

Does ITZ influence moisture transport in concrete?

Laura E. Dalton¹, Jacob LaManna², Scott Jones², and Mohammad Pour-Ghaz¹

¹ North Carolina State University, Department of Civil, Construction and Environmental Engineering, Raleigh, NC

² National Institute of Standards and Technology, Gaithersburg, MD

NC STATE
UNIVERSITY

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Background

- 1956: Interfacial Transition Zone (ITZ) or “aureole de transition” was first discovered by Farran
- 1956-1986: Many transport and structural deviations attributed to ITZ region
- 1986: Diamond questions interpretation of ITZ
- 1986-Present:
 - ITZ thickness reported to range 15 to 100 μm
 - 30 to 50 μm widely accepted
 - Various phenomena attributed to ITZ region
 - ITZ contributions remain disputed

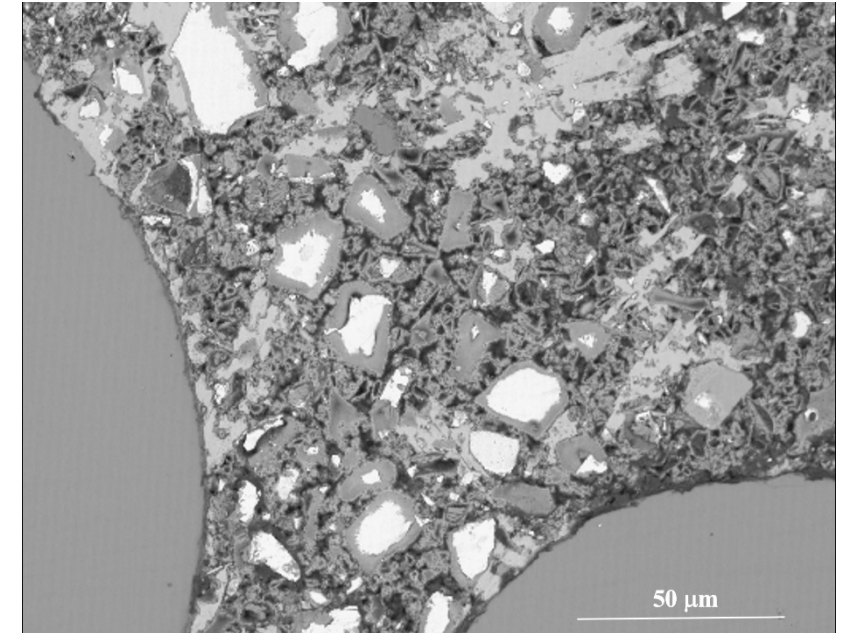
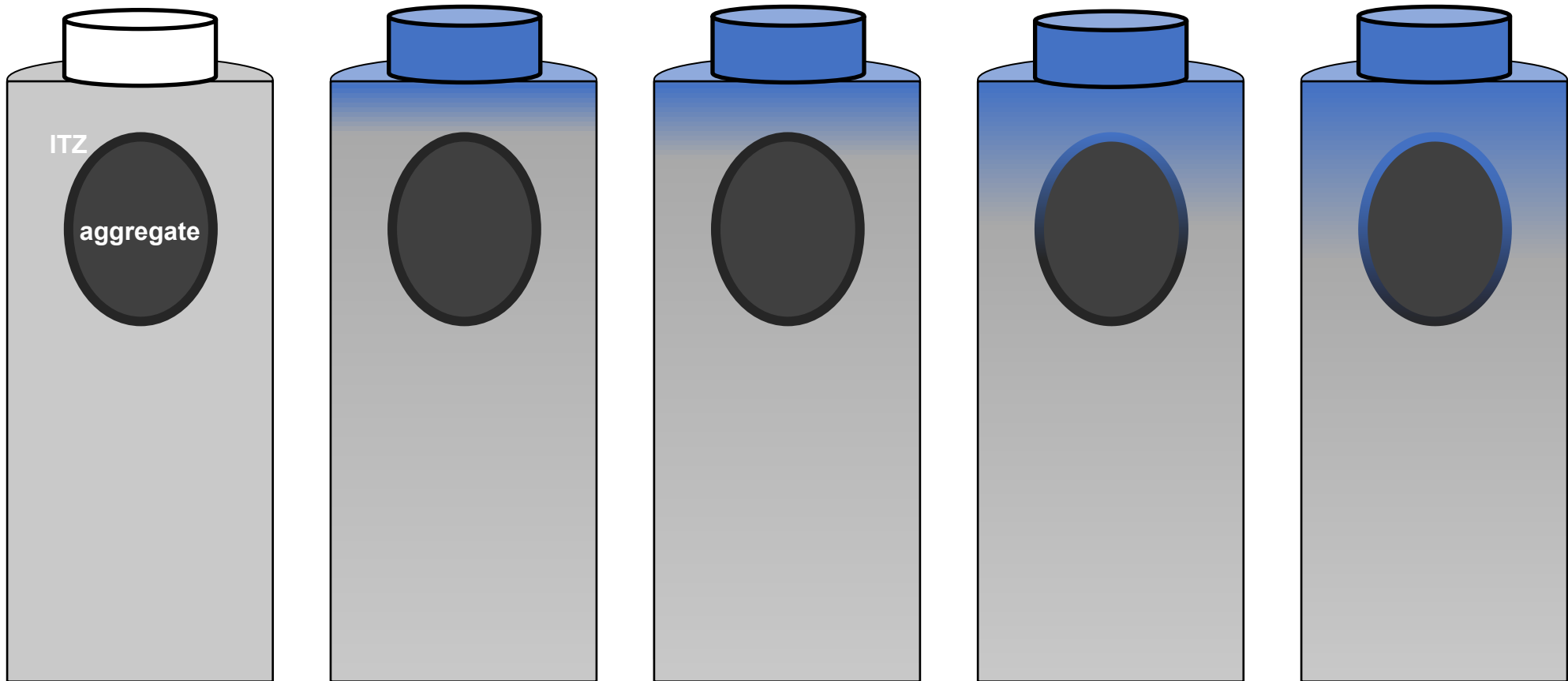


