Comparative Analysis of Water Sorption in Mortar with Olivine Sand Captured Using 4D X-ray CT

Kaina R. Vieira, Dr. Laura E. Dalton

Department of Civil and Environmental Engineering, Duke University

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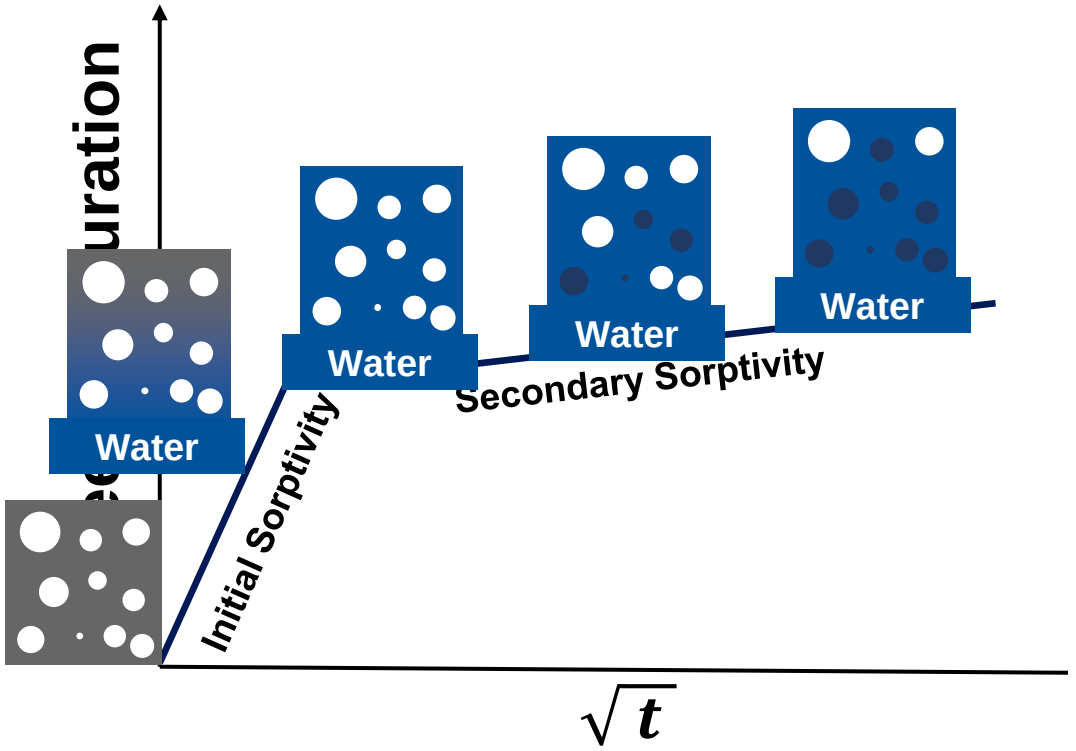
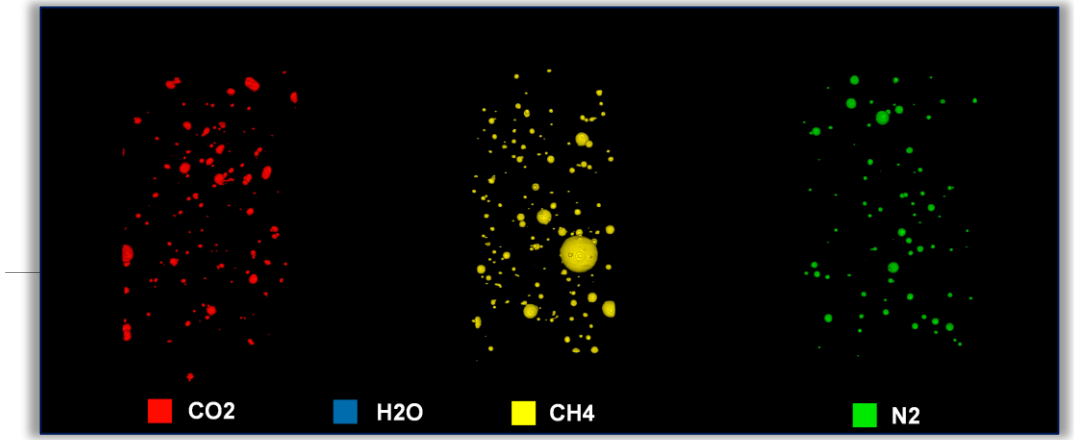
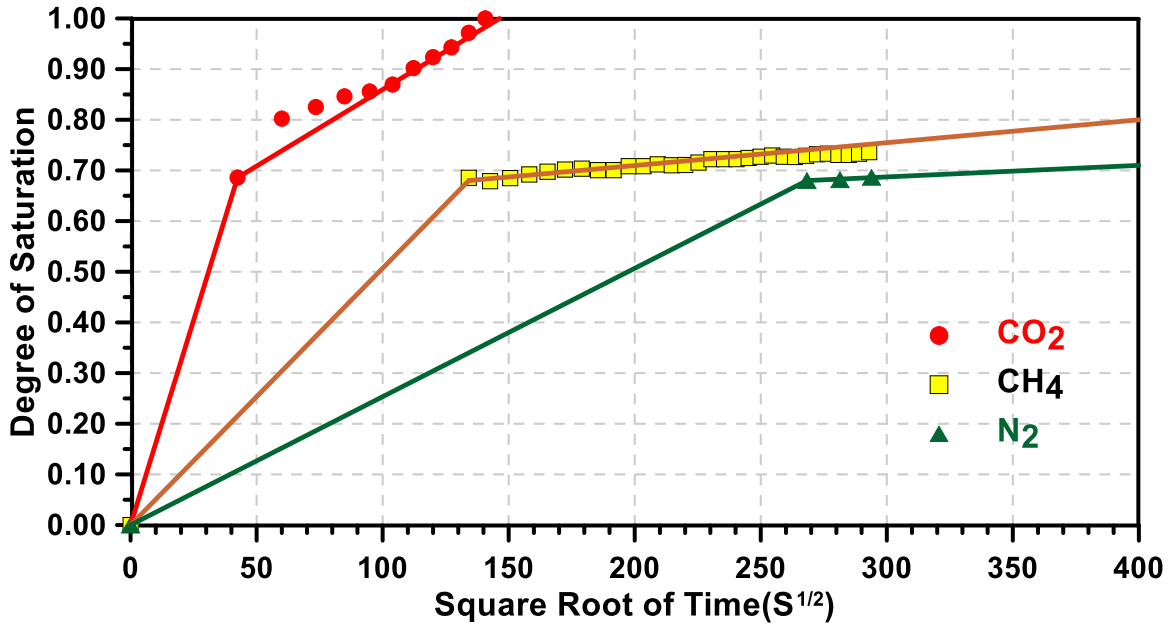
Background







