

Applications of High Resolution X-ray Computed Tomography (CT) to Planetary Science

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Planetary Background

- Planetary geology and remote sensing
- MS University of Hawai'i
- TIR emission spectroscopy and Martian geology
- Research scientist associate at the High-Resolution X-ray CT facility in JSG
- Topics:
 - facility capabilities
 - planetary research in the CT lab

High Resolution X-ray CT

- NSF-supported multi-user facility in JSG
- Higher energy and resolution than medical CT scanners
- Non-destructive 3D imaging for planetary samples

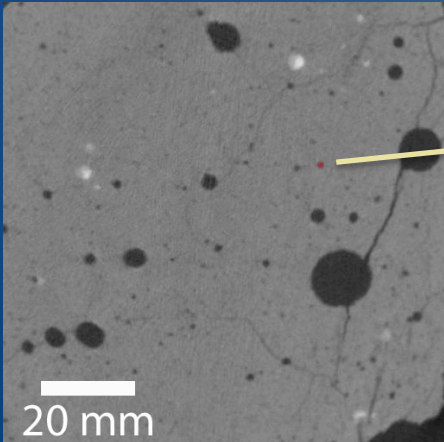
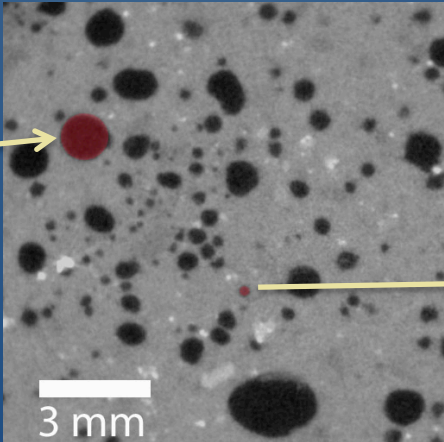
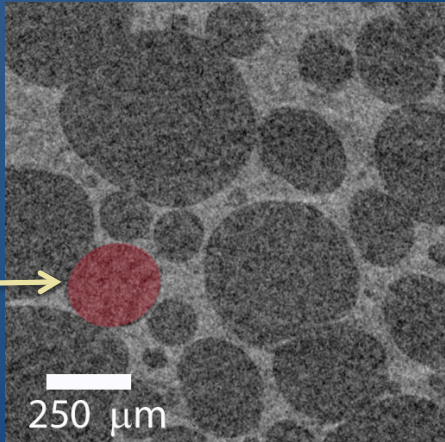


Xradia MicroCT



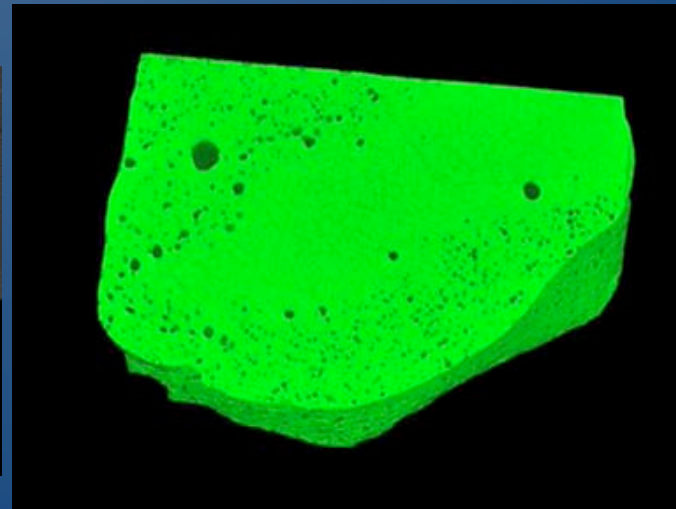
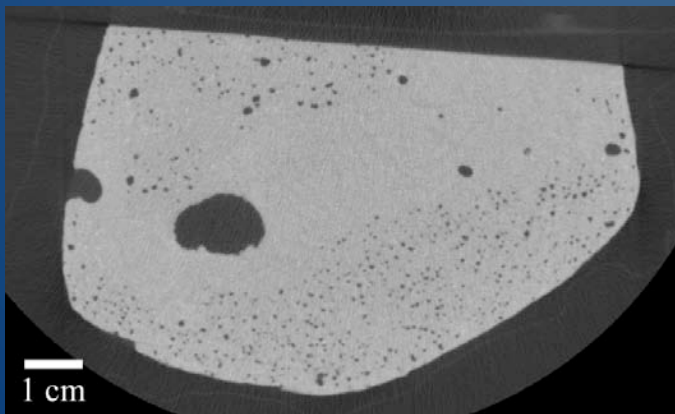
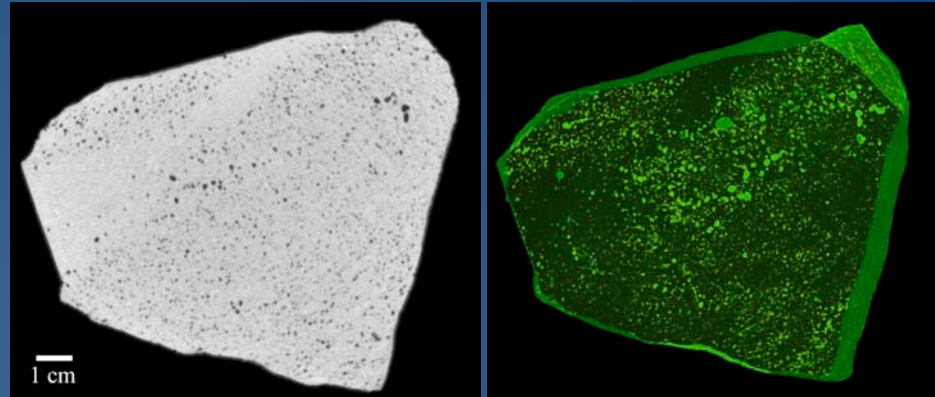
High energy P250 and high resolution II