Image courtesy of Paul E. Stutzman

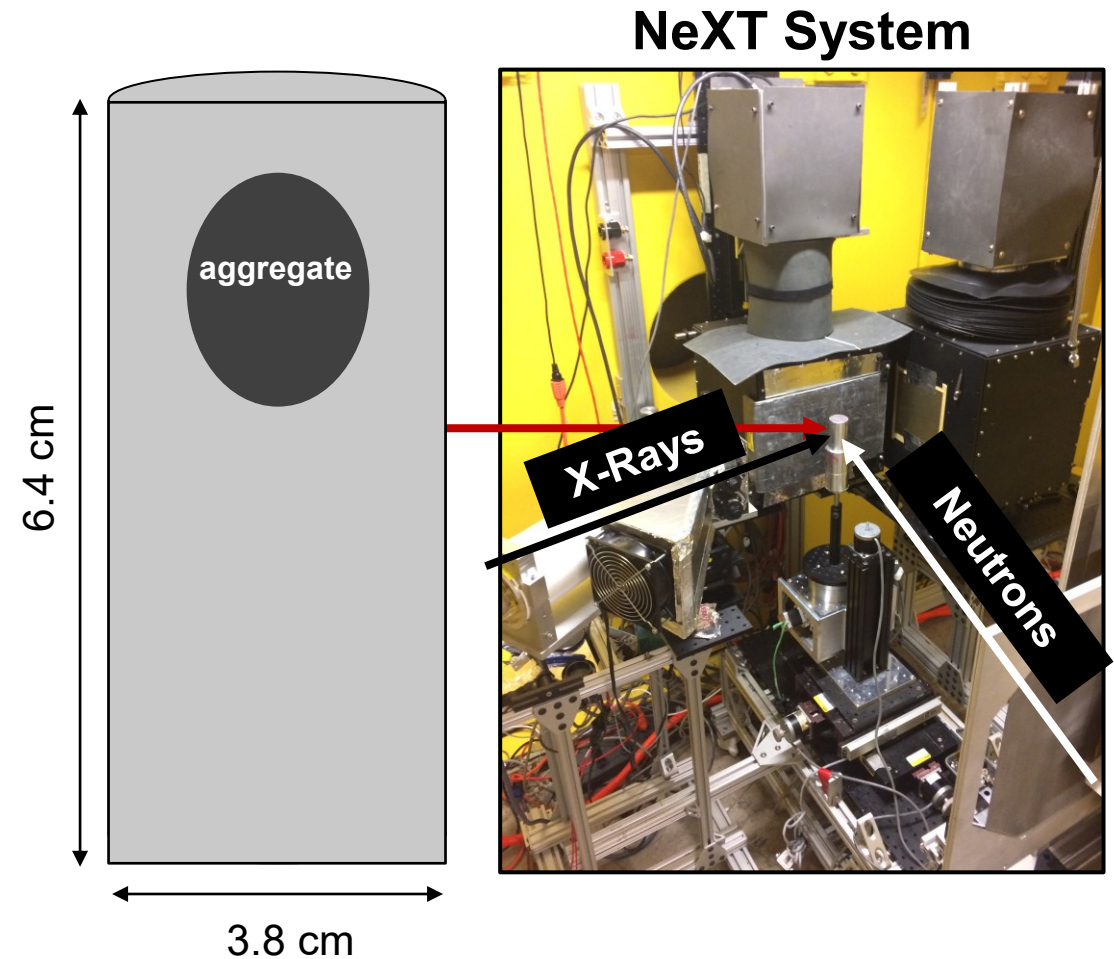
Research Question

- If ITZ is a more porous region around the aggregate, does water move more rapidly in the ITZ region relative to the bulk paste during unsaturated flow?



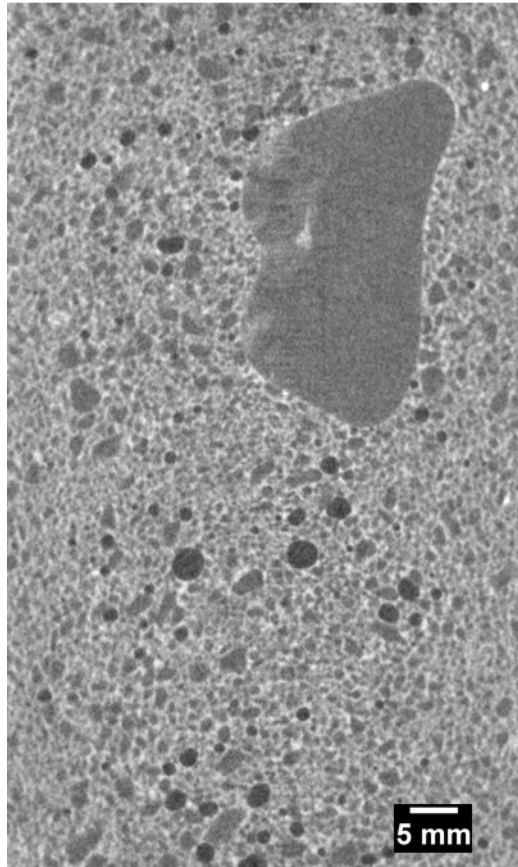
Experimental Setup

- Neutron and X-Ray beam lines placed perpendicular to obtain complementary information
- Both modalities have high spatial resolution
- Large projection (720 projections) scans completed on dry sample
- Series of sparse projection scans (60 projections per hour) during water ingress
- 30 μm voxel resolution, 60 μm spatial resolution

