# X-CT morphological study of giant Antarctic micrometeorites

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# I. The samples

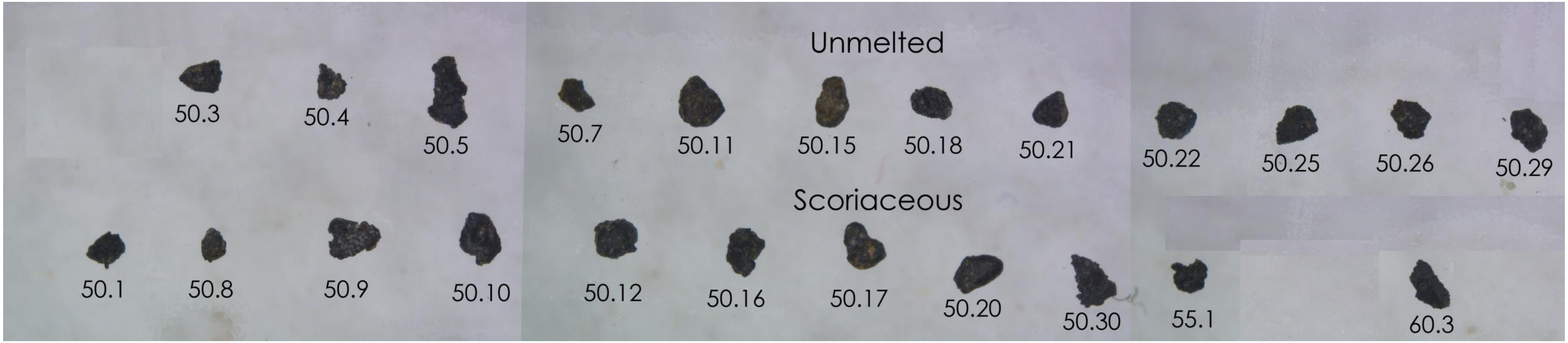
- 400 µm < ..... < 2 mm

- Collect in the Transantarctic Mountains (PNRA2016)

# I. The samples

Giant Micrometeorites (MMs)
(~ 500-600 µm) :

12 Unmelted
11 Scoriaceous



# I. The samples

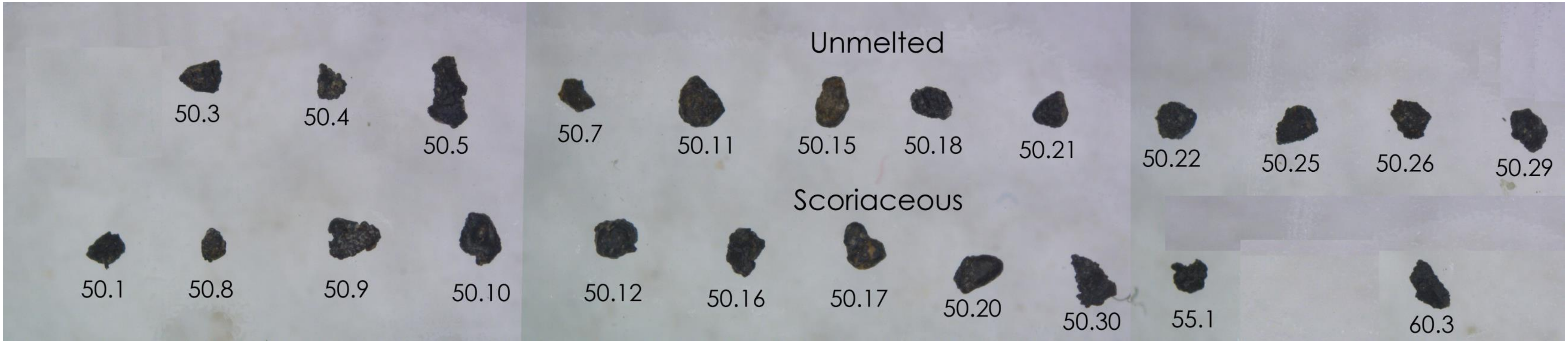
<u>Giant Micrometeorites (MMs) (~ 500-600 µm) :</u>

12 Unmelted
11 Scoriaceous

**Why these samples ?**

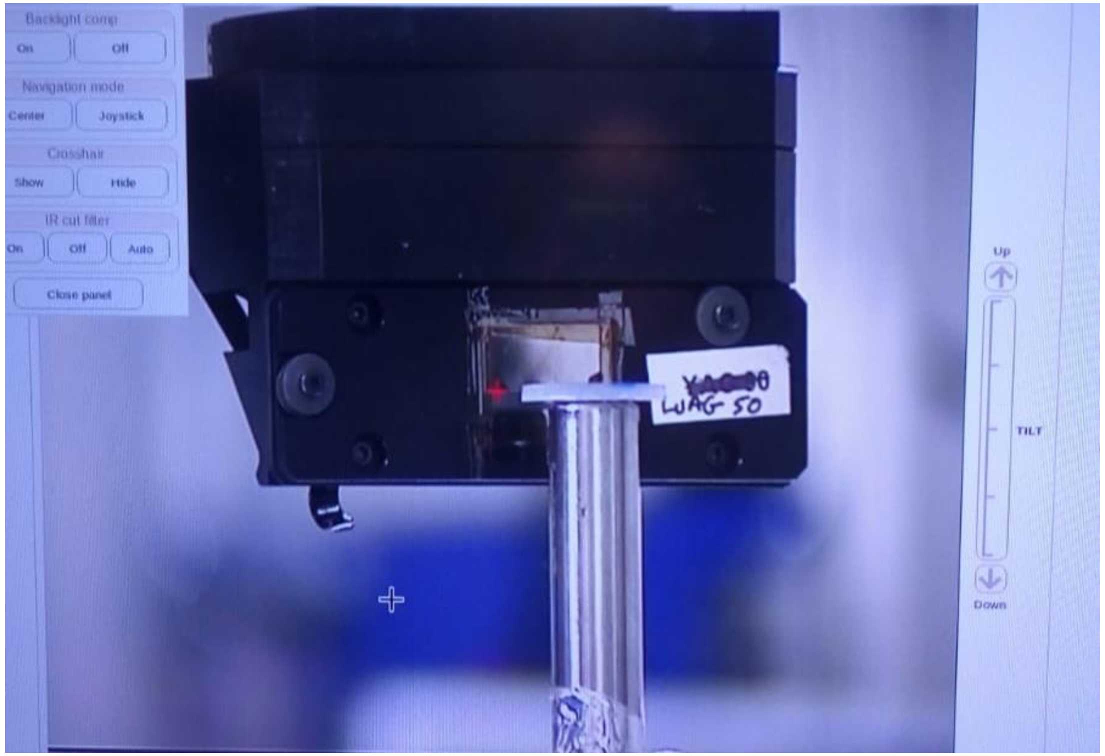
- samples from a variety of dust-producing bodies
- Important size -> possibility to observe whole structures

- Study the effect of the atmospheric entry
- Pre-accretional processes on unmelted samples



