X-ray tomography: A valuable tool to study chondritic meteorites

Kelly G. Padilla[1,2], Joan Carles Melgarejo[1], Jordi Llorca[2,*]

[1]Universitat de Barcelona

[2]Universitat Politècnica de Catalunya – BarcelonaTech

X-ray tomography produces 3D images that allow us to study the distribution of metal, sulphide, silicate, impact veins and alteration phases in primitive meteorites and determine the porosity. It represents a powerful and non-invasive characterization technique.

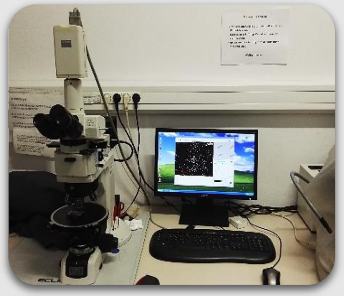
CONTEXT

- Meteorites represent a set of samples from different planetary bodies. Their study is fundamental to understand the formation and evolution of the Solar System and beyond
- Usually, meteorites are cut into slices and studied in thin sections to identify and characterize mineral assemblies, which are used to determine the physical-chemical processes occurring in their parent bodies
- But thin sections only give 2D mineral distributions; 3D information is lost. SEM-FIB can be used for 3D reconstruction, but it is expensive, time consuming, and has low resolution because of the ion milling process involved
- Here we show that X-ray tomography can be used to obtain 3D mineral distributions. We have chosen an ordinary chondrite and calibrated the X-ray tomography data with SEM-EDX analysis over exactly the same area to validate the results

METHODOLOGY

Ksar Ghilane 007
(ordinary chondrite, type H6)