High Resolution X-ray CT

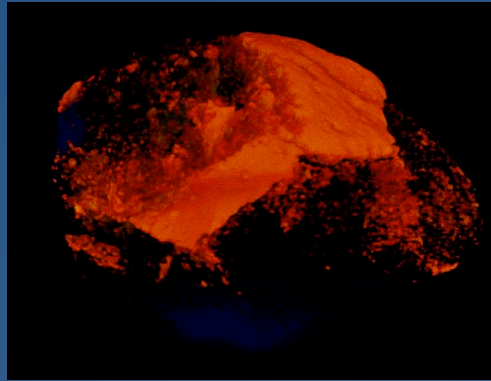
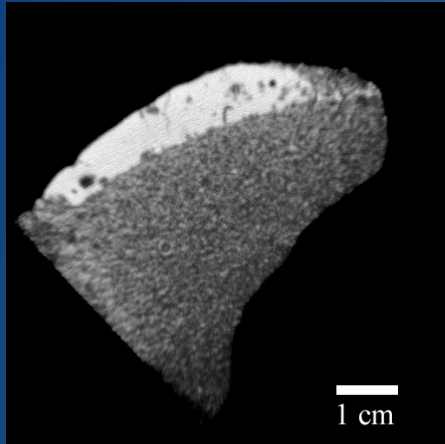
P250 High Energy	II High Resolution	Xradia MicroCT
450 keV	225 keV	150 KeV
50 cm diameter 150 cm height	5 - 6 cm diameter 15 cm height	3.5 cm
120 – 300 micron in-plane 0.25 – 5 mm Z	5 – 250 micron	0.5 – 40 micron
		

Meteorite Imaging

- 2 slabs of Ibitira (eucrite)
- Vesicular basaltic meteorites
- Origin of vesicles from thin dikes at depth
- Ground truth for DAWN at Vesta 4 in 2011

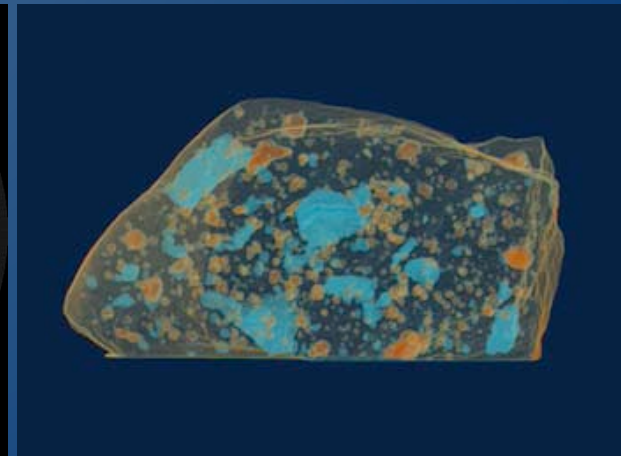
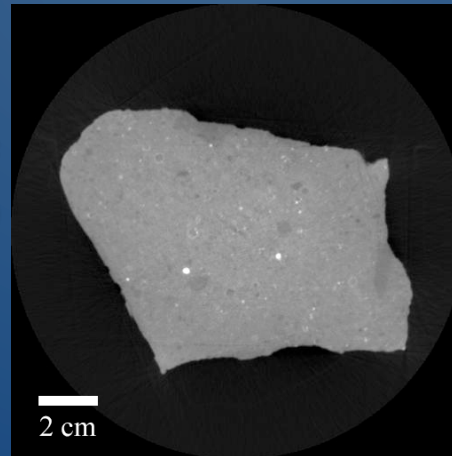