# II. Data collection

## 1. X-CT measurement



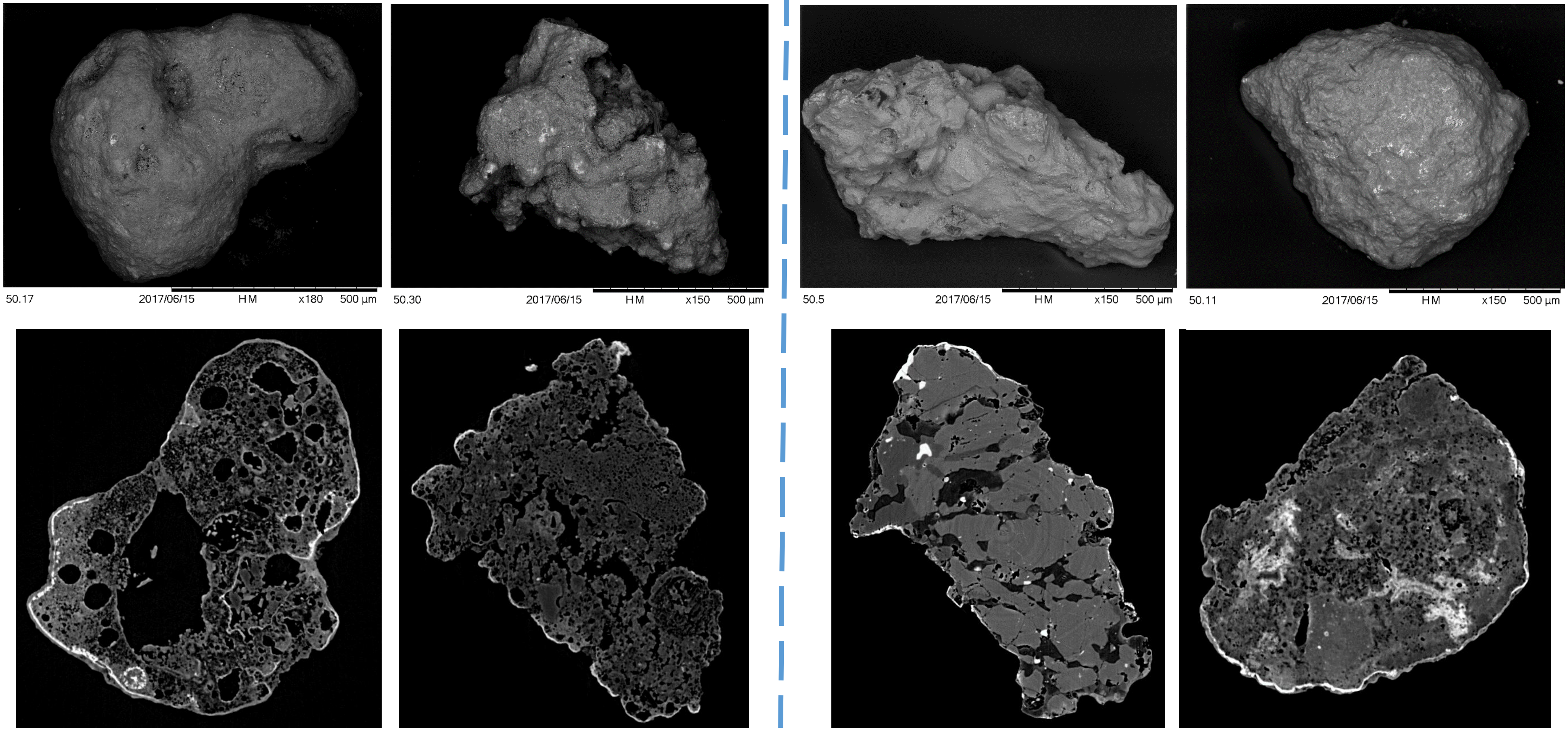

<u>Measurement done on the PSICHE beamline:</u>
(@SOLEIL Synchrotron, France)

25 keV
Field of view : 1.3 mm
Voxel size : 0.65 µm
Spatial resolution : 1 µm

## Scoricaeous vs. Unmelted MMs

## Coarse-grained vs. fine-grained MMs

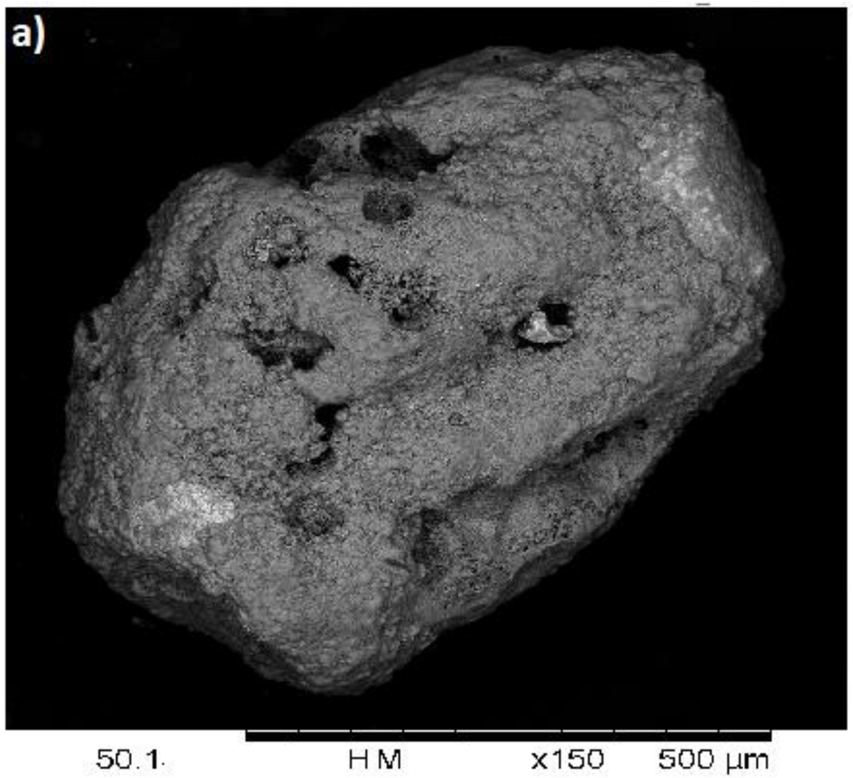
Scoricaeous MM 50.17 | Unmelted MM 50.30 | MM 50.05 | Enstatite MM 50.11