1

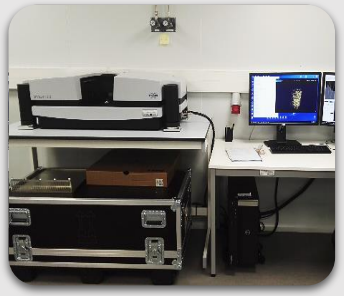


Optical microscopy

2

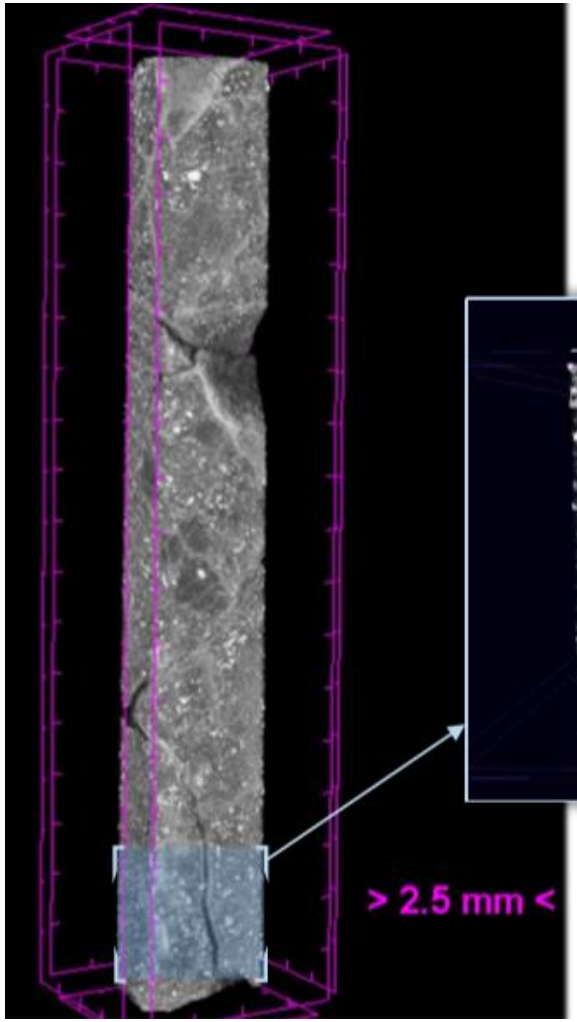
SEM-EDX

3

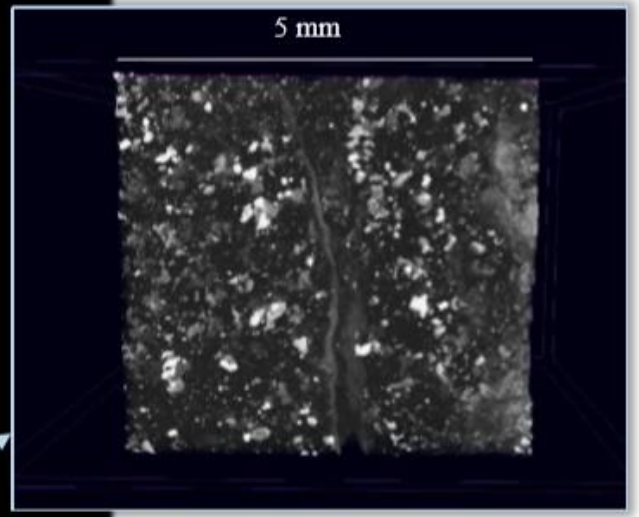


X-ray tomography

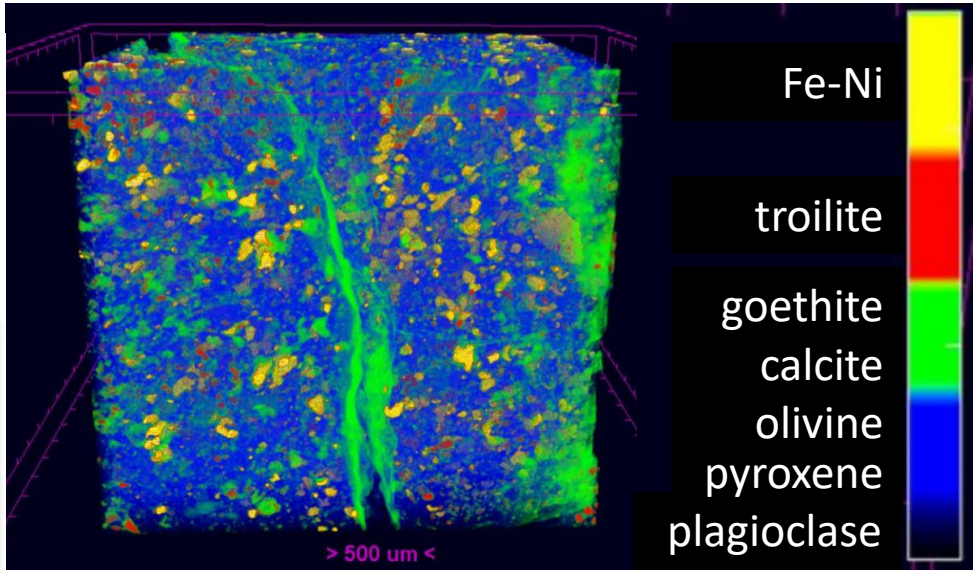
RESULTS (1/2)



3D X-ray tomography



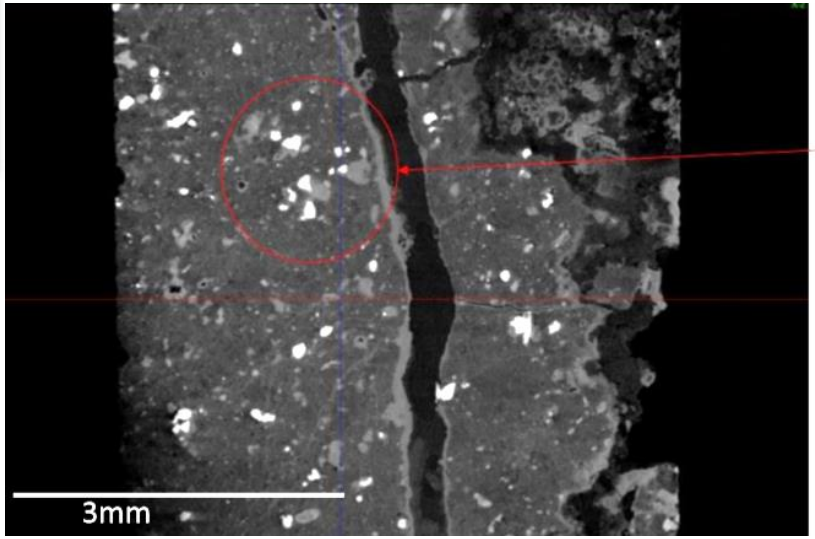
comparison between SEM and X-ray tomography