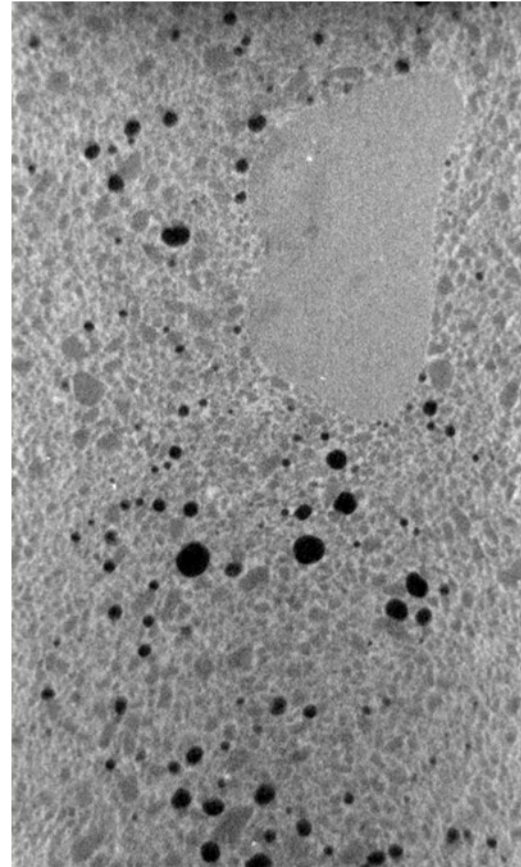


Phase Segmentation

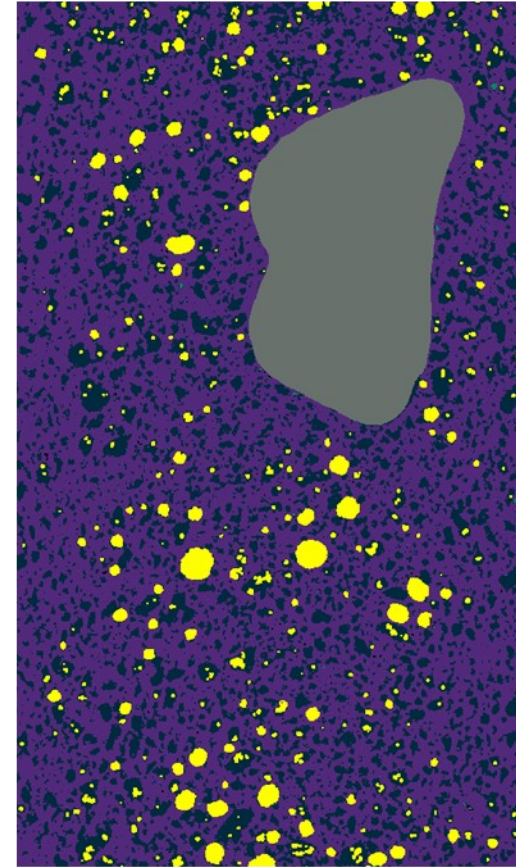
Fine Aggregate Coarse Aggregate Hydrated Cement Unhydrated Cement Entrapped Air