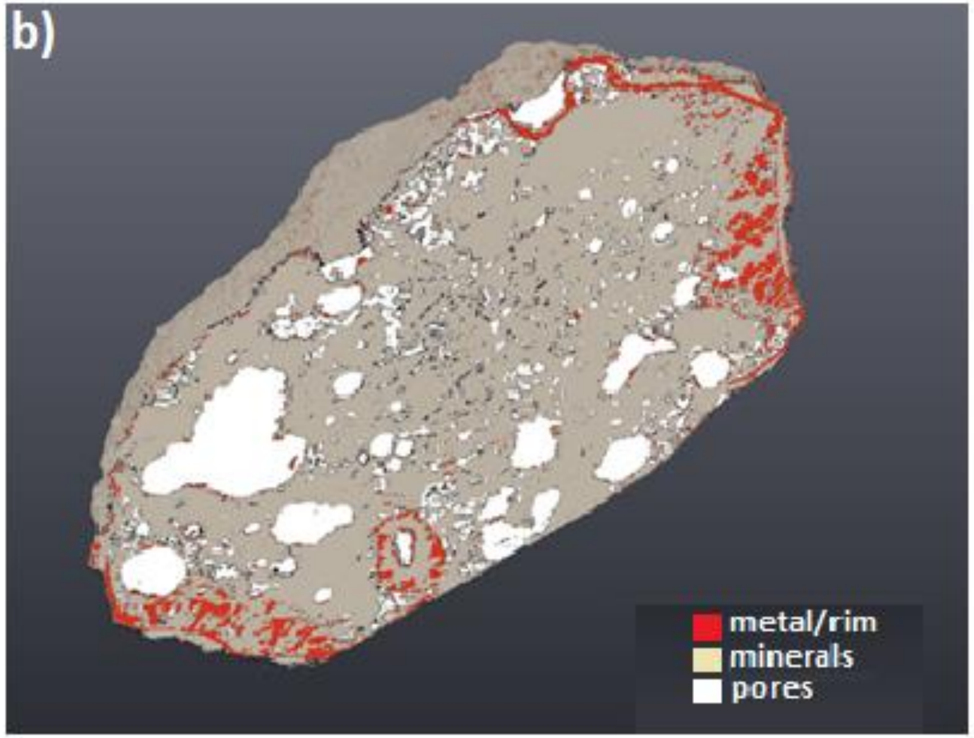


# II. Data collection

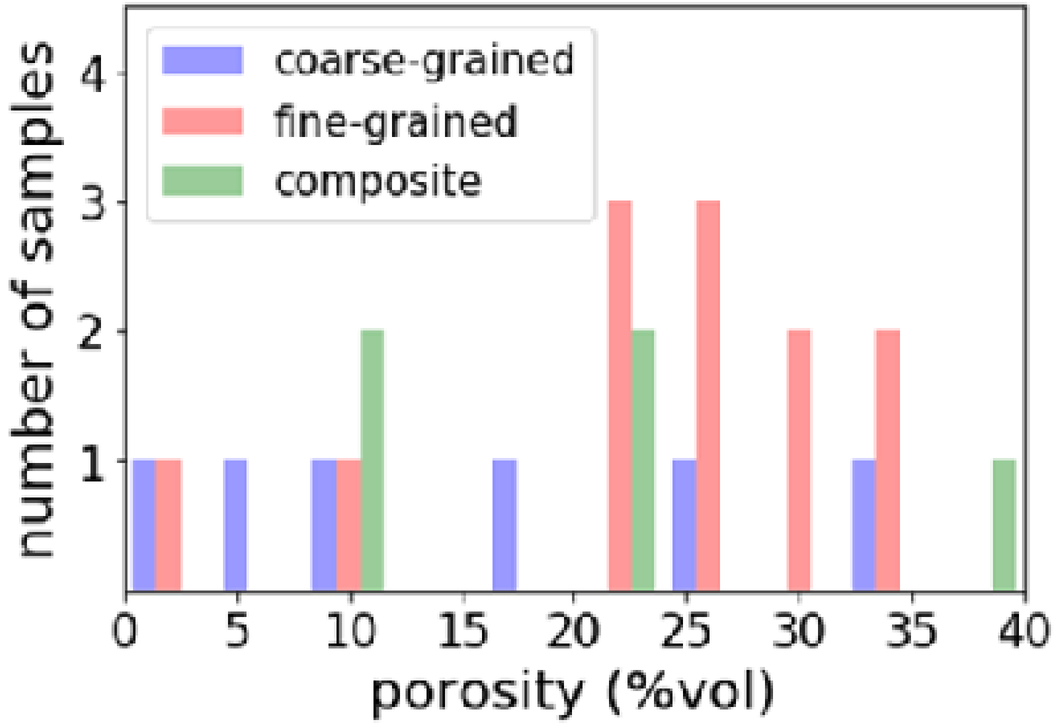
1. X-CT measurement

2. Segmentation



# III. Study of the porosity




- No proper classification according to their texture

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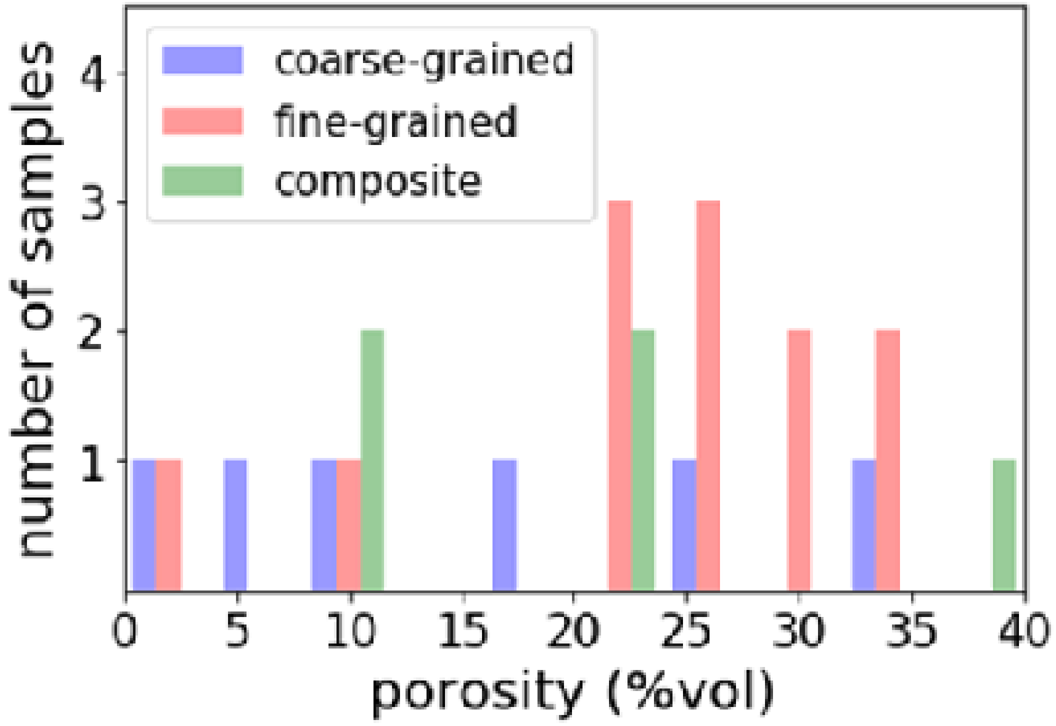


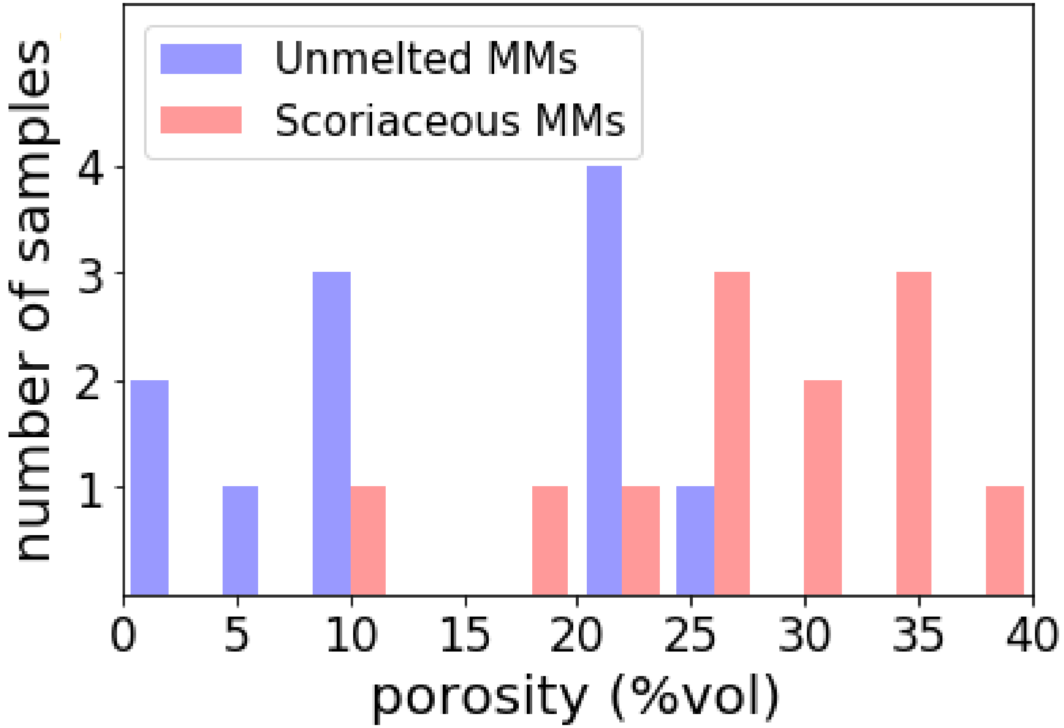


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- Confirmation of different porosity range for Unmelted and Scoriaceous MMs (Kohout et al., 2014)