Dalton et al. (2020)

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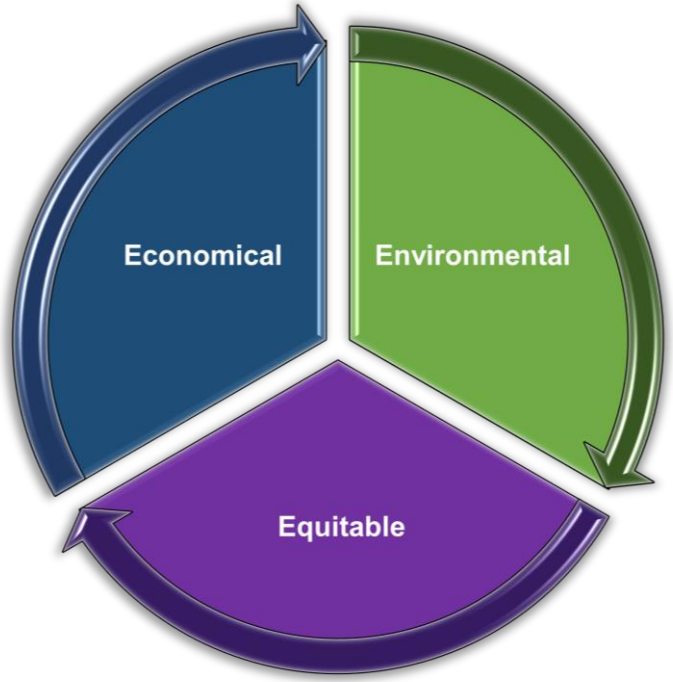
Research Motivation and Objective

Need to lower carbon footprint in the concrete industry

Portland cement concrete naturally sequesters CO_2

Enhanced rock weathering using tools from nature



Brundtland (1987); United Nations (UN)

Accelerate natural carbonation by using sustainably engineered solutions

Integrate local Mg-rich materials to accelerate CO_2 mineralization

Ensure durability is not reduced with Mg-rich additions

Research Objective: Develop sustainably engineered geomaterials using Carbon Capture, Utilization, and Storage (CCUS).

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Materials: Norway Olivine

- **Located in Åheim, Norway Sibelco is the world's largest commercial mining and processing company of high magnesium olivine**

Particle Size Distribution
Method: Dry Sieving. Sieves: ISO 3310-1

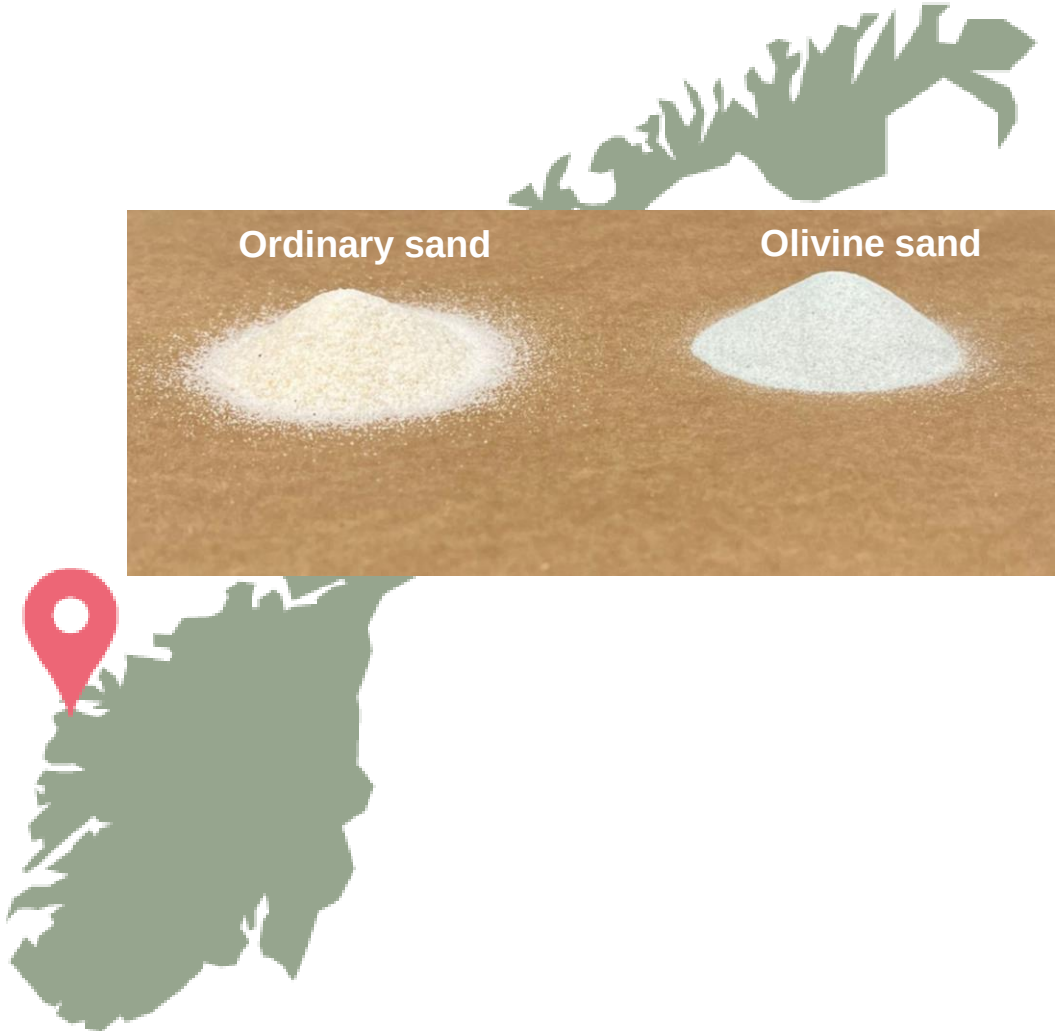
	Size [mm]	Average [%]	Std.dev
	2.800	0,0	0,00
	2.000	0,0	0,00
	1.400	27,0	0,00
	1.000	57,9	0,00
	0.710	13,8	0,00
Retained on sieve	0.500	1,1	0,00
	0.355	0,2	0,00
	0.250	0,0	0,00
	0.180	0,0	0,00
	0.125	0,0	0,00
	0.090	0,0	0,00
	0.063	0,0	0,00
	PAN	0,0	0,00
	SUM	100,0	