Neutron



X-Ray

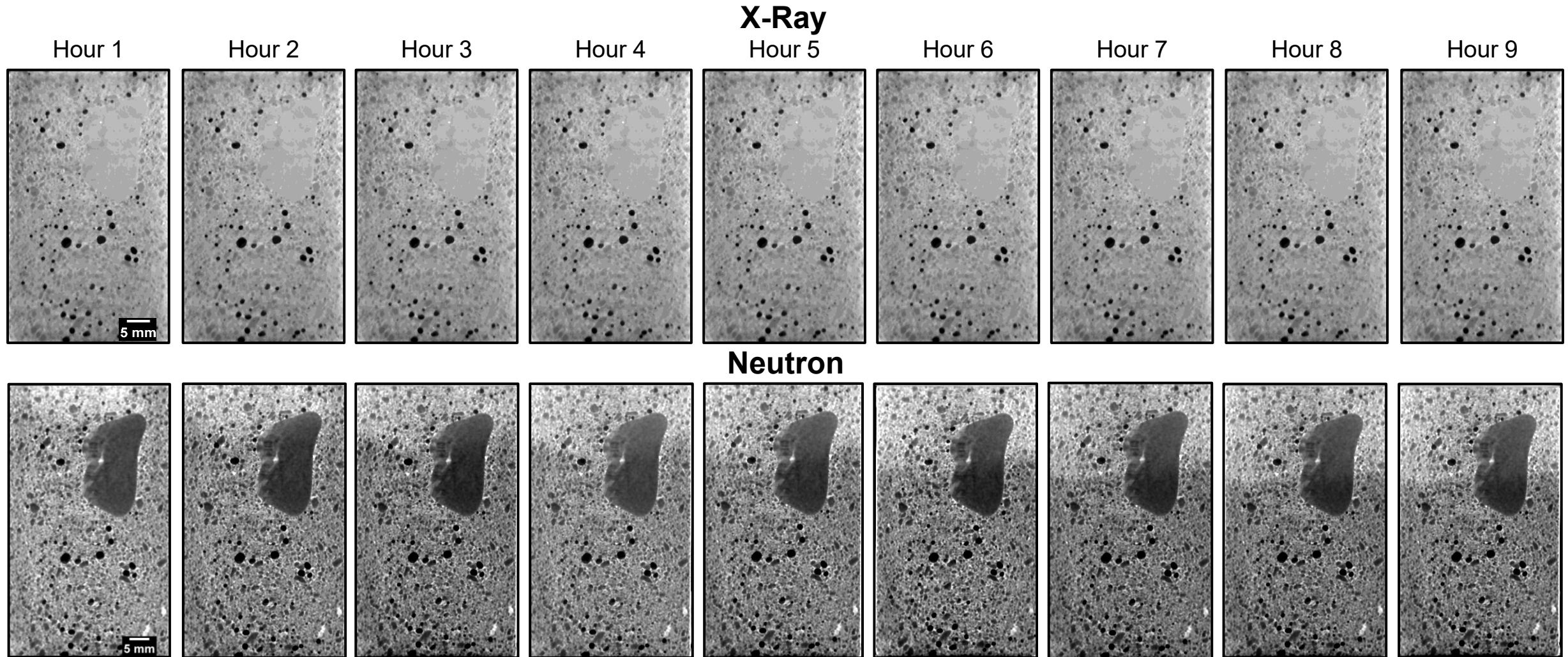


Segmentation

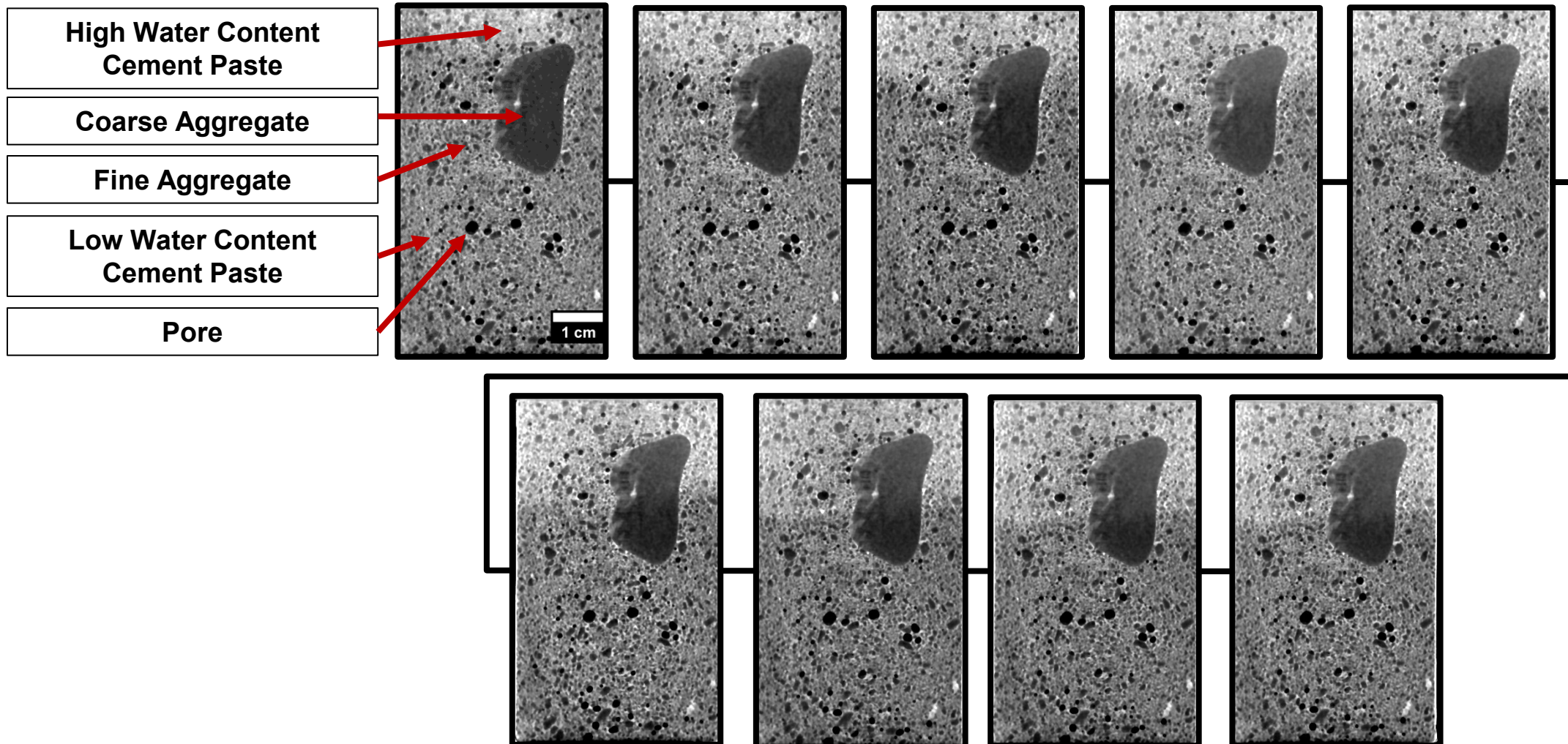


3D Rendering

Seeded Neutron and X-Ray Reconstructions

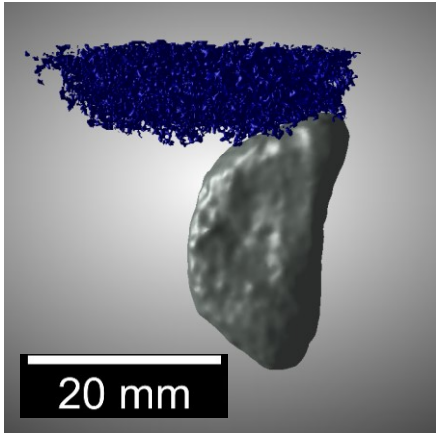


Seeded Neutron Reconstructions