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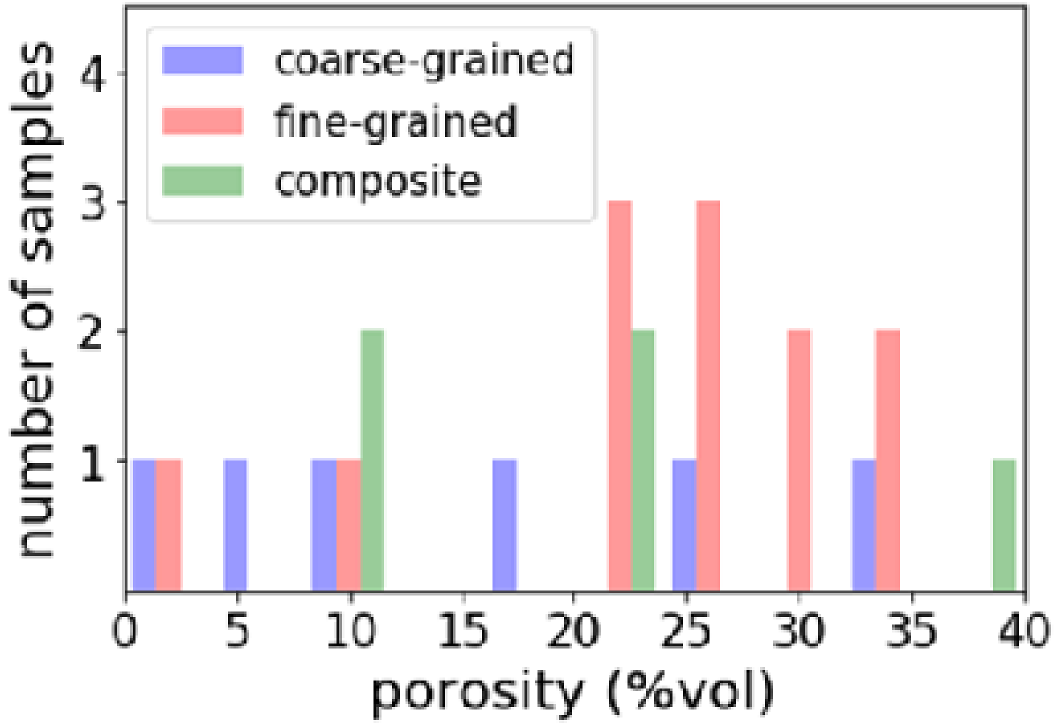


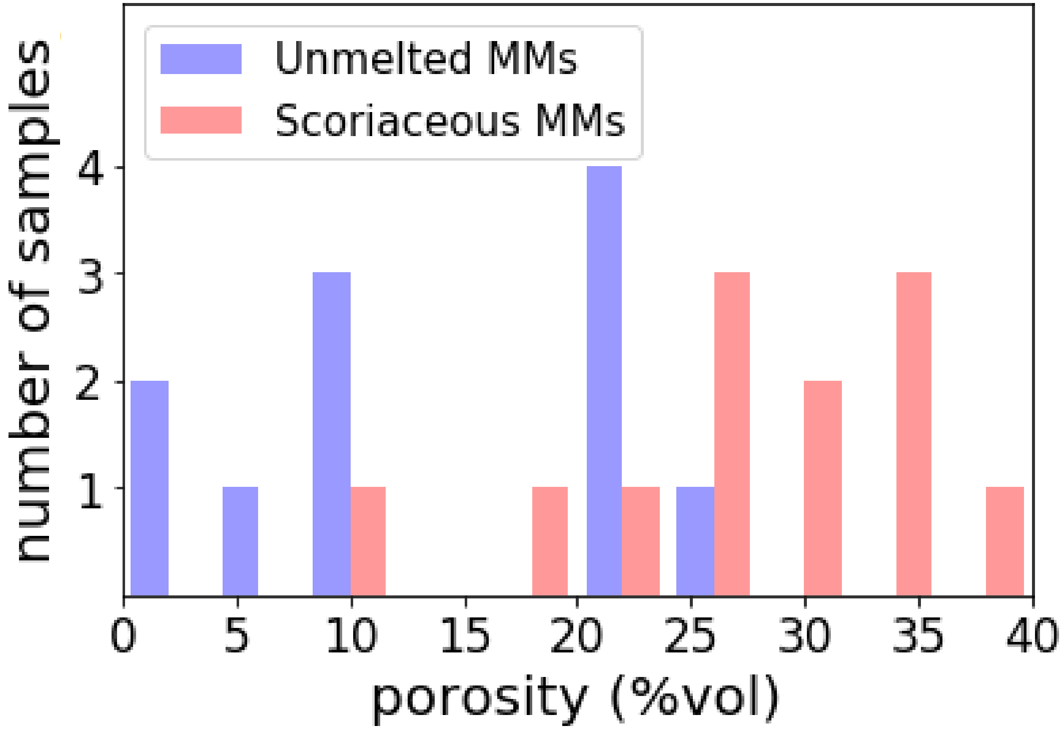


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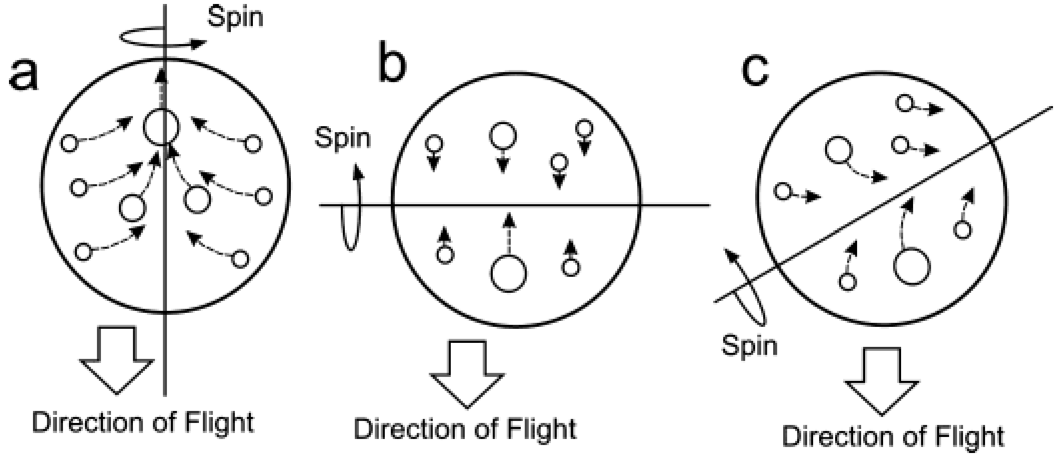
=> How does atmospheric entry affect pores ?

- Spinning entry

⇨ Migration of the different components
Observed in cosmic spherules




From Genge 2017

# • Spinning entry

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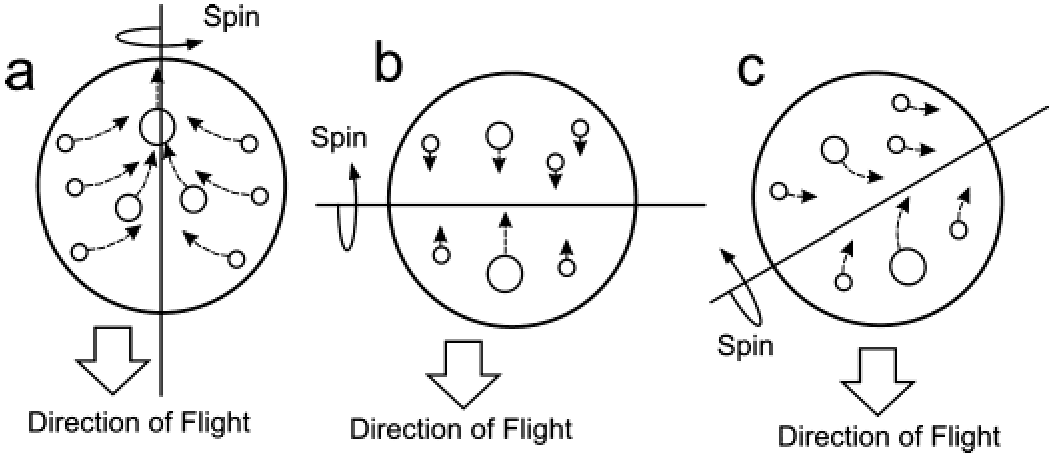


