Field Observations and Geochemical Analysis of Laterally Continuous Aragonite Veins: Insight into Ancient Fluid Travel*

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Abstract

The capability to store CO₂ in subsurface geologic reservoirs is a proposed technique that will reduce the amount of human-generated CO₂, a greenhouse gas, from accumulating in the atmosphere. By examining bedrock sites where evidence for ancient carbonate deposition, and where we see natural CO₂ leaks, we can understand how fluid flow in the subsurface behaves in relation to faults and fractures. Understanding fluid flow in a natural system improves our understanding of risks involved in the storage of CO₂ in subsurface reservoirs. We focus on two different outcrops of Mesozoic rocks associated with active CO₂ leaks. The field locality for this work is in the Salt Wash Graben SE Utah, adjacent to the Ten-Mile fault, a normal fault with hundreds of meters of offset. Field observations at this location allow an understanding of crosscutting relationships of laterally extensive carbonate veins and travertine deposits associated with the Salt Wash fault zone. Maps of crosscutting relationships in outcrop are used to understand timing of mineralization along with petrographic analysis of host rock and vein mineralization of calcite veins to understand relationships between host rock and mineralization. Both stable carbon and oxygen isotope analysis are used to understand changes in the fluid reservoir composition. Preliminary stable carbon isotope analyses give δ¹³C values between 3.9-6.0 per mil; variations may indicate change in fluid source, relative timing of mineralization, and depth of mineralization. Stable carbon isotope analysis is important because they serve as geochemical markers related to source fluids.
**Introduction**

There are several exposed vein systems within Salt Wash graben that are created by CO₂ charged groundwater leaking from deeper subsurface reservoirs. These vein systems are up to hundreds of thousands of years old and record changes in fluid chemistry (Burnside, 2010). We evaluate the geochemistry and mineralogy of aragonite and calcite veins associated with this natural system of CO₂ storage.

**Methods**

- Field mapping and hand sample collection of a laterally continuous aragonite vein
- Geochemical analyses: Stable carbon and oxygen isotopes
- Elemental analysis: X-Ray Diffraction
- Petrography

**Illustration of Studied Vein**

- Sample collection from projected sources
- Image of vein and section
- Microphotographs of vein and section

**Results**

- Inverse relationship between Mg/Ca and Na/Ca Ratios
- Fluid pathways preserved in samples
- **Key Results**

  - **Stable Carbon and Oxygen Isotopes**
    - Correlation between elemental signatures, vein textures and isotopic amounts (Chaps. 5-6)
    - Carbonate veins formed by repeated degassing and calcite precipitation
  - **Trace Element Geochemistry**
    - Mg/Ca
    - Na/Ca
- **Implications**

  - These results suggest that in a CCS system, if there is a rapid change in chemistry and stable isotope volumes, this rapid change in chemistry and stable isotope values may exist, and bleed out away from the source.

**Acknowledgments**

-屯 Mike Grimes, Salt Wash Graben.

**References**