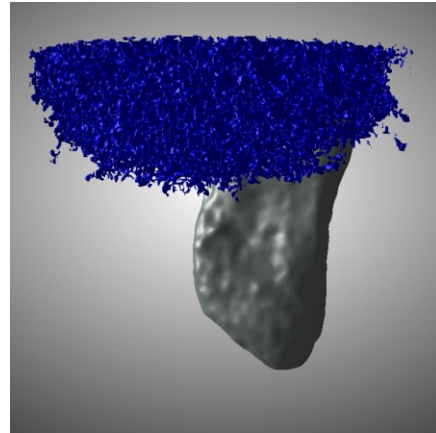


Results: Water Ingress

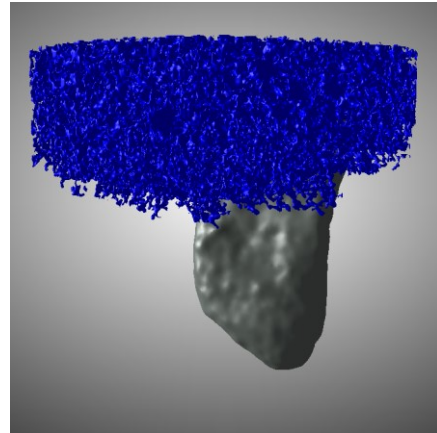
Hour 1



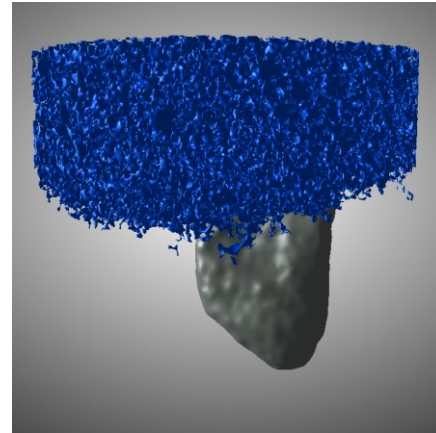
Hour 2



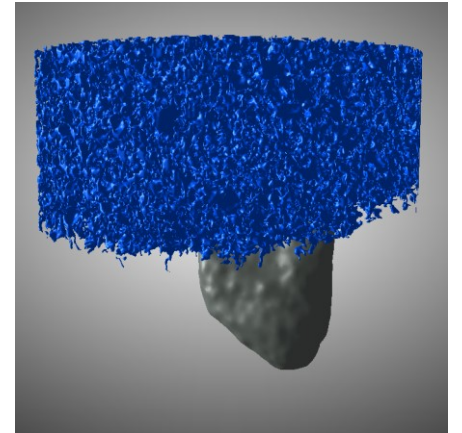
Hour 3



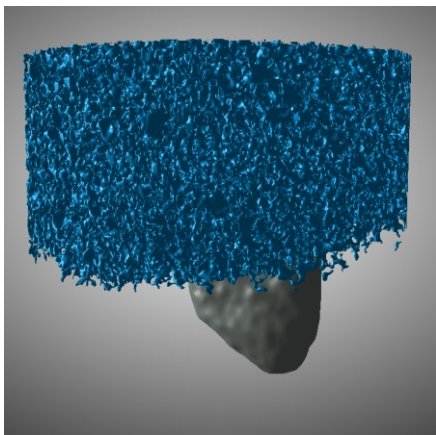