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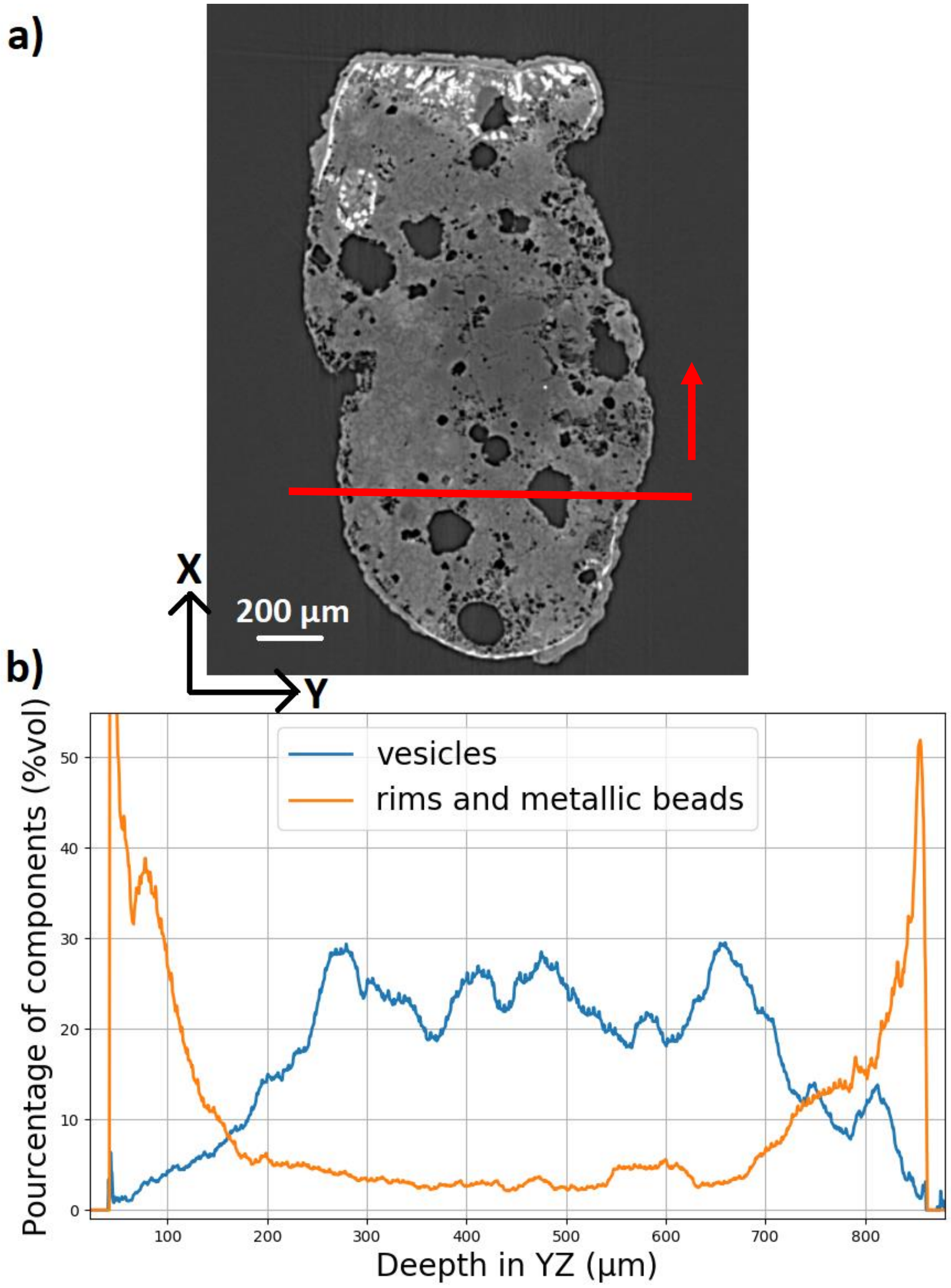

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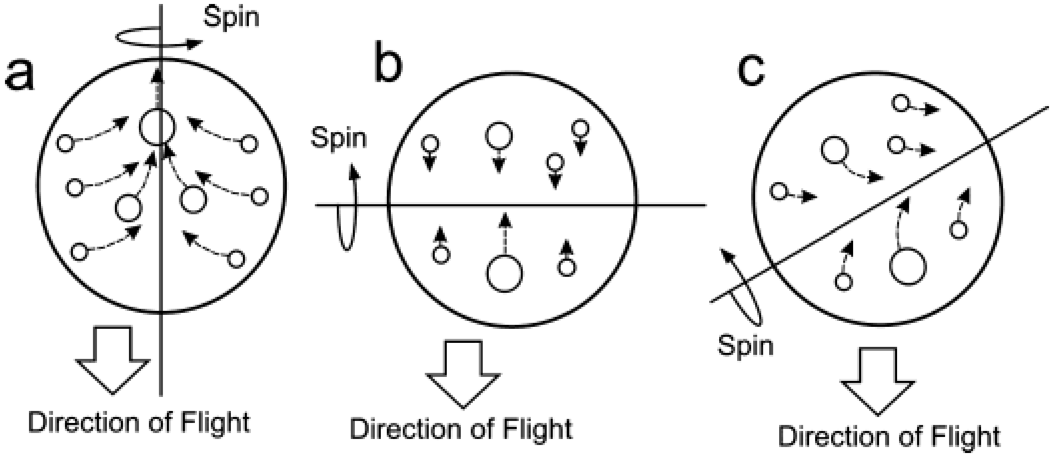
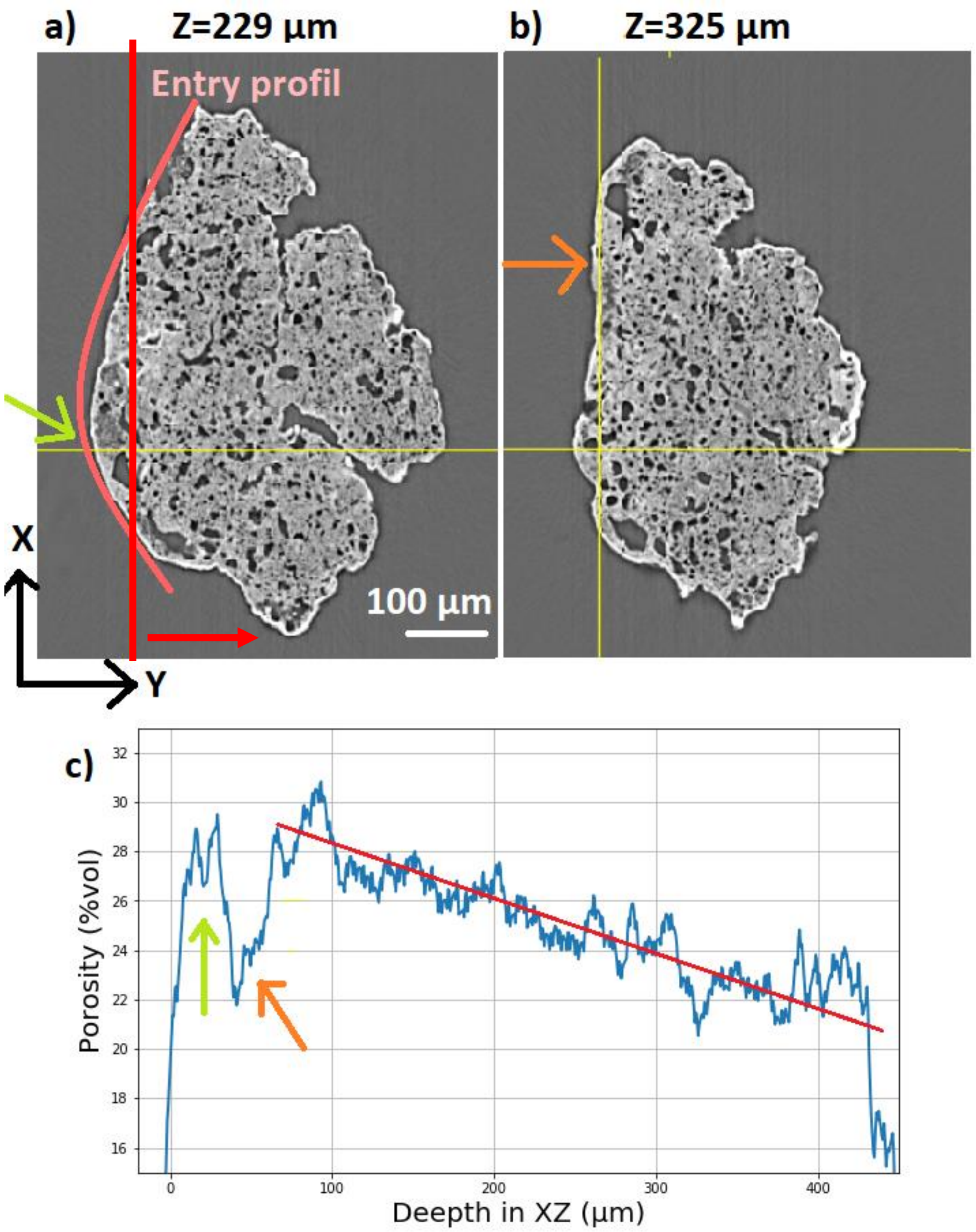



