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Postdoc Research

# Investigating Hydrated Silica in Syrtis Major: Implications for the Intensity of Water-Rock Interaction

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## 1. BACKGROUND

- Hydrated silica (or opaline silica) has been detected on the martian surface in orbital near-infrared reflectance spectra, thermal infrared emissivity spectra, and from in situ rover observations [1–6].
- Opaline silica forms from water-rock interactions under a variety of aqueous and pH conditions, but can be used as a tool to indicate certain environment conditions.
- **Opal crystallinity can be used as a proxy for the intensity of water-rock interaction, where amorphous silica (e.g., opal-A) indicates short-lived aqueous alteration and more crystalline silica (e.g., microcrystalline quartz) indicates a prolonged exposure to water** [7].

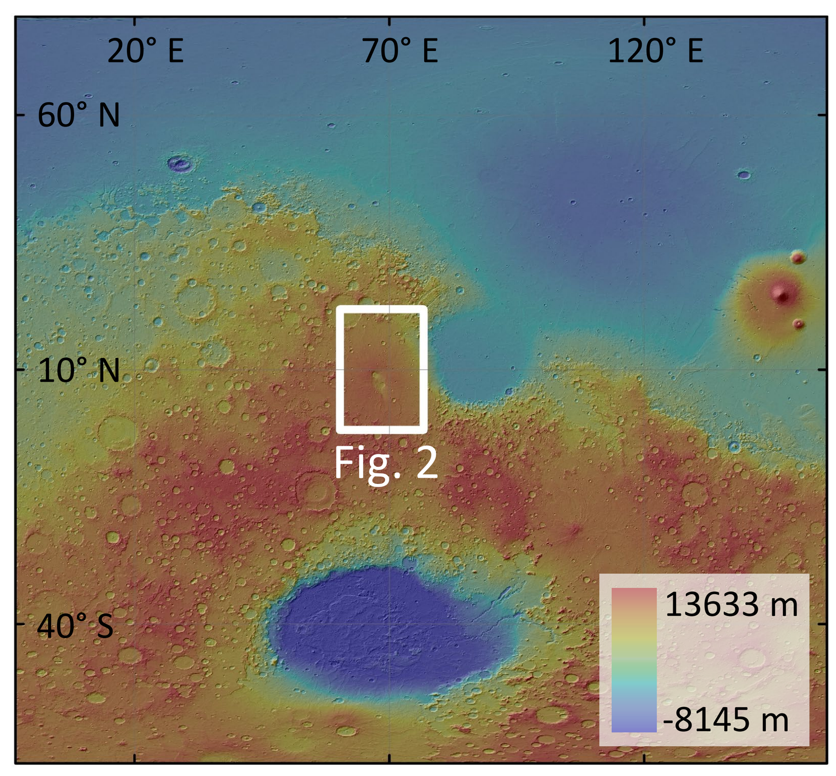


**Fig. 1** Location of the study site overlain on MOLA DTM.

## 2. OBJECTIVES AND RELEVANCE

- We investigate hydrated silica in Syrtis Major on Mars to constrain the longevity of aqueous conditions in Nili Patera and the surrounding Syrtis Major Planum.
- This work has implications on aqueous conditions on the martian surface.
- Siliceous material—including opal—provide an excellent substrate to preserve biosignatures and therefore opal-bearing terrains might represent prime targets for future astrobiological explorations.

## 3. APPROACH AND RESULTS

### Geological Analyses:

- To understand the geologic context, our geological investigation is based on the global 6 m/pixel CTX images and mosaic [8, 9] and 0.3 m/pixel HiRISE images [10] and includes CSFDs of the main units.