Chemical Composition
Method: XRF. Analytical Instrument: AXIOS

Component	Average [%wt]
MgO	49,0
SiO_2 (*)	42,0
Fe_2O_3	7,4
Cr_2O_3	0,38
Al_2O_3	0,52
NiO (**)	0,32
MnO	0,09

Method: Loss on ignition

	Average [%wt]
L.O.I.	0,84



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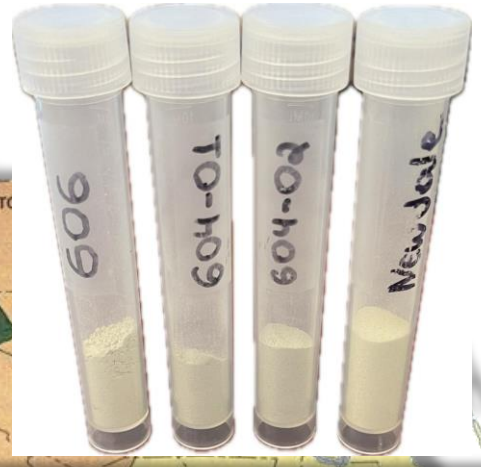
Materials: North Carolina Olivine



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https://www.deq.nc.gov/geological-survey

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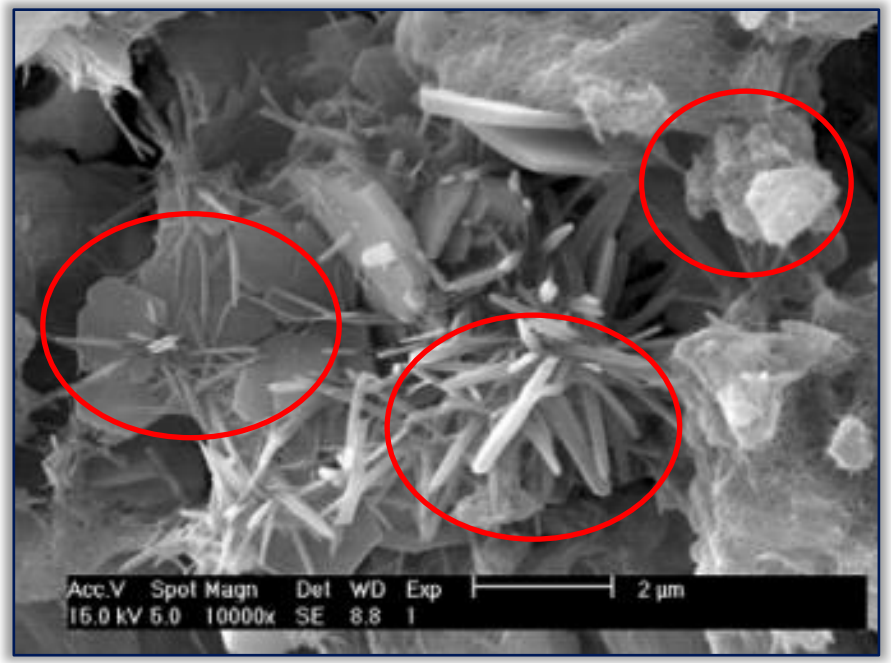
Methods: Carbonation

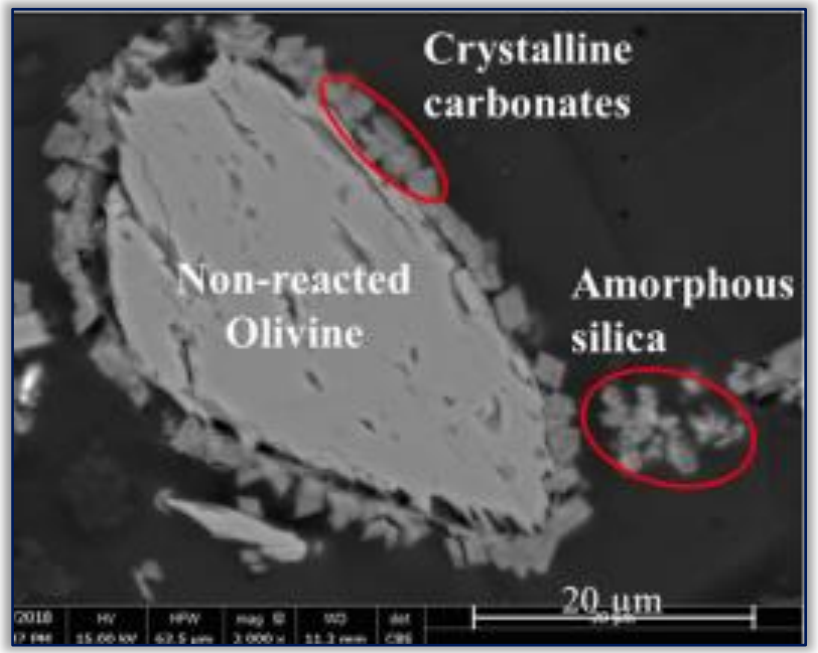
Portland Cement



Cizer *et al (2006).*

Hydration Products

Olivine



Wang *et al* (2019)