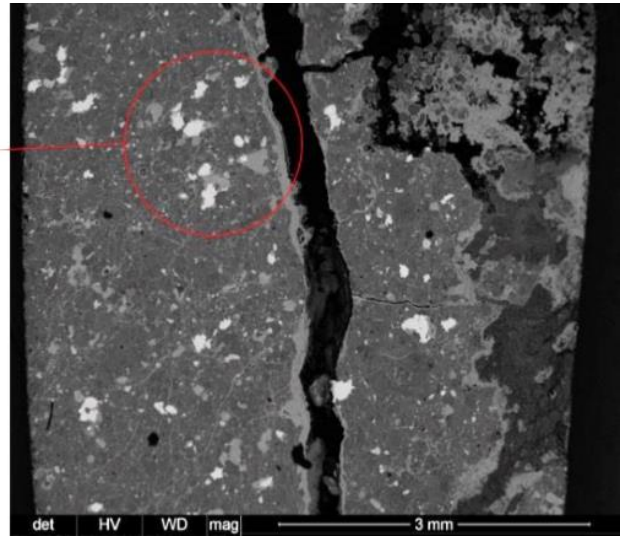


identification and distribution of phases by X-ray tomography

X-ray tomography

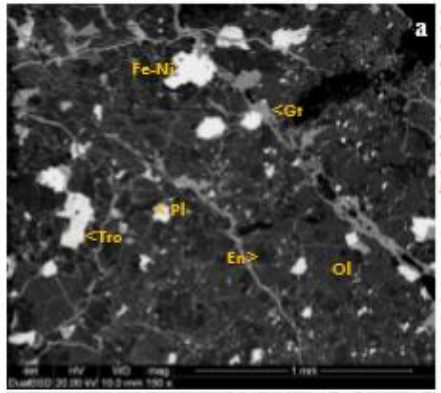
SEM

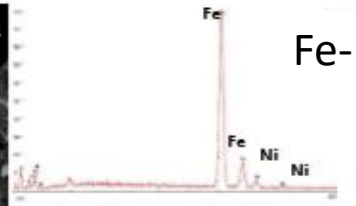




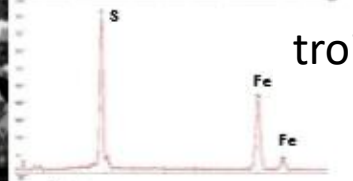
RESULTS (2/2)