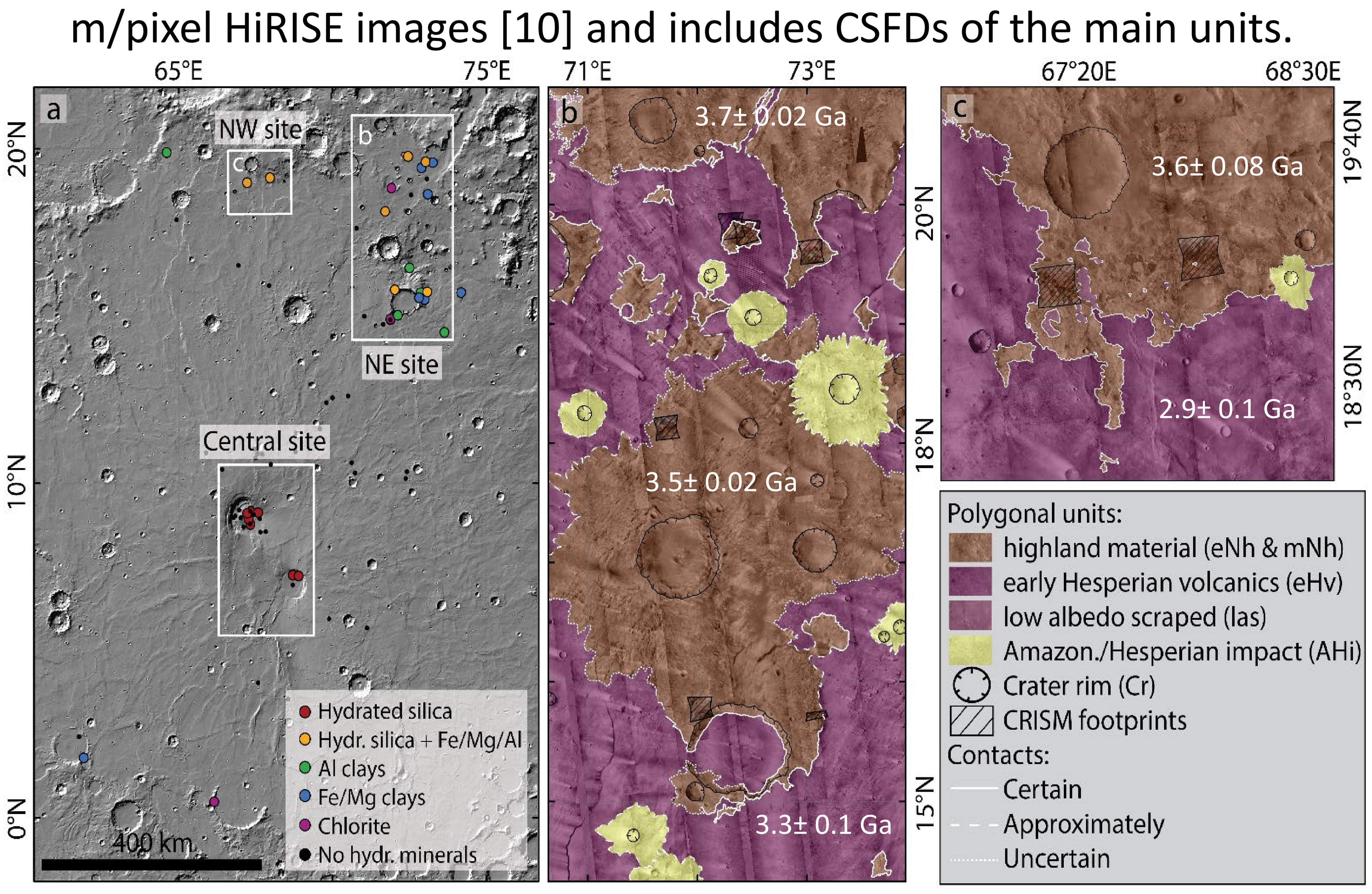


**Fig. 2** a) Overview of hydrated minerals detections in Syrtis Major. Geologic map of the northeastern site in b) and northwestern site in c).