$CaO + CO_2 = CaCO_3 + 179\ kJ\ mol^{-1}$

Carbonates (Mineralized CO_2)

$MgO + CO_2 = MgCO_3 + 118\ kJ\ mol^{-1}$

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Methods: 4D X-ray CT Sorption Tests

Sorption tests using 4D X-ray Computed Tomography (CT)

Designation: C1585 – 20

Standard Test Method for Measurement of Rate of Absorption of Water by Hydraulic-Cement Concretes[1]

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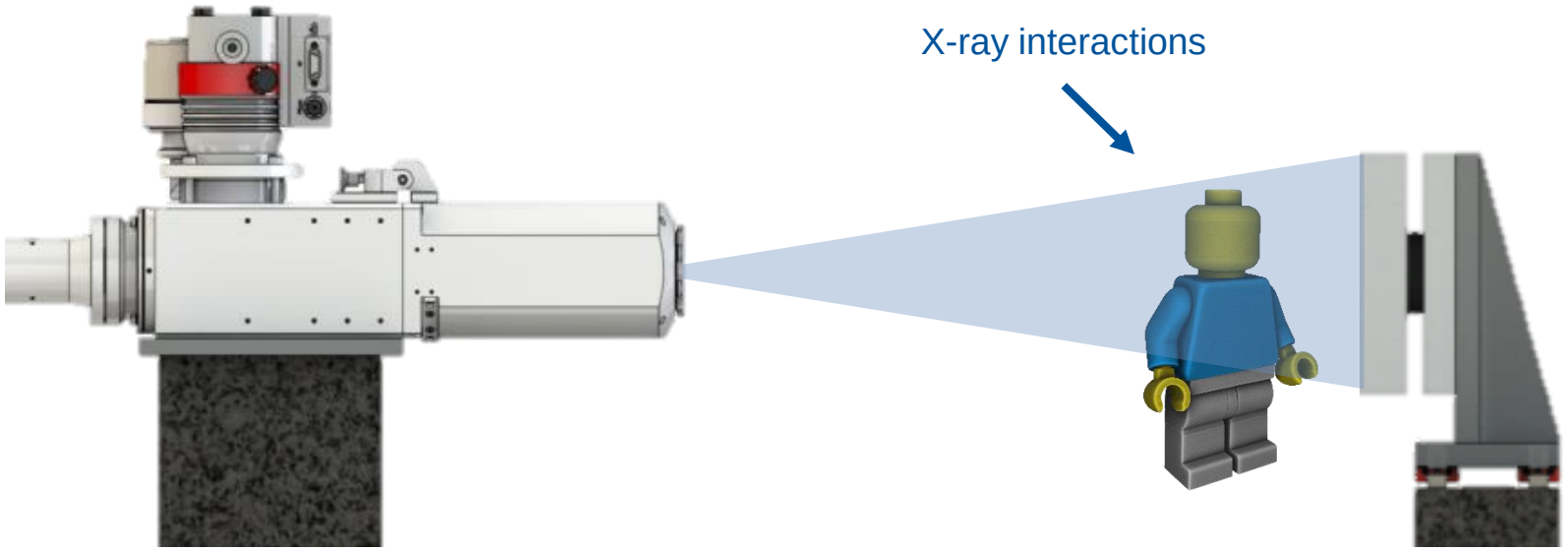
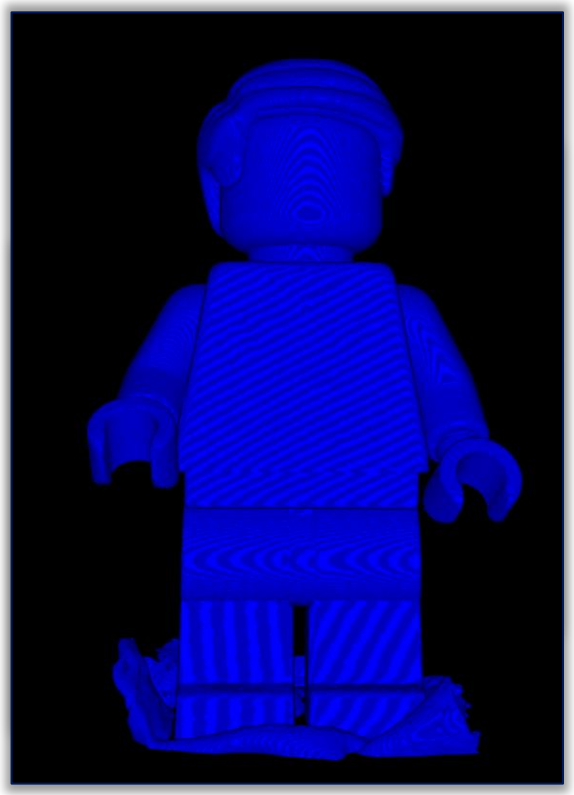
Methods: X-ray Computed Tomography



