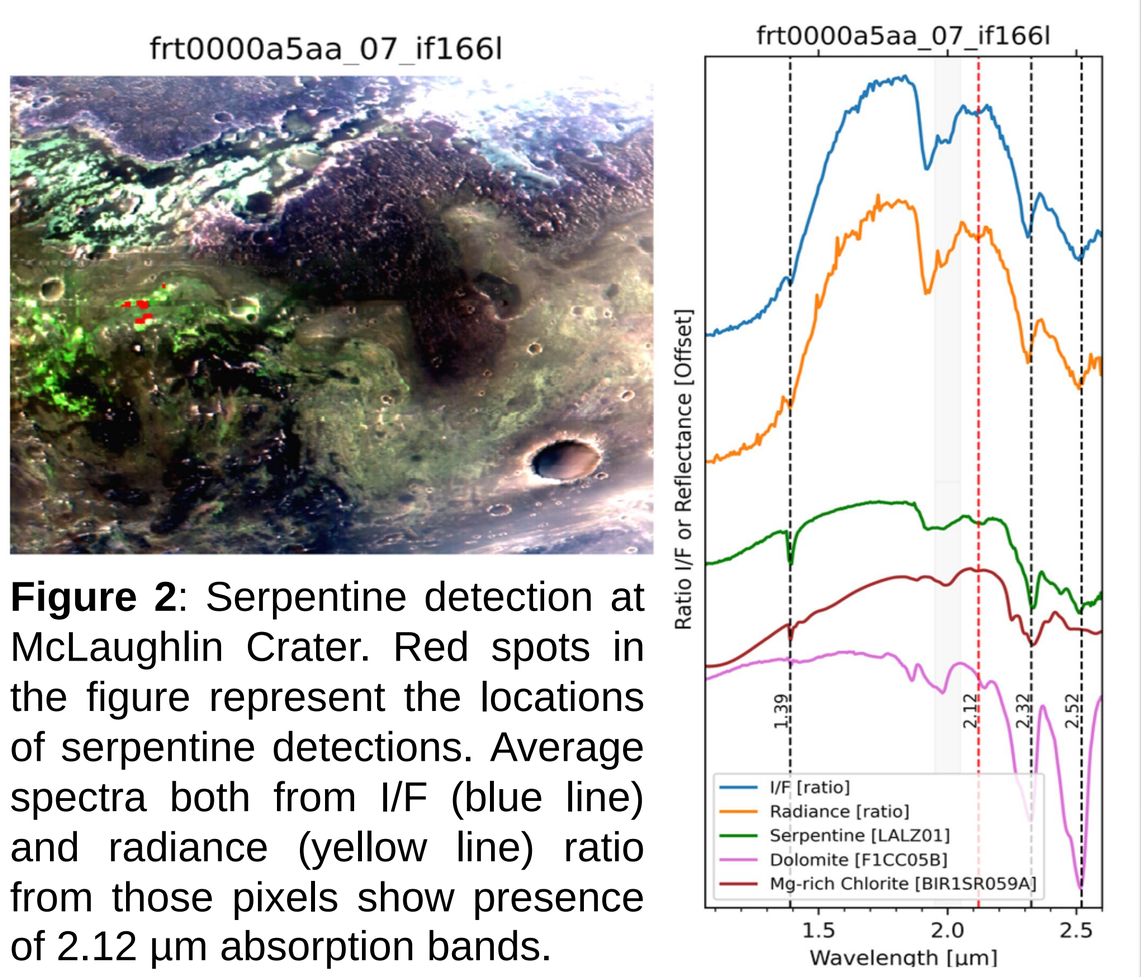

Figure 2: Serpentine detection at McLaughlin Crater. Red spots in the figure represent the locations of serpentine detections. Average spectra both from I/F (blue line) and radiance (yellow line) ratio from those pixels show presence of 2.12 µm absorption bands.

- ❑ 16+ CRISM images show serpentine detection with high confidence (6 has been previously detected)
- ❑ The global serpentine map reveals a concentration of detections accumulated over a few regions.
- ❑ Nili Fossae and Nili Planum show the highest concentration of serpentine detections.
- ❑ Serpentines are mostly detected at craters, valleys, and plains (based on preliminary results).
- ❑ Majority of serpentine detections are linked to Noachian crust — suggesting serpentinization was active in Mars' past.

Significance of Results/Benefits to NASA/JPL

- ❑ Constrain the amount of H_2 and CH_4 available for warming – when early Martian climate was above freezing.
- ❑ Localize the regions of martian crust that potentially hosted habitable paleoenvironments and the distribution of hydrothermal activity in the subsurface and the geochemical conditions.
- ❑ Inform the selection of landing sites for JPL/NASA's next Mars rover.

Future Work

- ❑ Connect the geologic context, terrain age, and stratigraphic context to the detected serpentine locations.
- ❑ Make the results available to research communities including astrobiologists, planetary geoscientists, Mars atmospheric scientists, and Mars mission planners inside and outside of JPL.

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