From Genge 2017

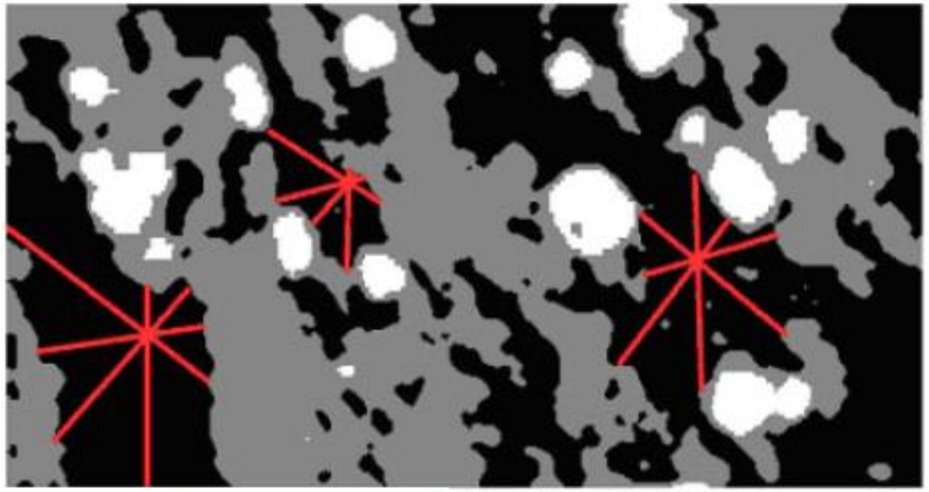
- Stable entry

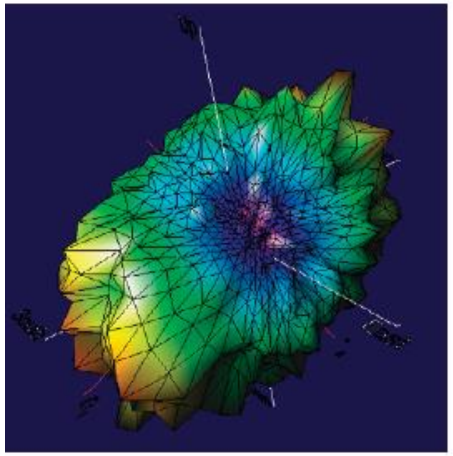
⇨ Variation of the porosity in parallel of the front entry



# IV. Study of the secondary processes

## 1. Shock history



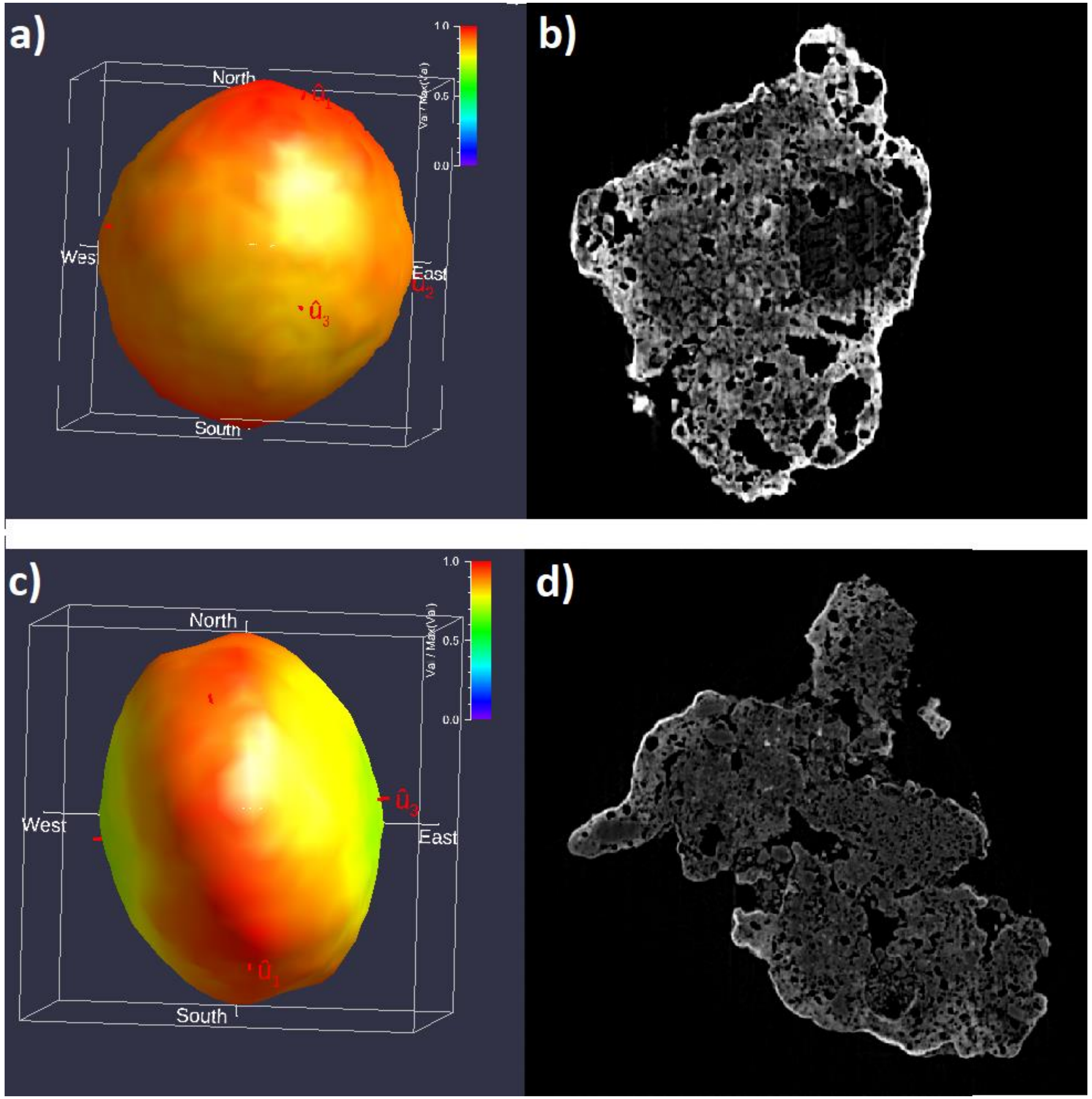


from Ketcham et al. 2004

- Random generation of points in 3D
- Keep the ones in holes
- Estimate the length inside the hole in all directions to have the Star Volume Distribution
- Creation of an eigenspace
- Calculation of the anisotropic index :