X-ray Source

Detector



Original slides from

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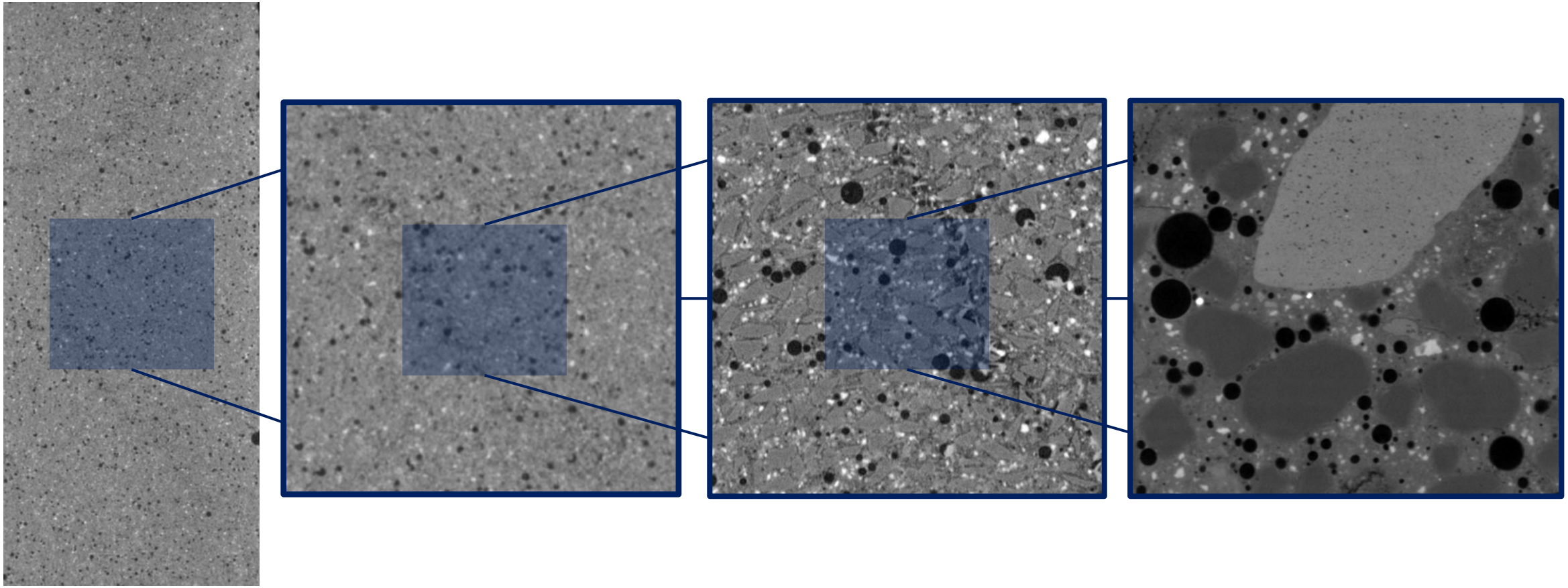
Ongoing Results: X-ray CT

10 µm voxel size, 5-minute scan → **996 nm** voxel size, 2 hour scan



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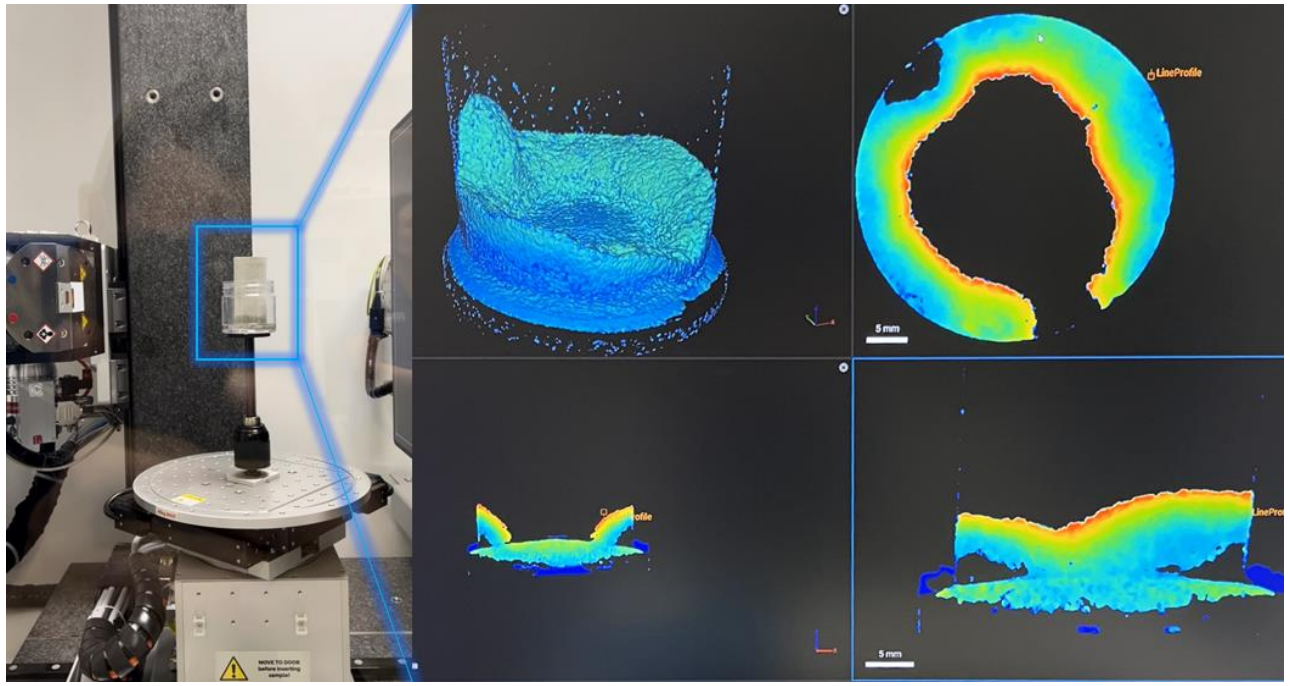
Ongoing Results: 4D X-ray CT

- 4D X-ray CT scan for the first week of curing
- Analyze microstructural features
- Conduct 4D X-ray CT sorption tests



30% KI/weight doped solution

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Ongoing Results: Sample Preparation