Hour 4



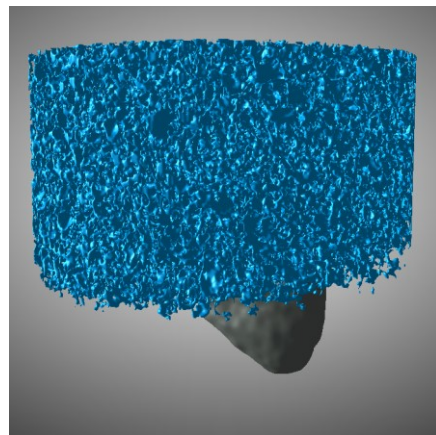
Hour 5



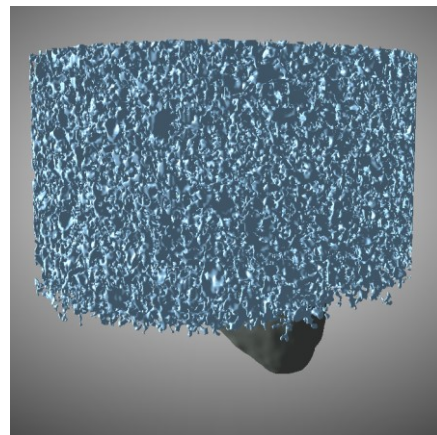
Hour 6



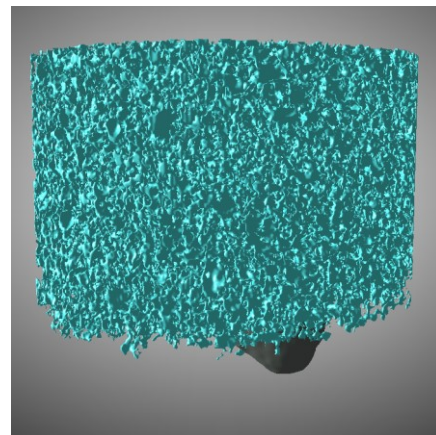
Hour 7



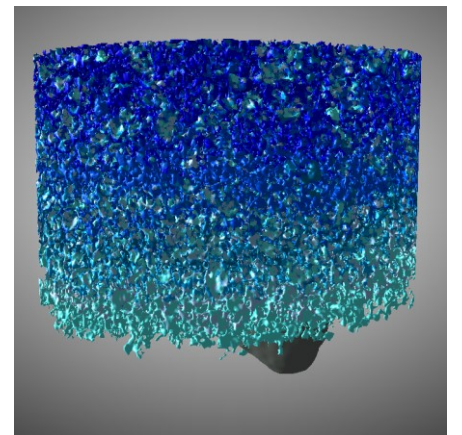
Hour 8



Hour 9



Combined



Results: Water Ingress Video