$$A= T_3/T_1$$

# Comparison of the shape of the vesicles on the Unmelted MMs




TAM 50.04
A= 1.80

TAM 50.30
A= 5.46

-> more shock undergone by this MM

# IV. Study of the secondary processes

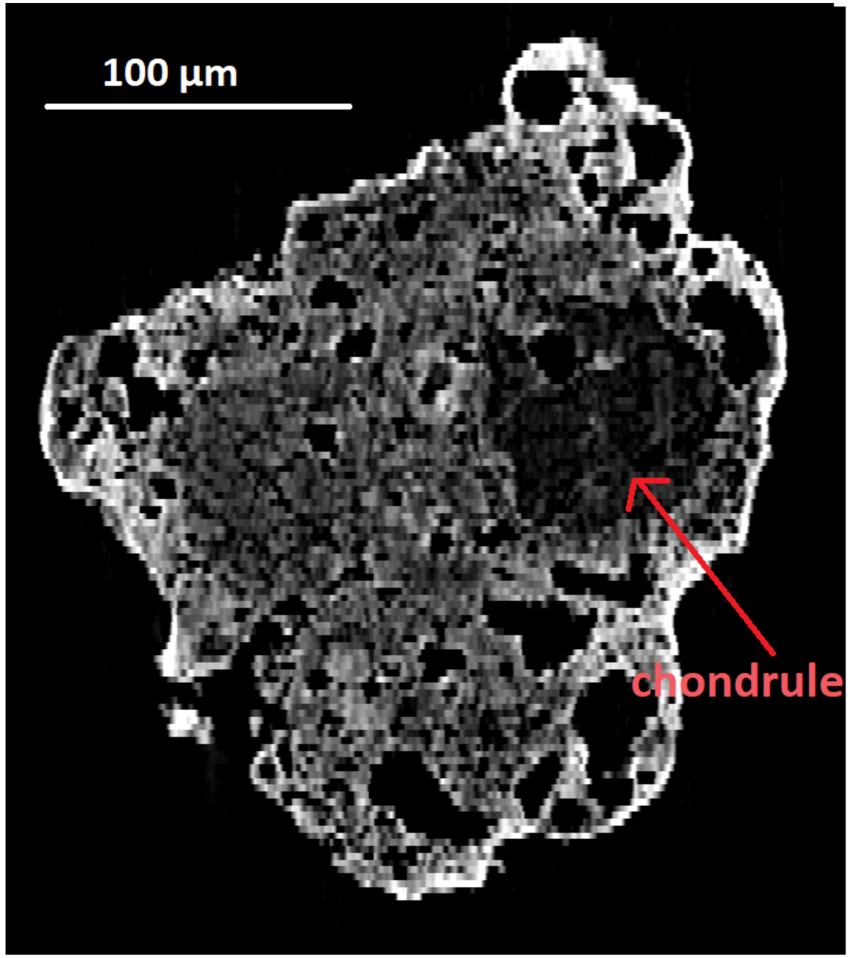
1. Shock history

2. Aqueous alteration

Presence of chondrules and igneous rims in several MMs

Detection of pseudomorphic chondrules
-> sign of intense aqueous alteration

Suttle et al. 2019



# What's next ?

**Non destructive preliminary characterization**

Collect and Classification → µX-CT → SX-RD

L. Folco and M. Gemelli

µX-CT:

Characterization of structures in the volume
Detection of ROI
Calculation of porosity
Body shock fabric

SX-RD:

Identification of the crystalline phases

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Identification of the crystalline phases