Control Samples

Olivine Samples

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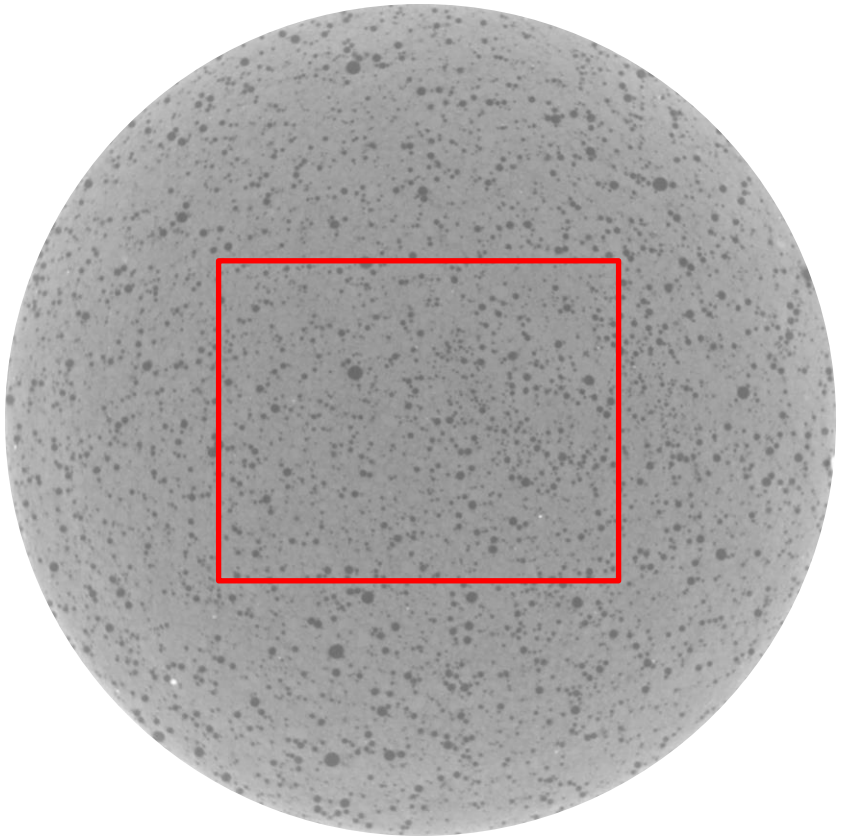
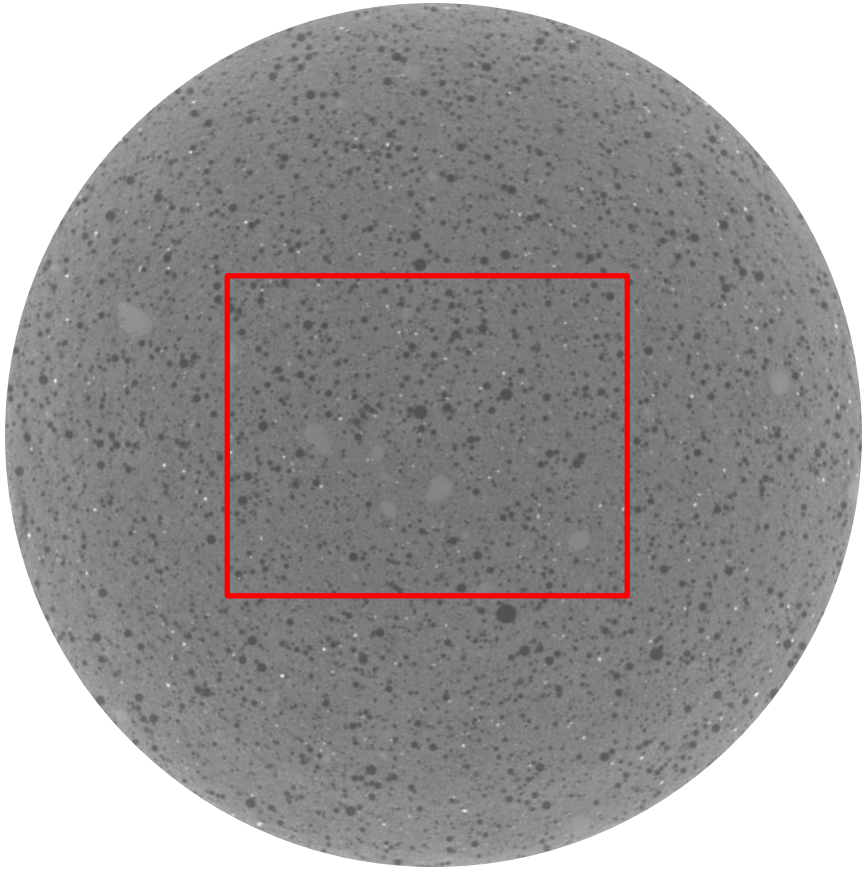
Ongoing Results: Scan Results

