Searching for Micron- to Sub-micron-sized
Glassy Inclusions in Martian Meteorites

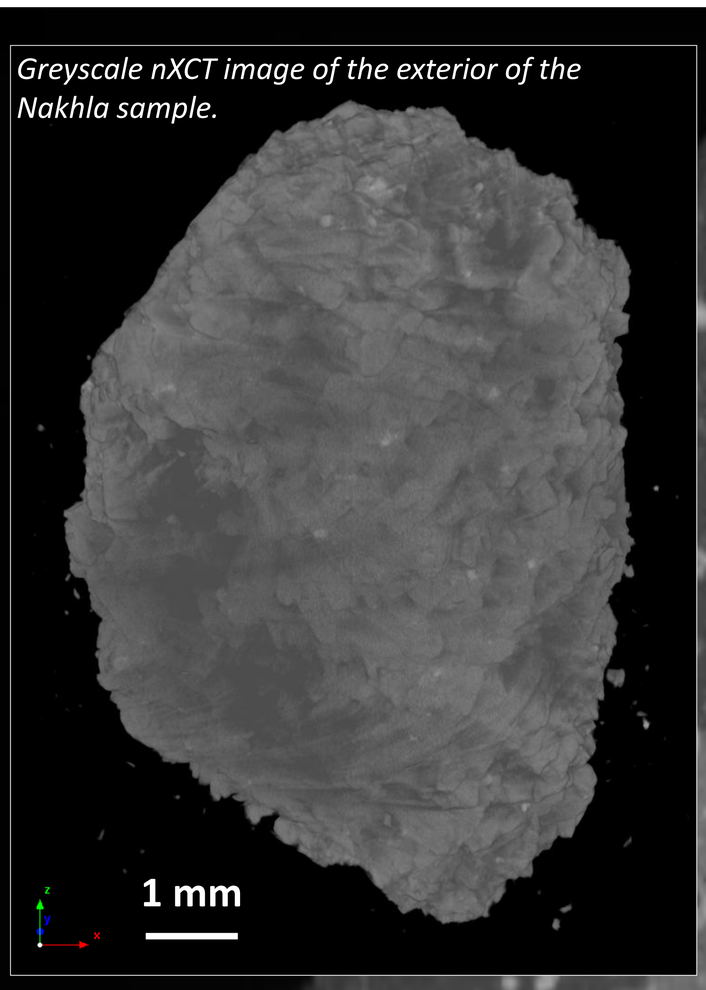
P-E. M. C. Martin[1], I. Leya[1], A. Pommerol[1], H. Busemann[2], D. Haberthür[3], R. Hlushchuk[3], and O-Z. Khoma[3]

[1]Space Sciences and Planetology, University of Bern, Bern, Switzerland, [2]Institute of Geochemistry and Petrology, ETH Zürich, Switzerland, [3]Institute of Anatomy, University of Bern, Bern, Switzerland.

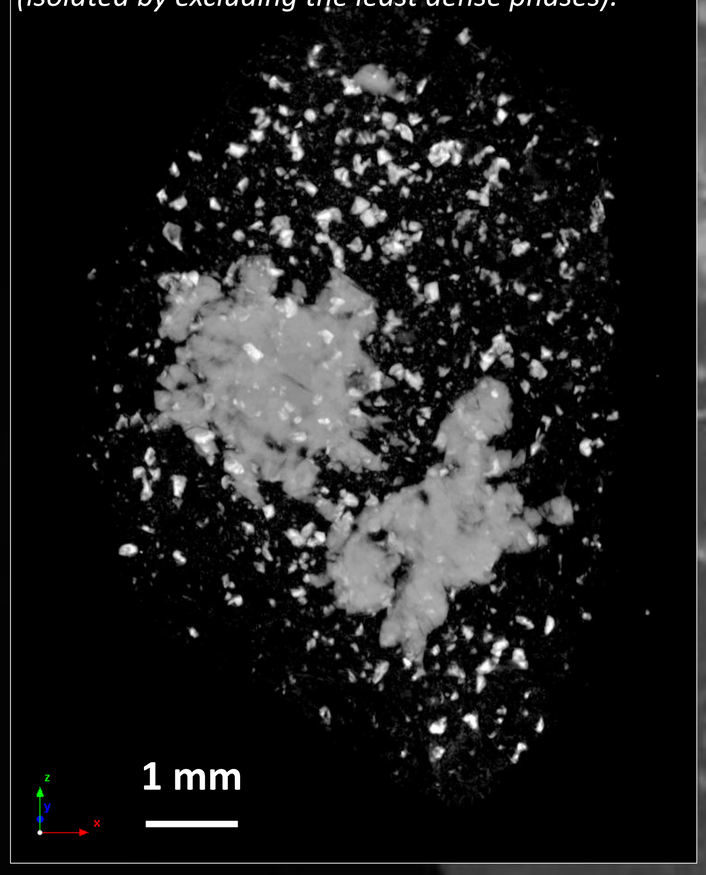
National Centre of Competence in Research