Oxygen isotopic composition

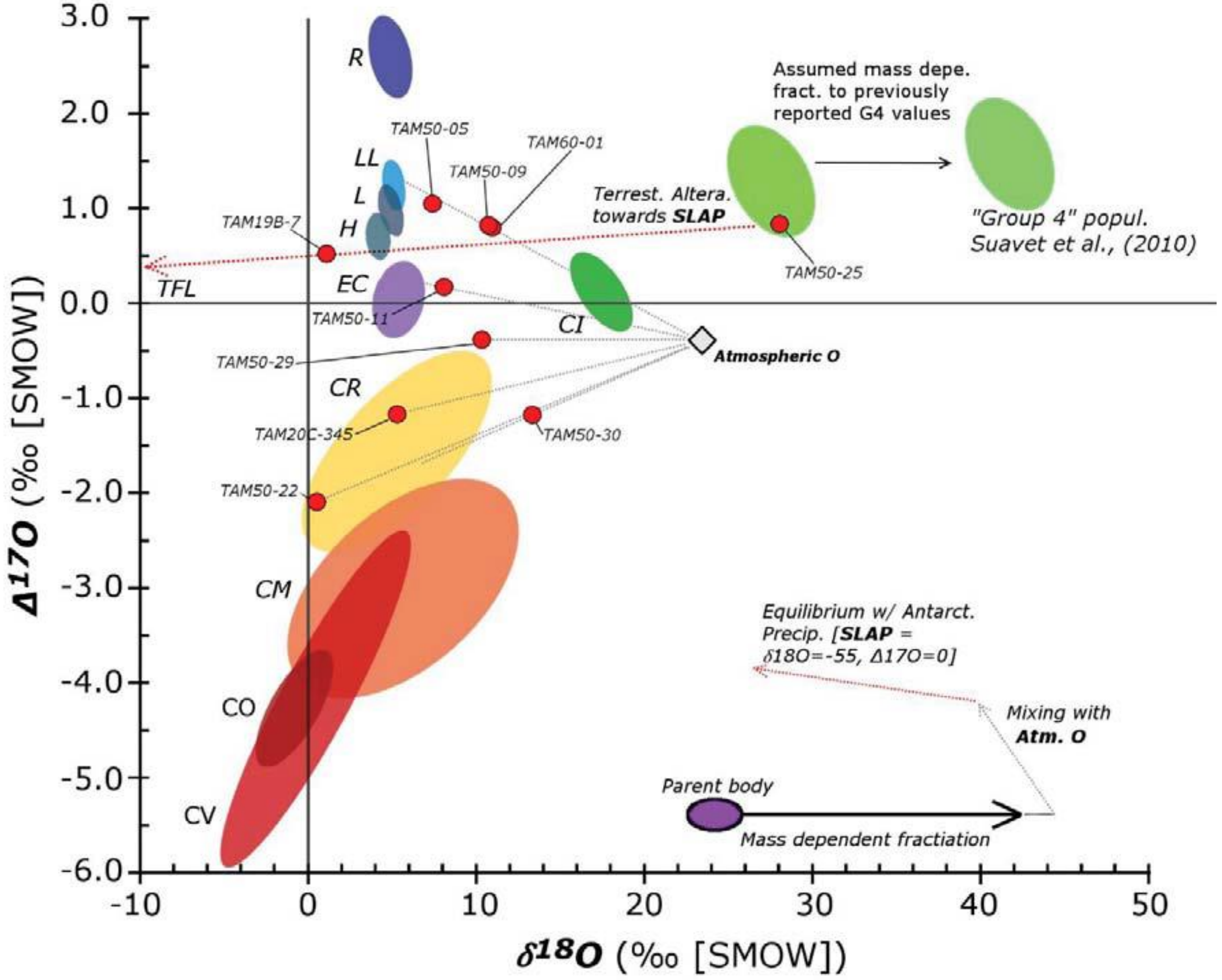
M. Suttle

*Sections*

IR spectroscopy

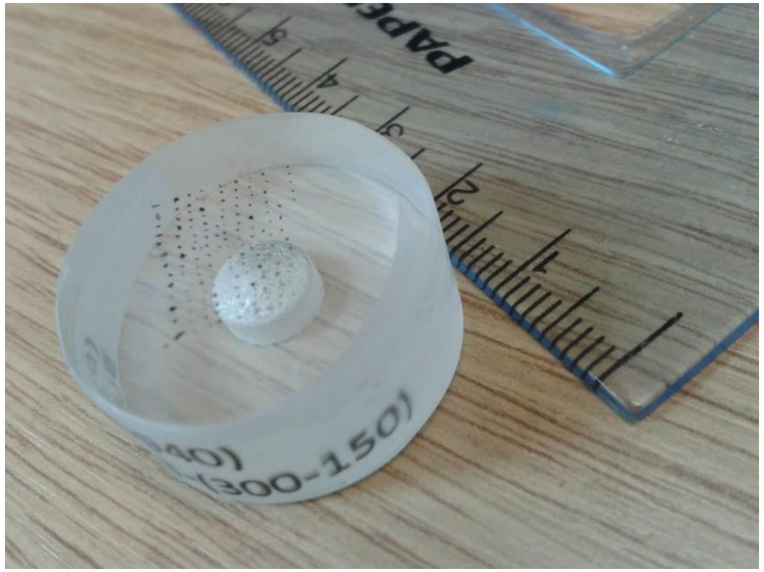
FESEM-EDX

# Oxygen isotopic measurement




- *First enstatite micrometeorite*
- *A new hydrated chondrite: Group 4*

# Sectioning: toward 2D analyses



-> particles are embedded inside resin
-> sectioning and polishing

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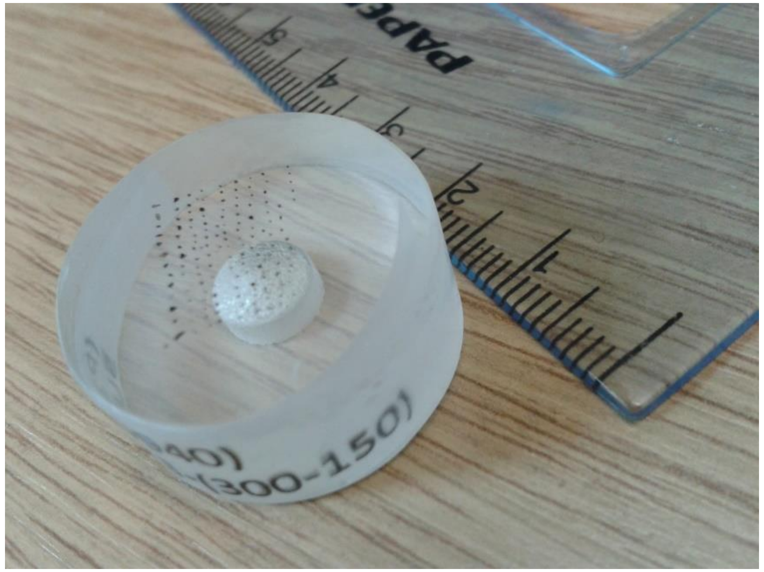

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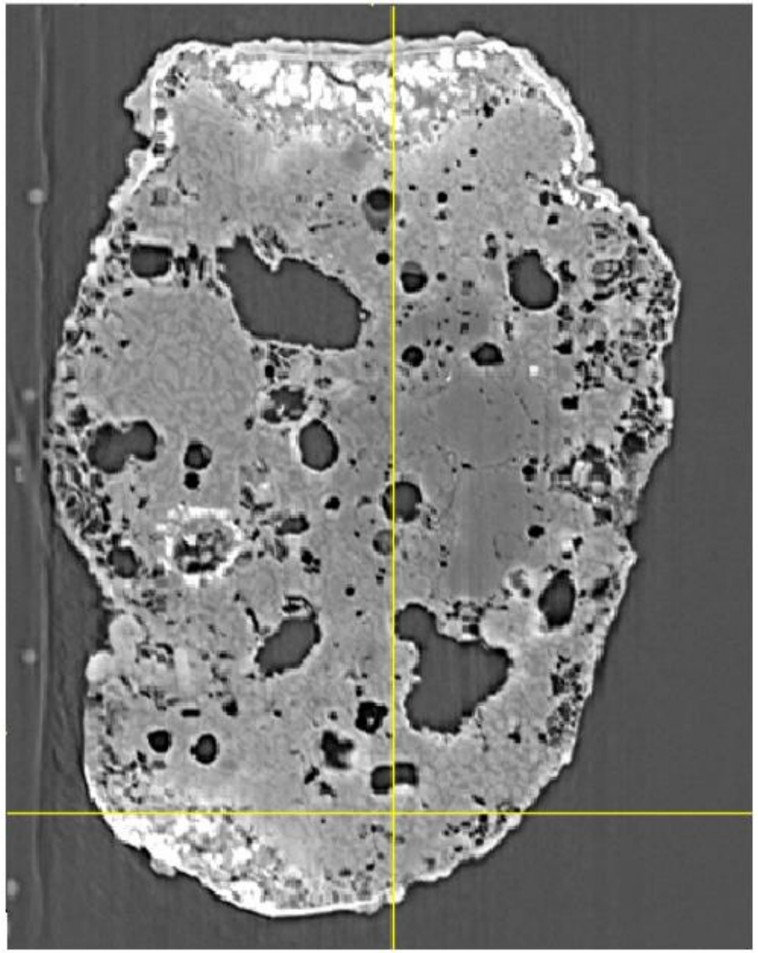
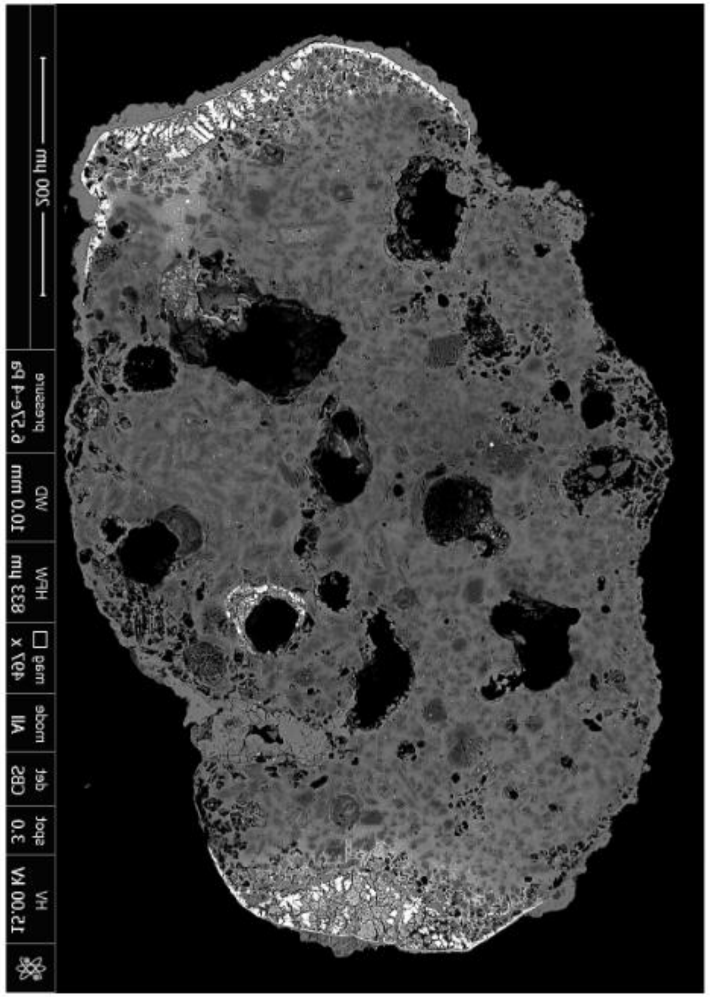
X-CT slice



EDX image



# Conclusions

<u>µX CT is a high-resolution (subµm -scale) non destructive method for:</u>

- 3D structural and textural characterization of extraterrestrial dust
- MMs classification based on vesicularity (unmleted vs scoriaceous)
- investigating the origin of primary (accretionary), secondary (parent-body and atmospheric flight) petrofabrics
- identification of key components (chondrules, CAI and other inclusions) for subsequent in depth-investigations

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