Carbon Sequestration in Basalts
Sidewall Core Characterization – Wallula Pilot Project

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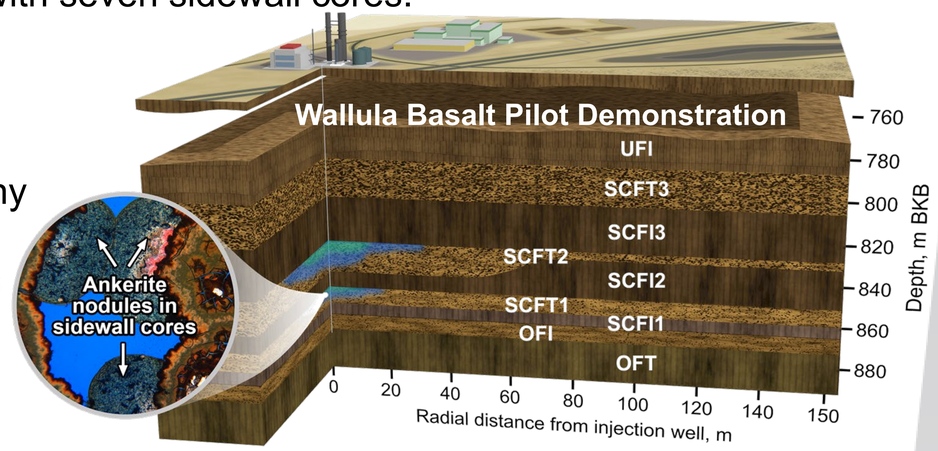
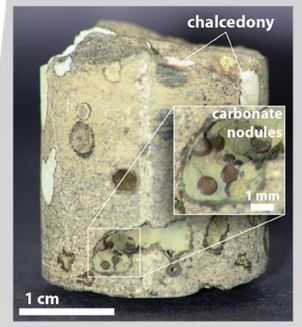
ABSTRACT: Carbon sequestration in geologic formations is a promising strategy that enables long-term storage of CO_2. Continental flood basalts are an attractive storage option, primarily due to their reactivity. In 2009 a Basalt Pilot study was initiated in the Columbia River Basalt where ~1000 MT of CO_2 was injected ~850 m into the subsurface. Two years later, 50 sidewall cores were collected from the injection zone and characterized for evidence of CO_2 mineralization. This effort summarizes those key findings associated with seven sidewall cores.

BACKGROUND

- The Wallula Basalt Pilot demonstration was initiated in 2009
- Injected ~1000 MT CO_2
- Post injection characterization included collection of 50 sidewall cores; many contained carbonate minerals resulting from the CO_2-basalt interactions
- Recent calculations (2020) indicate ~60% of CO_2 mineralized in 24 months
- Characterization data associated with seven sidewall cores have been organized into a single citable report for long-term preservation.





Basalt core (~2.5 cm) removed from Zone 3 (856 m)

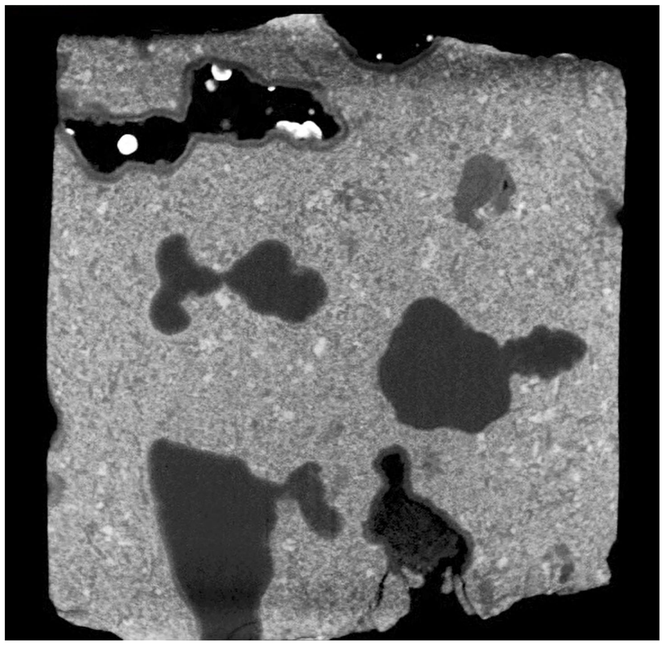
DATA TYPE & APPROACH

- Scanning electron microscope (SEM)
- Energy dispersive X-ray spectroscopy (EDX)
- 300+ SEM images and 200+ EDX chemistries
- Created unique identifiers and correlated images with chemistries