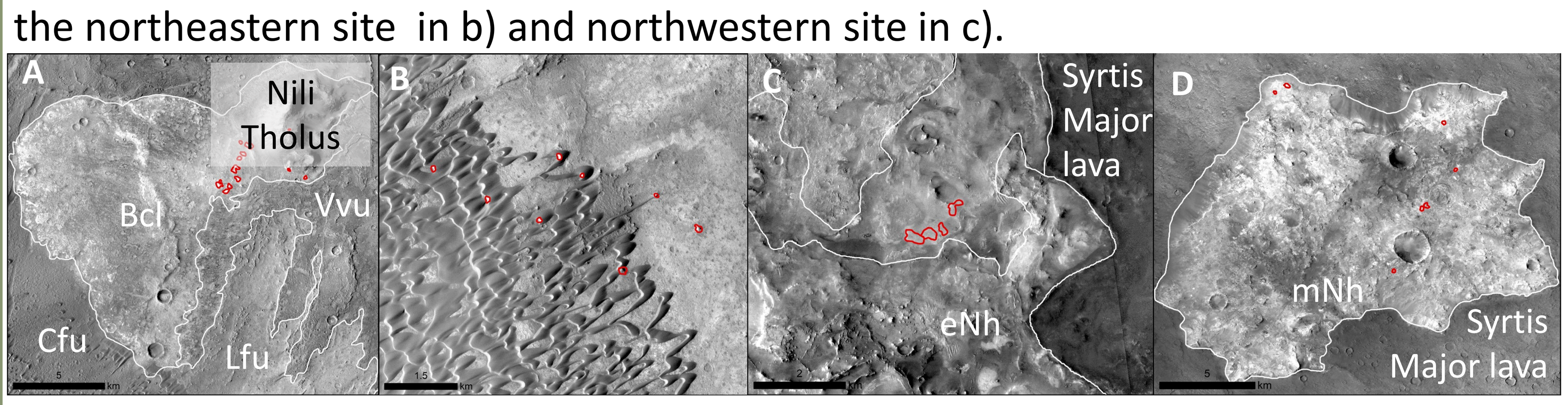


**Fig. 3** Morphological examples of hydrated silica detections (on CTX images) are outlined in red and white lines show contacts. **(A)** Modified contacts from [14] with: bright central lava unit (Bcl), crater floor unit (Cfu), layered floor unit (Lfu), and variegated volcanic unit (Vvu). **(B)** Hydrated silica along the lee sides of dunes. **(C)** Contacts within the Early Noachian highland unit (eNh; 15) and **(D)** contact between highland material unit (mNh; 15) and Syrtis Major lava in the Early volcanic Hesperian unit (eHv; 15).

### Spectral Analyses:

- 108 CRISM images (18 m/pixel and 36 m/pixel) [11] were analyzed.
- Hydrated silica was identified based on 1.4, 1.9, and 2.2 µm absorptions. The 1.4 µm band position was used to characterize the crystallinity, with shorter wavelengths representing amorphous silica and longer wavelength corresponding to more crystalline opal-CT or microcrystalline quartz [12, 13].

