# ■ Magmatic crystallisation of Martian Fe/Mg-rich clay minerals *via* igneous differentiation

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## ■ Supplementary Information

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## *Materials and Methods*

### SEM & TEM

Scanning electron microscopy (SEM) and EDXS mapping was performed on a thin section of Nakhla using a SEM-FEG Ultra 55 Zeiss (IMPMC - Paris, France) microscope operating at a 15-kV accelerating voltage and a working distance of 7.5 mm for imaging with backscattered electrons and EDXS mapping. Transmission electron microscopy in scanning mode (STEM) was performed on FIB foils using a Thermofisher Titan Themis 300 microscope operated at 300 keV (CCM – Lille, France). TEM-based hyperspectral EDXS data were obtained using the super-X detector system equipped with four windowless silicon drift detectors with a high sensitivity for light elements. The probe current was set at maximum 200 pA with a dwell time at 10 μs per pixel.

### FIB

Focused ion beam (FIB) ultrathin sections were extracted from the mesostasis of Nakhla using an FEI Strata DB 235 (IEMN, Lille, France). Milling at low Ga-ion currents minimises common artefacts including: local gallium implantation, mixing of components, creation of vacancies or interstitials, creation of amorphous layers, local compositional changes or redeposition of the sputtered material on the sample surface (Wirth, 2009).

### EDXS data processing

A key aspect of this work is the post-processing of the collected EDXS hyperspectral data, performed using the Hyperspy python-based package (De La Pena *et al.*, 2017). The signal was first denoised using PCA and then fitted by a series of Gaussian functions and a physical model for background/bremsstrahlung. The integrated intensities of the Gaussian functions were used to quantify the compositions of the clay minerals thanks to the Cliff-Lorimer method, using experimentally determined k-factors. Absorption

correction was taken into account, which is mandatory to correct for the re-absorption within the sample of oxygen X-rays. These steps correct for the thickness of the sample. Finally, end-member phases were identified and their spectra used as inputs for linear combination fitting (multiple linear least square fits). Pixels of similar composition were given the same colors scaled as a function of the proportion of each phase.

## Supplementary Information References

De La Pena, F., Ostasevicius, T., Tonaas Fauske, V., Burdet, P., Jokubauskas, P., Nord, M., Sarahan, M., Prestat, E., Johnstone, D.N., Taillon, J. *et al.* (2017) Electron Microscopy (Big and Small) Data Analysis With the Open Source Software Package HyperSpy. *Microscopy and Microanalysis* 23, 214–215.

Wirth, R. (2009) Focused Ion Beam (FIB) combined with SEM and TEM: Advanced analytical tools for studies of chemical composition, microstructure and crystal structure in geomaterials on a nanometre scale. *Chemical Geology* 261, 217–229.