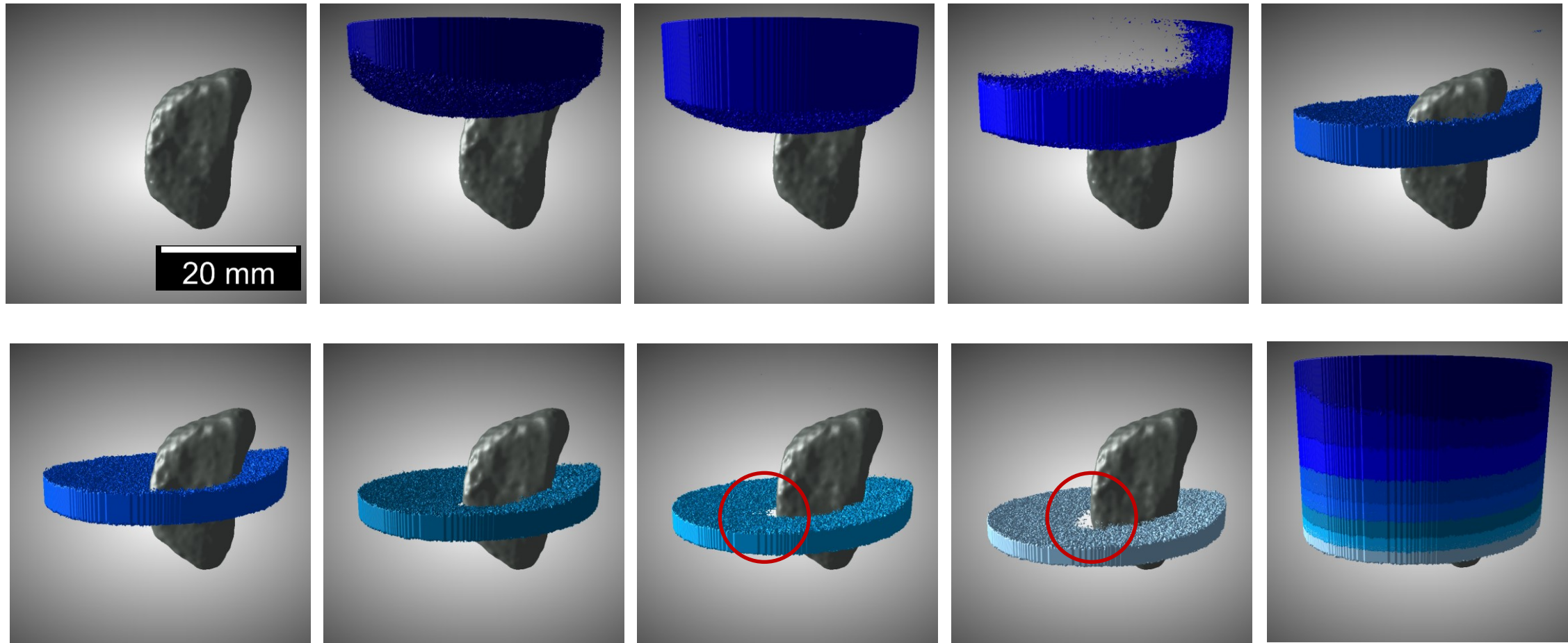


Projections

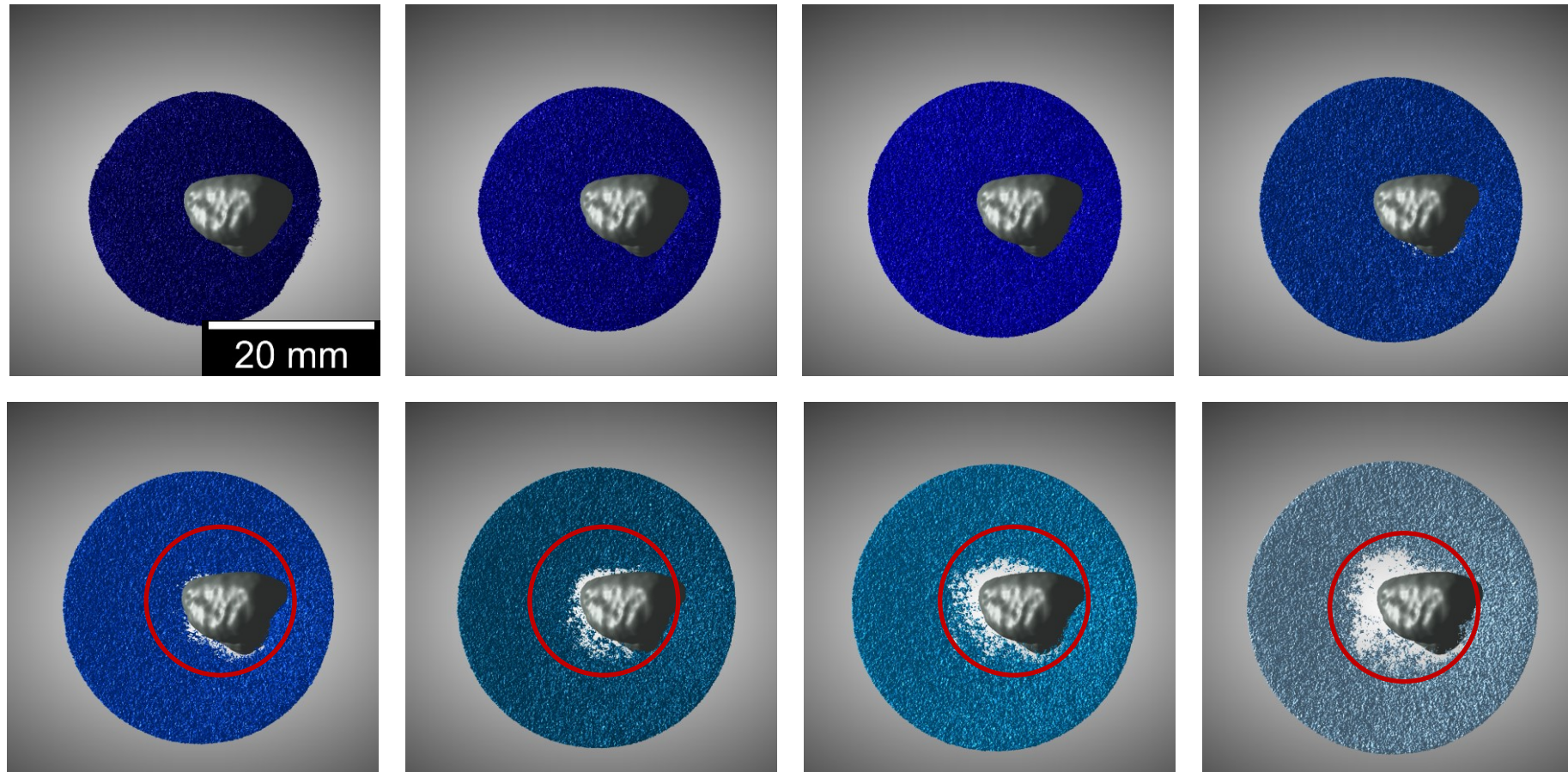


Segmented Reconstructions

Results: Water Ingress Volume Subtractions

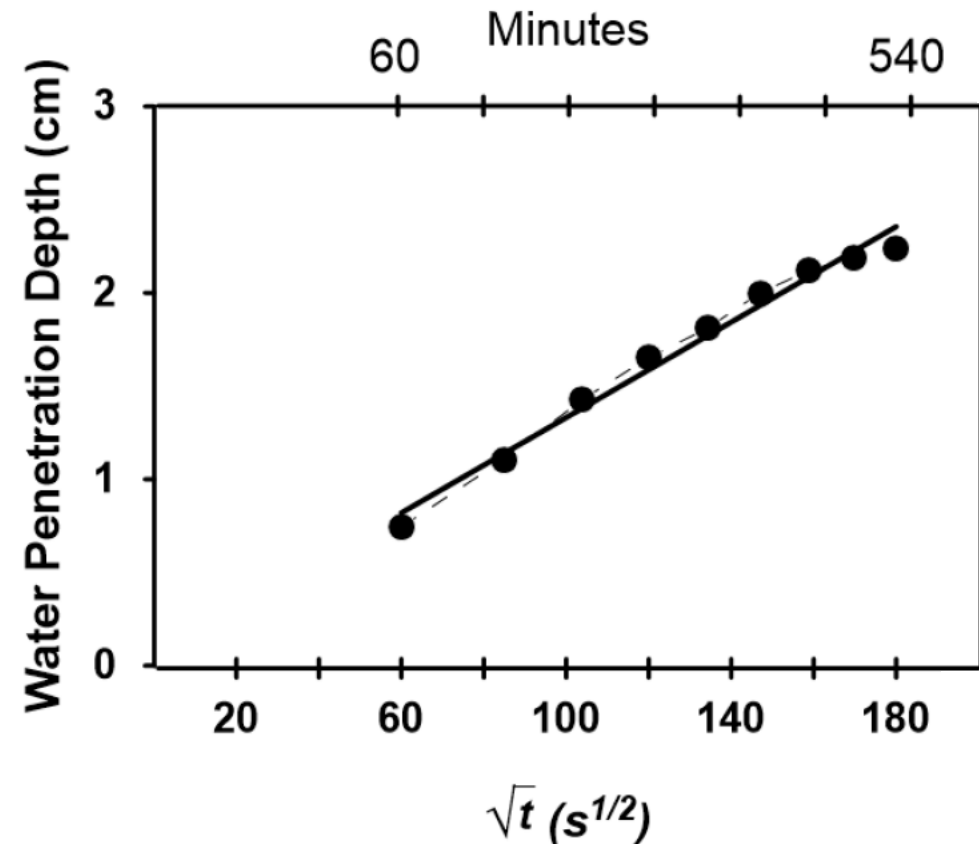
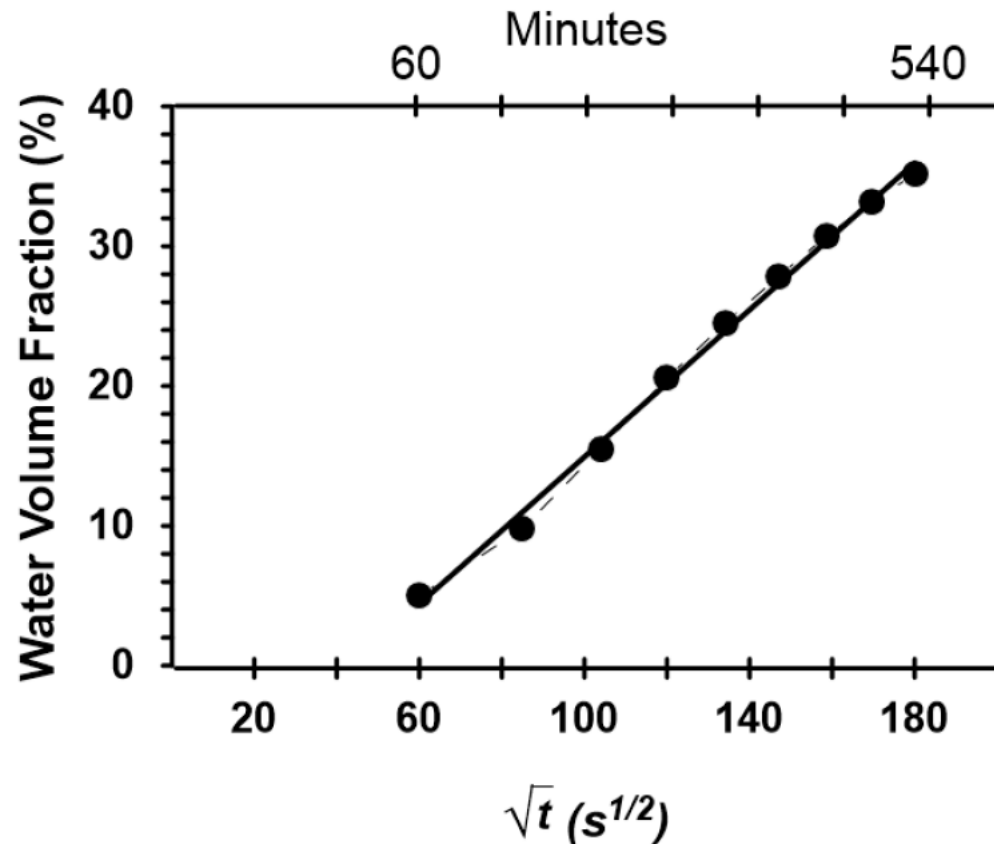