SEM EDX

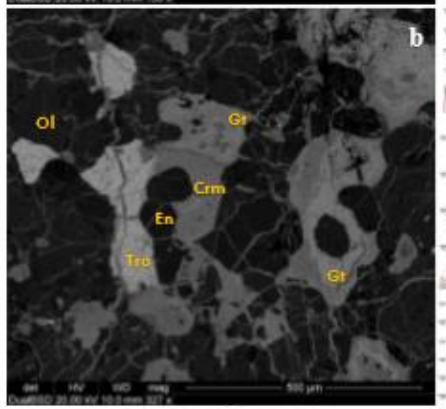




Fe-Ni

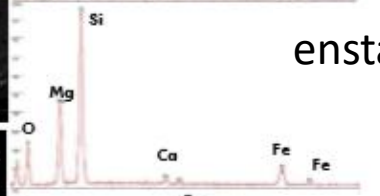


troilite

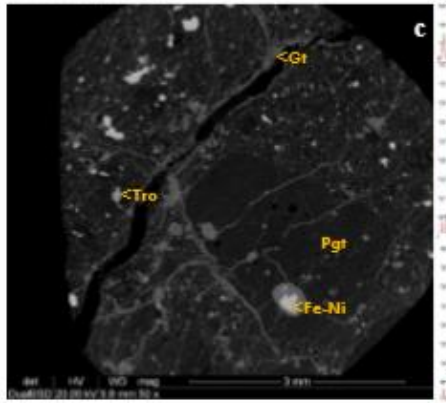


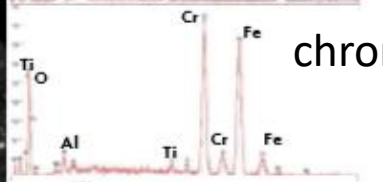
olivine

plagioclase

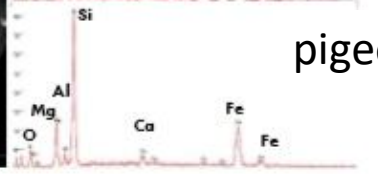


enstatite



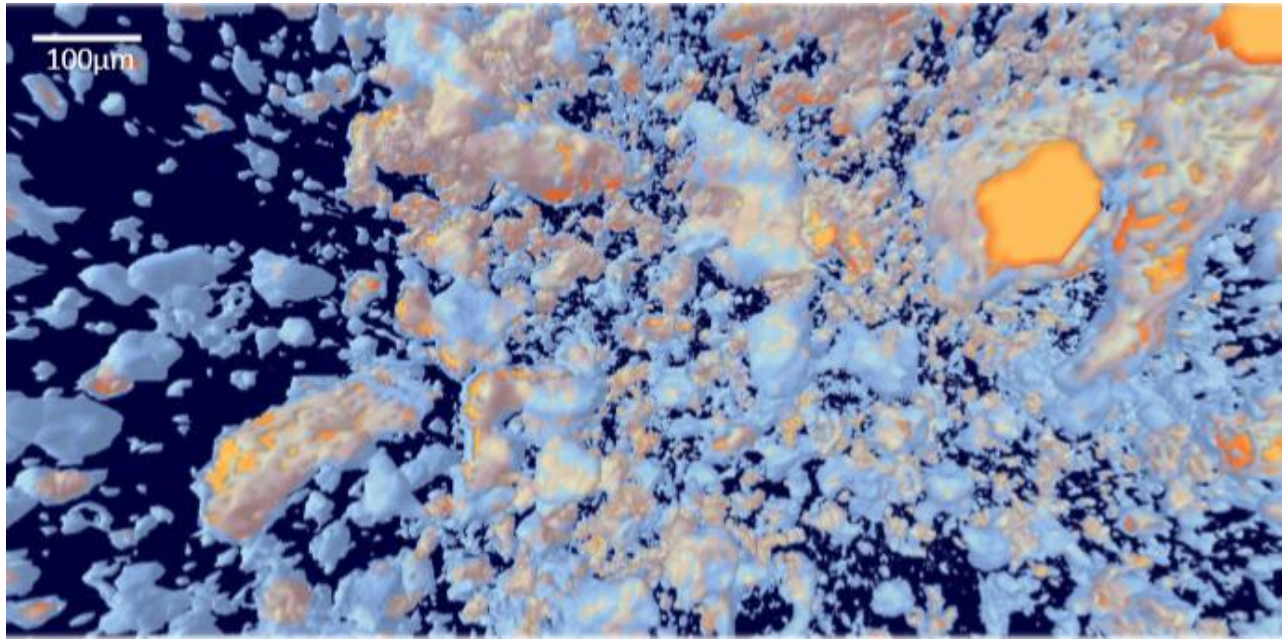


chromite

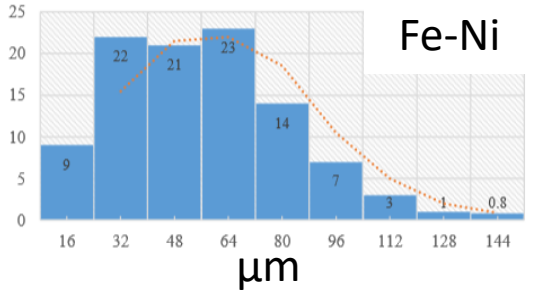


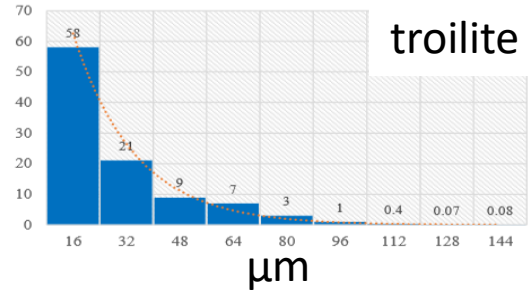
pigeonite

X-ray tomography



Fe-Ni metal (orange) is embedded in troilite (blue)





size distribution of Fe-Ni metal and troilite

IMPACT AND FUTURE PROSPECTS

- X-ray tomography yields 3D information of meteorites without the need to section them. It is a non-invasive and fast characterization technique

- This is particularly relevant for studying the genesis and relationships of both primitive mineral phases and secondary alteration products in meteorites, which is very valuable to infer on the physical-chemical processes occurring in their parent bodies (asteroids, the Moon, Mars...)

- Accurate modal mineral distribution, studies related to porosity, shock vein morphologies, and genetic relationships between primary phases and secondary alteration products are possible with X-ray tomography