Meteorite Imaging



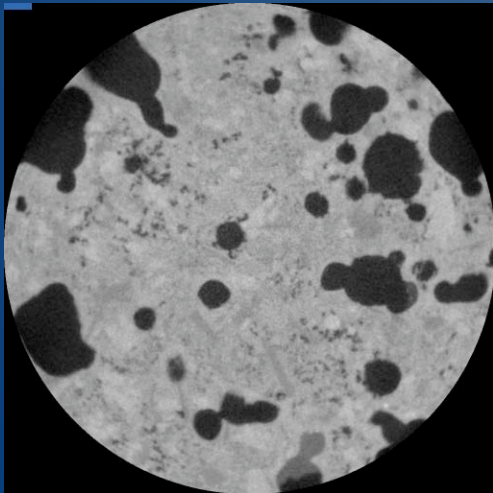
- GRA 95209
- Lodranite
- Bright metal-sulfide veins
- Metal segregation

- Vigarano
- Carbonaceous chondrite
- CAIs in blue (extracted)
- CAIs may predate chondrules (orange)

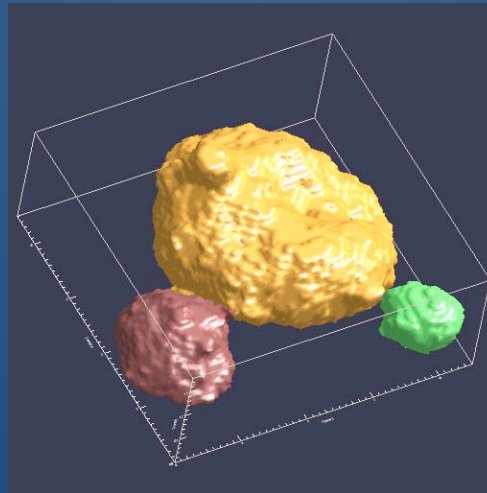


Analytical Software

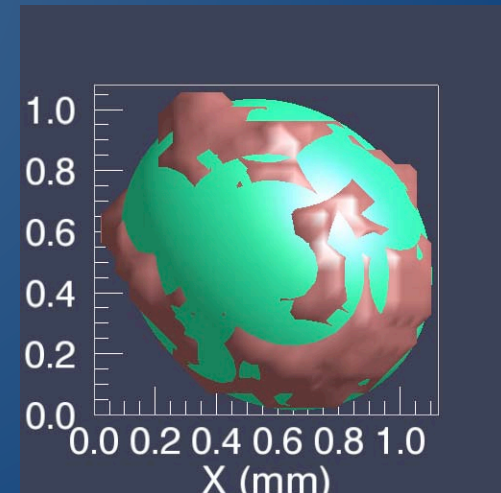
- Blob3D: 3D geometrical measurements of up to thousands of objects in a data volume
- Has been used to analyze vesicles, chondrules, porphyroblasts, clasts, and metal grains