Schweizerischer Nationalfonds

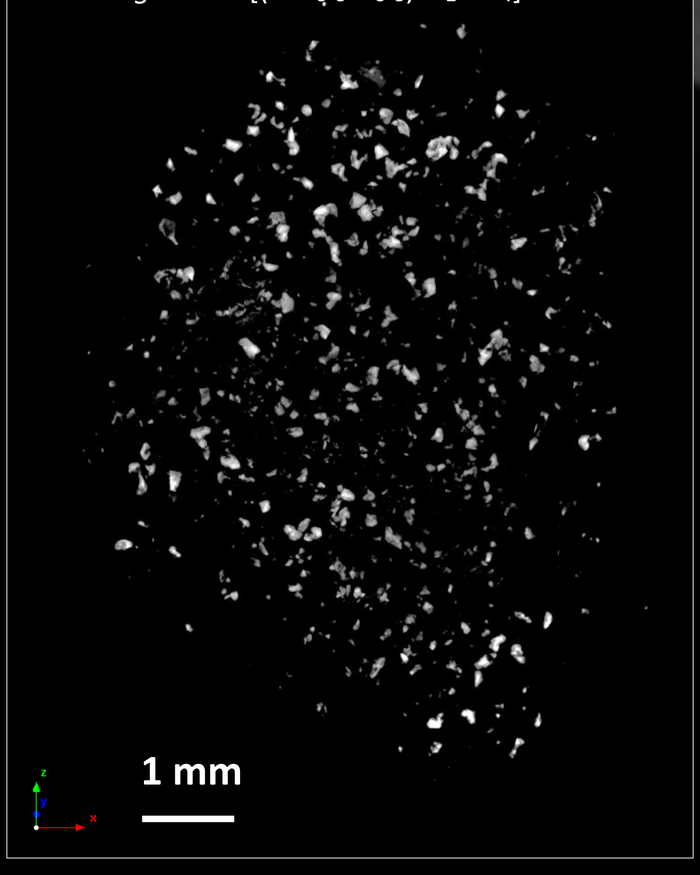
Greyscale nXCT image of the exterior of the Nakhla sample.



Probable olivine aggregates and Fe-Ti oxides (isolated by excluding the least dense phases).



Brightest (i.e., densest) phases may correspond to titanomaghemite $[(Ti^{4+}_{0.5}\square_{0.5})Fe_2^{3+}O_4]$.



False-colour 3D rendering of the exterior of the Nakhla sample:

Denser regions appear golden; less dense areas are shown in greyscale.

INTRODUCTION

- **Glassy inclusions** found within **Martian meteorites** (i.e., shergottites) have provided insights into the composition and evolution of the **Martian atmosphere**, which remains poorly constrained [1–2].
- This project aims to demonstrate the potential of **non-destructive** [3] **micro-X-ray Computed Tomography** (μXCT) and **nano-XCT** (nXCT) techniques to image and locate **sub-micron-sized impact melt inclusions** in Martian meteorites (e.g., glass pockets in shergottites) to better understand the Martian paleo-environment.

METHODOLOGY

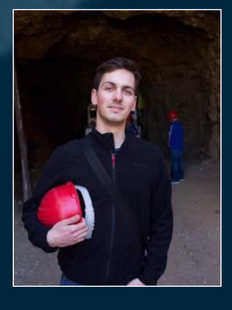
- A sample of the **Nakhla Martian meteorite** was scanned using a **Bruker SKYSCAN 2214** at the Anatomical Institute of the University of Bern. Obtained scans have a **resolution of 1.8 μm/voxel** (helical acquisition at 100 kV). The background image is a Maximum Intensity Projection (MIP) of the Nakhla sample.
- **Further optimisation** of the instrumental parameters (e.g., contrast enhancement, sample holder design, and sample size) is underway to **improve spatial resolution**.
- Future samples will include Martian meteorites, such as **Tissint**, which contain **glassy inclusions** with known **Martian atmospheric signatures** [4].

PROJECTED OUTCOMES

- After optimisation, identified regions of interest will be targeted for **noble gas analyses** (particularly **Ne**), which may reveal valuable information about the **paleo-environment** and **atmospheric evolution** of **Mars** [4–6].
- The technique will be further developed to locate **amorphous C-rich phases**, known as "**nanoglobules**", within **pristine carbonaceous meteorites** and **asteroid samples** [7–8].
- The final goal is to achieve **non-destructive, spatially resolved detection of sub-micron phases** in both **Martian** and **carbonaceous meteorites**, as well as in **asteroid-returned samples** (i.e., **Ryugu** and **Bennu**).

References

[1] Wiens R. C. et al. (1986) Earth and Planetary Science Letters 77 (2):149–158. [2] Wiens R. C. (1988) Earth and Planetary Science Letters 91 (1-2):55–65. [3] Ghaznavi P. et al. (2023) Meteoritics & Planetary Science 58 (6):897–900. [4] Wieler R. et al. (2016) Meteoritics & Planetary Science 51 (2):407–428. [5] Bogard D. D. et al. (1998) Geochimica et Cosmochimica Acta 62 (10):1829–1835. [6] Crowther S. A. et al. (2022) Geochimica et Cosmochimica Acta 336:372–393. [7] De Gregorio B. T. (2015) In Encyclopedia of Astrobiology, 990–991. [8] Mathurin J. et al. (2024) Astronomy & Astrophysics 684:A198.



Would you like to know more?

Dr. Pierre-Etienne Martin

PDRA at University of Bern

tinyurl.com/Spacerocklicker

pierre-etienne.martin@unibe.ch