Control Samples



Olivine Samples



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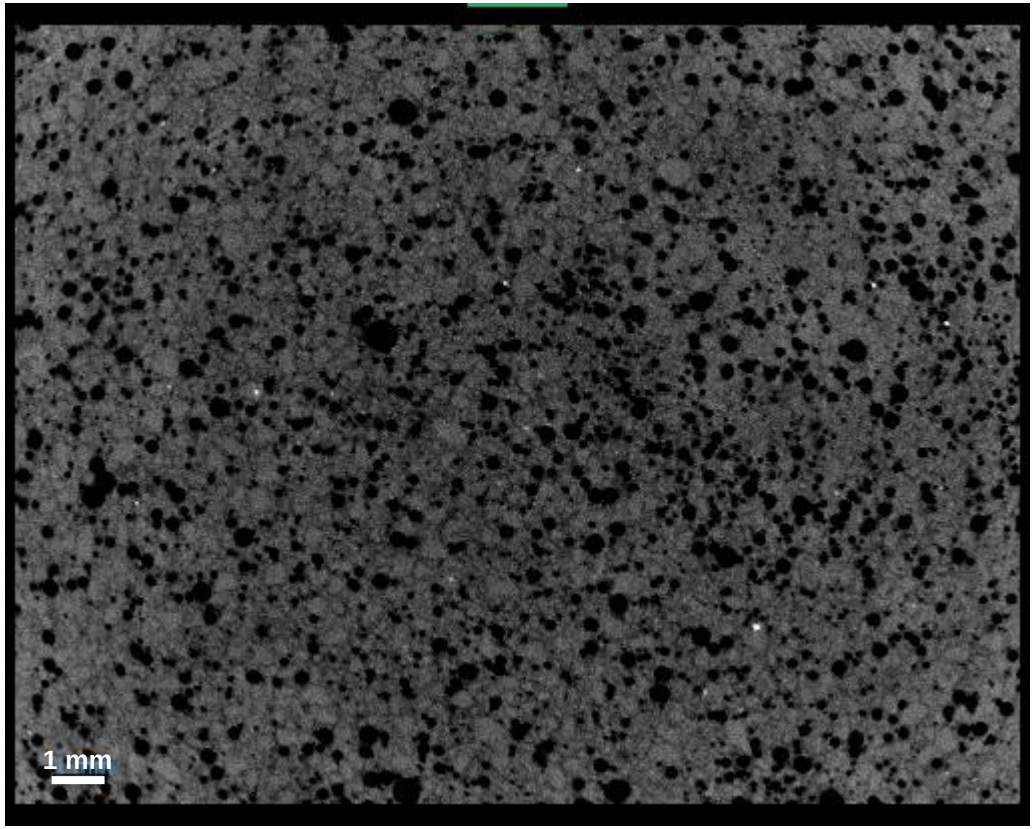
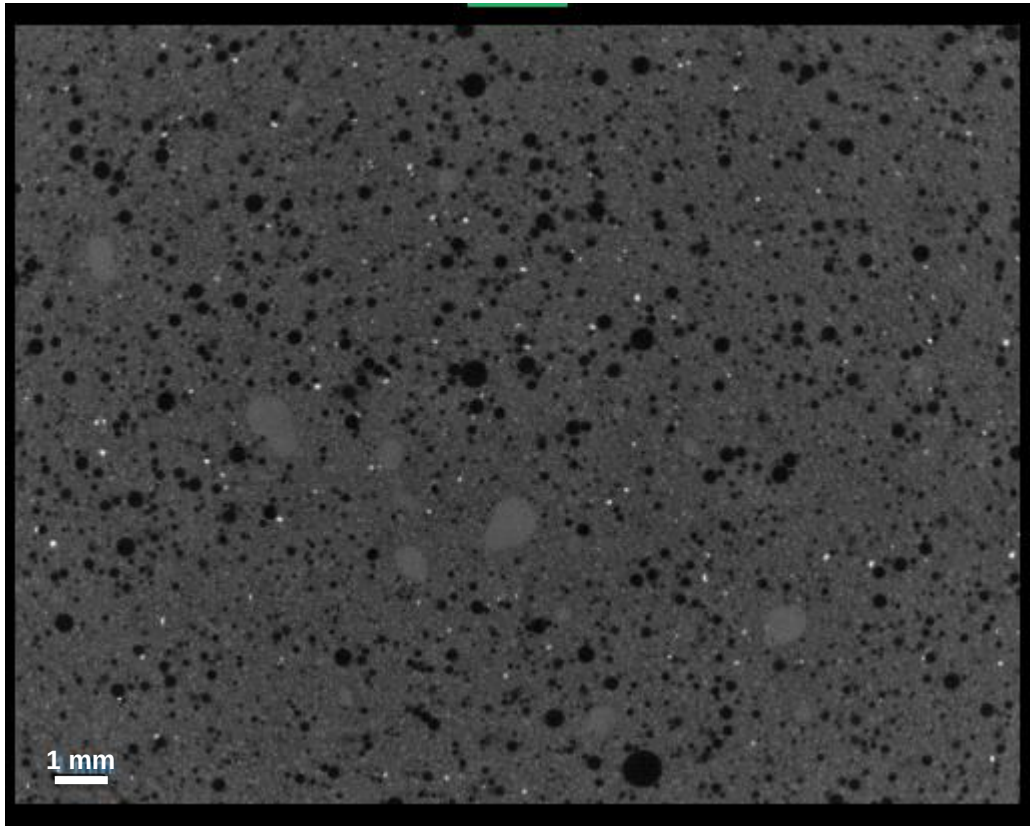
Ongoing Results: Scan Results

