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# Understanding the Evolution of Carbon Mineralization Processes in Basalt Reservoirs

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Fundamental Processes Reservoir Simulations Deployment & Monitoring

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## **The Wallula Basalt Pilot Project**

Geologic CO<sub>2</sub> sequestration in continental flood basalts offers a promising,

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- carbon-negative strategy towards the safe and permanent storage of CO<sub>2</sub> as stable carbonates:
- High CO<sub>2</sub> reactivity, porosity, and volumetric surface area make basalts ideal candidates
- ~1,000 MT of liquid CO<sub>2</sub> injected 829m below ground surface in 2013
- 50 sidewall cores retrieved for extensive characterization in 2015





Depp et. al., ACS Earth & Space Chem., 6, 2836 (2022)

#### Key Knowledge Gaps

- Accurate identification of all carbonate mineral phases formed down to the nanoscale is not known
- Role of secondary mineral phases is not well understood

#### Micro- to Nanoscale Insights into Carbon Mineralization Enables Commercial-Scale Sequestration Efforts

**X-Ray Fluorescence Spectro-Microscopy** enables compositional assessment of carbonate nodules, pore-lining phases, and host rock.









**Transmission Electron Microscopy** enables identification of mineral phases and their variabilities at the atomic scale.

- Four distinct carbonate phases identified
- Ordered end-member ankerite identified for the first time

Lahiri et al., 2024, Manuscript Submitted.







Pre-injection Mn map

#### Post-injection Mn map



The secondary pore-lining phases in weathered basalt serve as the primary source of Mn in anthropogenic carbonates. 

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Lahiri et. al., Environ. Sci. Technol., 57, 11843 (2023)

## Understanding the Structure and Composition of the Carbonate Phases Formed Now Allows:

- Parameterization of reactive transport models
- Refinement of storage capacity estimates
- Improved estimation of carbon sequestration timescales through better geochemical modeling

## and will Enable Commercial-Scale Sequestration Efforts Worldwide in Reactive Reservoirs in All Steps, including:

- Site selection
- Class VI permitting
- Compliance reporting
- Monitoring
- Storage validation

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