Vesicular basalt CT data



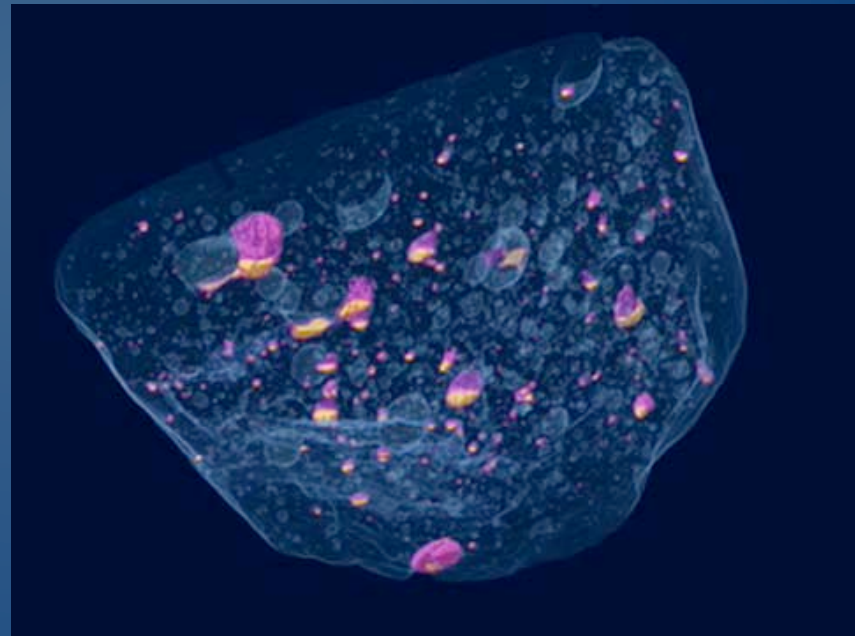
Extracted vesicles



Ellipsoid fit to vesicle

L Chondrite PAT 91501

- Unshocked, igneous-textured impact melt
- Imaging revealed that metal and sulfide grains orientated themselves in the local gravitational field
- Measurements of vesicles and metal-sulfide particles in CT data confirmed their preferred orientations and constrained parameters of formation
- Yellow = metal, magenta = sulfide, blue = vesicles

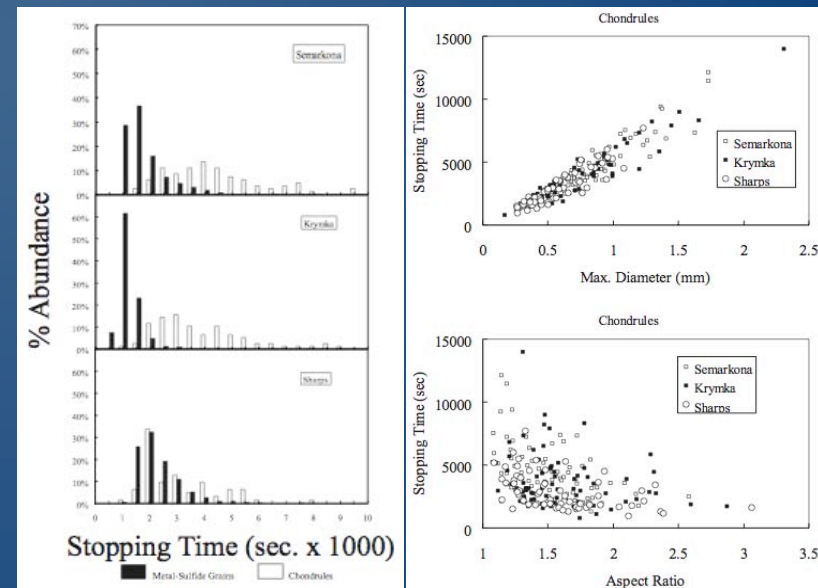
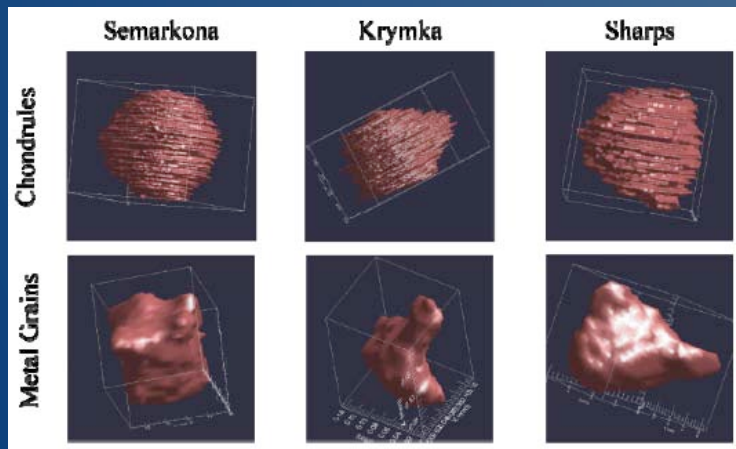


Benedix, G.K., et al. (2008)

The formation and chronology of the PAT 91501 impact-melt L chondrite with vesicle-metal-sulfide assemblages. *Geochimica et Cosmochimica Acta*, 79, 2417-2428.

Chondrites: Nebular Sorting

- Semarkona (LL3.0), Krymka (LL3.1), and Sharps (H3.3)
- Used Blob3D to separate out and calculate various metrics of chondrules and metal grains
- Metrics used to test 3 different models of nebular sorting



Images from Nettles, J.W., 2007. Petrology of Chondrule Precursors and Sorting of Particles in Ordinary Chondrites, . Ph.D. dissertation, Univ. of Tennessee, 179 pg.

Summary

- X-ray CT provides non-destructive 3D imaging and analysis for planetary samples
- Range of scanning capabilities for any size specimen or project requirement
- Reduced rate for NSF EAR grants
- Poster: “Variations among dark-toned intracrater deposits in Amazonis Planitia, Mars” (Romy Schneider)
- Collaboration interests: VIS/NIR/TIR spectroscopy, X-ray CT

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