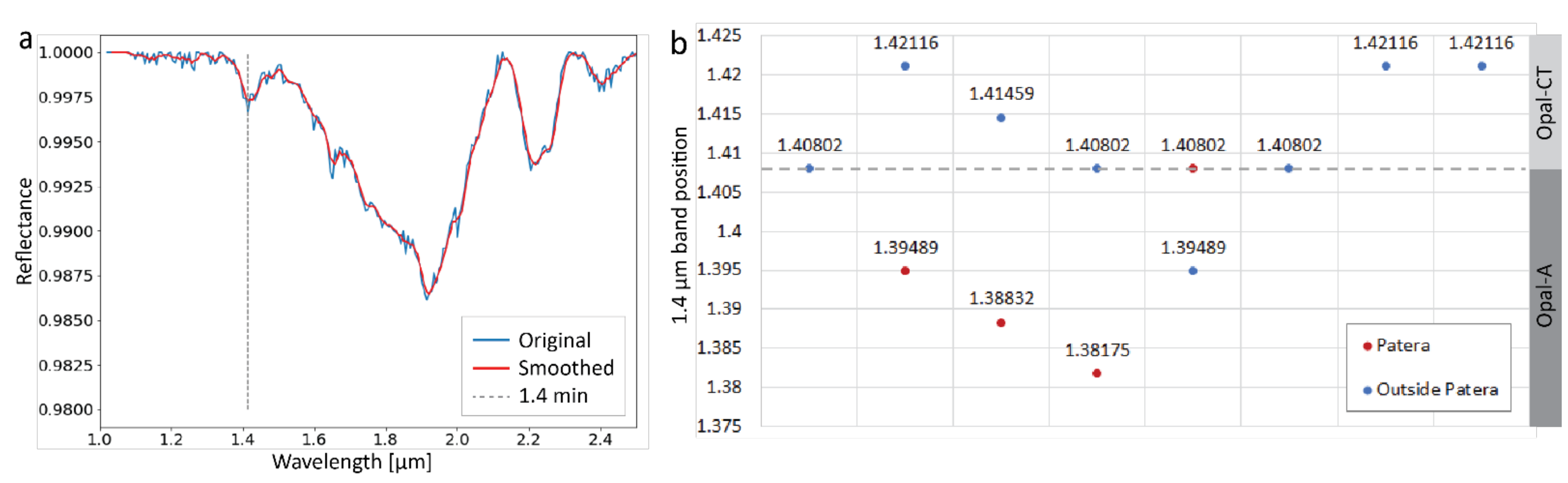


Fig. 4. a) Example of original spectra (blue) and smoothed spectra (red) for hydrated silica detections in CRISM image FRT0000406B. b) Plot of the 1.4 µm minimum position of all detected hydrated silica. The red dots show the locations in the eHv unit. The blue dots show the locations in the hm unit, outside of the Patera.

**Central Study Site:**

| CRISM ID | 1.4 µm position |
|---|---|
| FRT00004185 | 1.441<br>1.448 |
| ~~FRT000082EE~~ | ~~1.421~~ |
| FRT0000B80F | 1.388 |
| hrl00013052 | 1.388 |
| Hrs0000c6d7 | 1.395 |
| Frs0002b3d1 | 1.382 |
| FRT00010628 | 1.402 |

**NW and NE Study Sites:**

| CRISM ID | 1.4 µm position |
|---|---|
| FRS00027508 | 1.408 |
| FRT000034FE | 1.421 |
| FRT0000406B | 1.415 |
| FRT00009365 | 1.408 |
| FRT0000A9BE | 1.395 |
| FRT0000AE09 | 1.408 |
| FRT000186FA | 1.421 |
| FRT0001B615 | 1.408 |

Tab. 1 left: 1.4 µm band positions in Nili Patera and Meroe Patera in the central study site. right: 1.4 µm band in highland materials NW and NE sites. Green = agrees with hypotheses, Yellow = transitional zone, Red = disagrees with hypothesis.

## 4. CONCLUSIONS AND OUTLOOK

**Conclusions:**

- We found hydrated silica in bedrock units and aeolian landforms.
- Our findings support the hypotheses that amorphous silica is associated with younger terrains whereas more crystalline silica, formed from prolonged interaction with water, is associated with older regions.

**Future work:**

- Next sites: Valles Marineris, Noctis Labyrinthus, Mawrth Vallis, Terra Sirenum, Hellas Basin, and Acidalia Planitia.

## 5. PUBLICATIONS AND ACKNOWLEDGEMENTS

J. R. C. Voigt, V. Z. Sun, K. M. Stack (in prep.): Investigating Water-Rock Interaction in the Syrtis Major Region, Mars; J. R. C. Voigt, et al. (2023). Investigating the Formation Environments of Hydrated Silica in Syrtis Major, Mars. AGU2023.*invited; V. Z. Sun, et al. (2023). Investigating Hydrated Silica in the Nili Patera Region, Mars. LPSC LIV-1654.

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