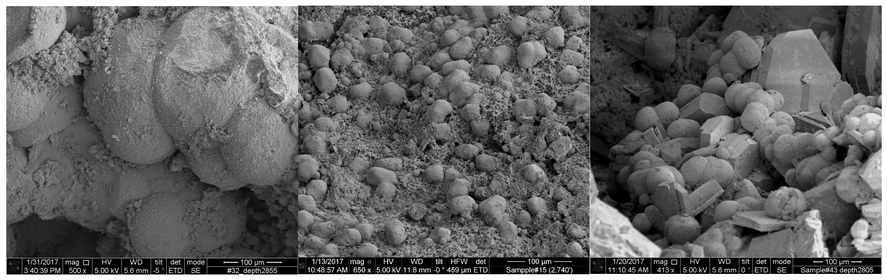
RESULTS

Two years post injection, sidewall cores removed from the injection zone were imaged with SEM and corresponding chemistries determined by EDX. Well formed nodules of iron-rich ankerite [$Ca(Fe,Mg,Mn)(CO_3)_2$] dominated the carbonate mineralogy; naturally occurring secondary silicate minerals including clays and zeolites were also identified throughout the cores. Representative examples of carbonate nodules (size and shapes), different types of secondary minerals, and their associated chemistries are discussed below.

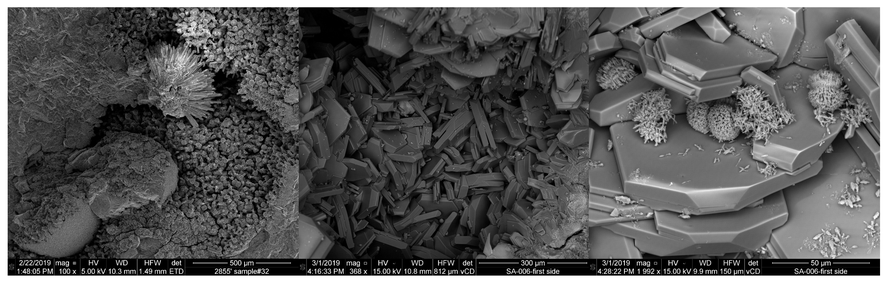
XMT of Core Collected from 856 m



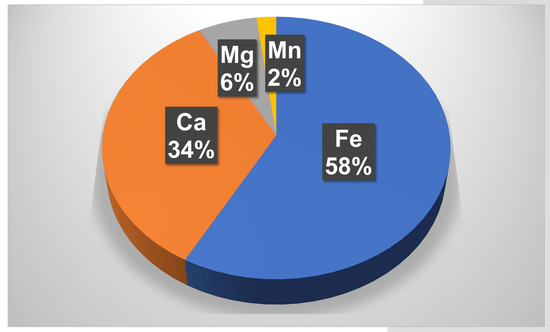
X-Ray Microtomography is a non-destructive imaging technique that was used to identify the cores with carbonate nodules (bright white spots) that were then down selected for enhanced characterization by SEM-EDX



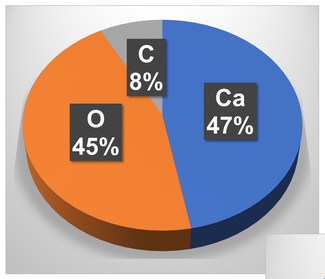
- Carbonate nodules (200-300 um) dominated Zone 3
- Carbonate nodules (10-50 um) common in Zones 1 and 2
- Appearing together, carbonate nodules, clays, and zeolites



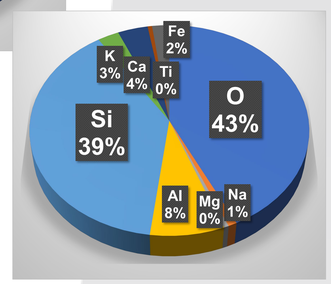
- Aragonite ($CaCO_3$, needles) appeared in clusters reaching ~500 um
- Clay minerals were found in most cores and typically contained iron
- Zeolites, displaying well-formed crystal edges, were easily identified and typically occurred in the 50-60 um range



- Average carbonate nodule chemistry



- Aragonite chemistry



- Zeolite chemistry

Relevance:

- **Characterizing CO_2-basalt reactions in sidewall cores retrieved from the Basalt Pilot Demonstration borehole is providing key insights into how CO_2 reacts with basalts to form stable carbonate minerals.**
- **Organization and analysis of characterization data associated with these sidewall cores is important for the success of ongoing and future carbon storage projects.**

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