Results: Volume Subtractions Bottom View



Results: Water Ingress Plots

- Water ingress follows a linear trend as a function of the square root of time

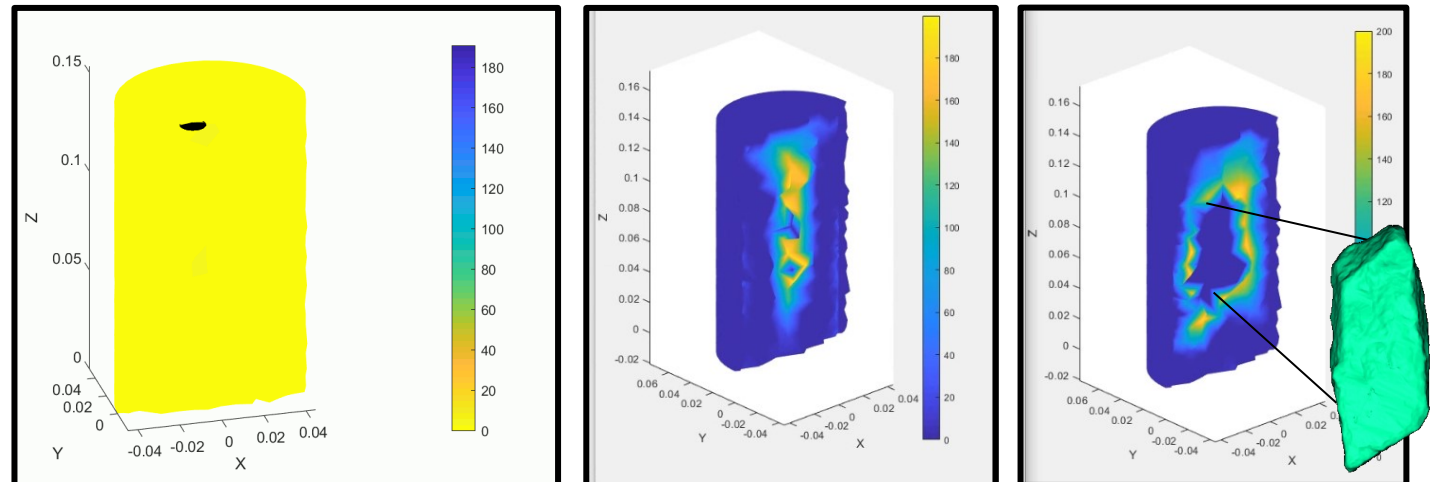


Summary

- Technique development using NeXT system to image water ingress in concrete
- Seeded reconstructions: Adaptive Steepest Descent-Projection Onto Convex Sets (ASD-POCS)
- Expediated transport not observed in the ITZ region at the tested imaging scales

Ongoing/Future Work

- Electrical capacitance tomography has high temporal resolution
- Cracked mortar and concrete cylinders containing single course aggregate



Acknowledgments

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Questions?