Control Samples



Olivine Samples



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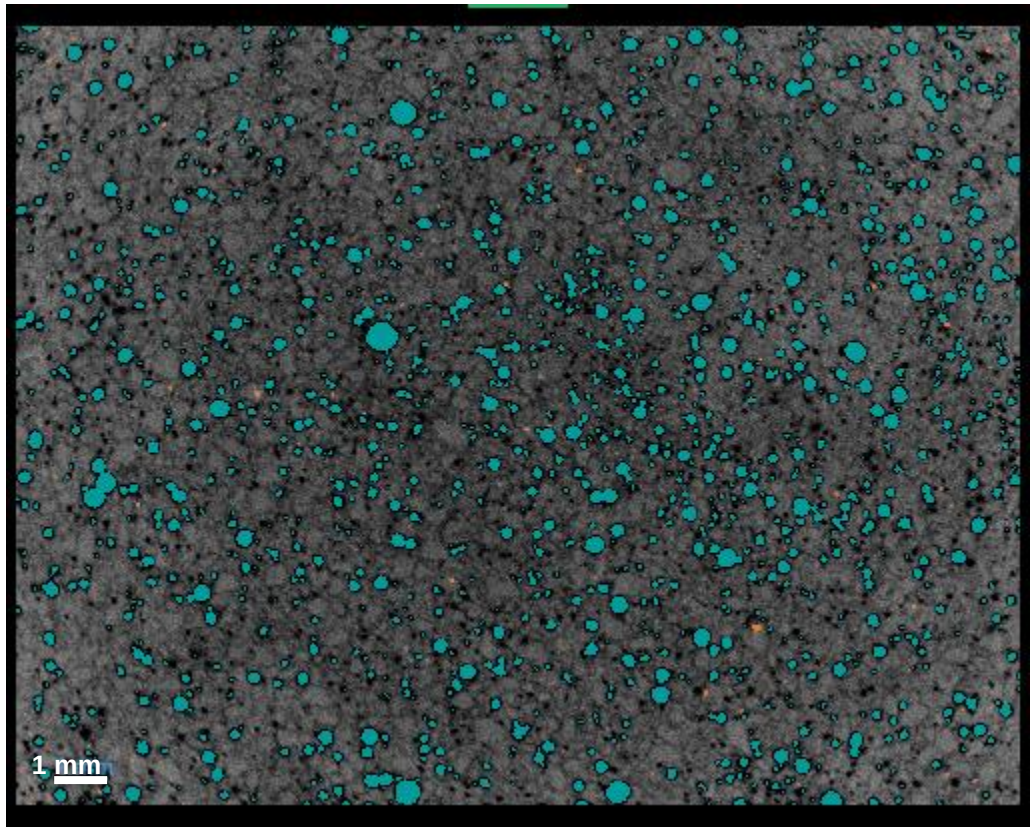
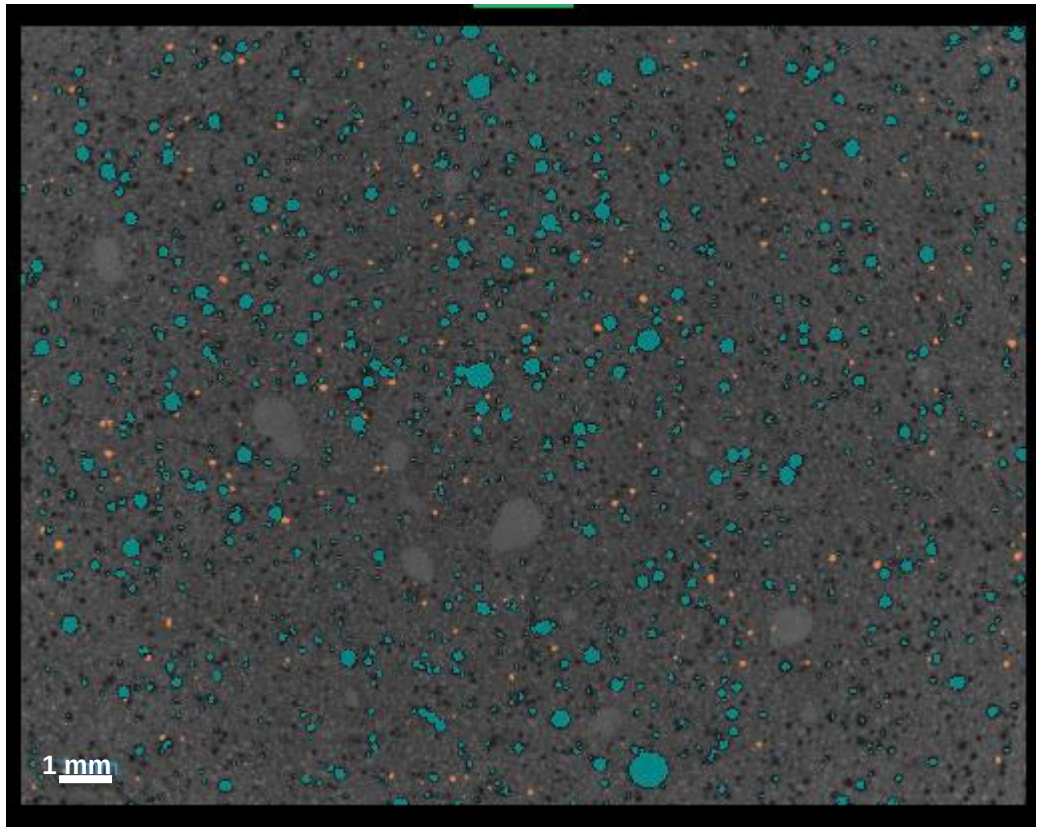
Ongoing Results: Scan Results

Control Samples



Olivine Samples

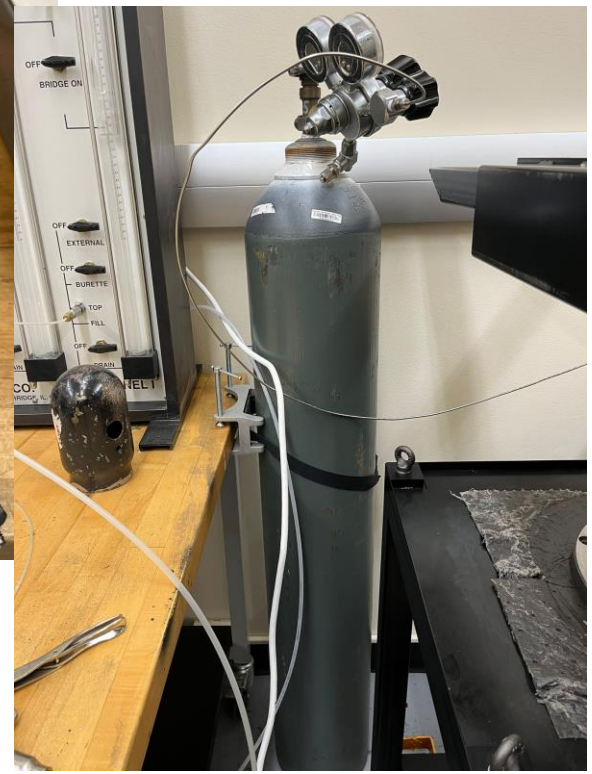


High-density Materials

Pores

Future Work

- Expose to high concentration of CO_2 and perform second sorption experiment
- Complete another X-ray CT scan after CO_2 exposure
- Conduct sorption tests
- Quantify CO_2 mineralization using thermogravimetric analysis



Acknowledgments

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Thank you for your attention!

Questions?

Email: kaina.vieira@duke.edu