Structural and diagenetic controls on CO_2 leakage in a natural long-term carbon sequestration analogue, Little Grand Wash fault, Utah

Scientific Achievement

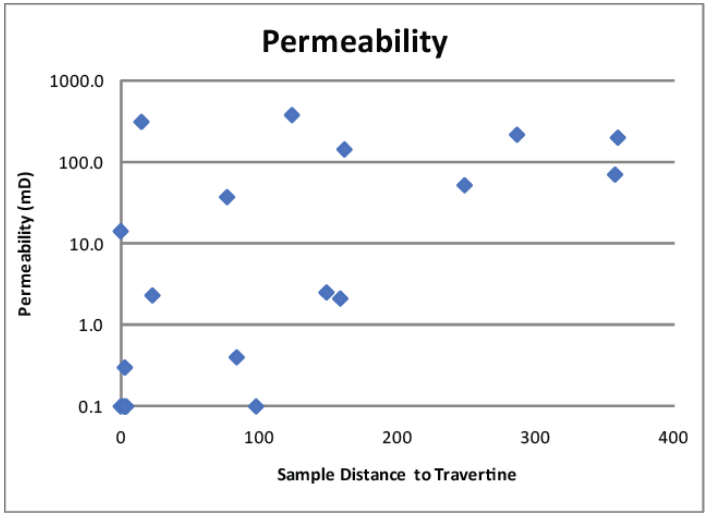
Determined footprint of fault-controlled CO_2 leakage in a natural long-term analogue of a carbon sequestration sandstone reservoir.

Significance and Impact

Highly focused flow and limited lateral extent of CO_2 footprint around fault leakage conduits requires dense monitoring networks in sequestration applications.

Research Details

- CO_2-related alteration as a proxy for paleo-leakage of CO_2 along exhumed fault leakage conduits.
- Distribution of CO_2 alteration indicates that flow is focused along narrow (10-50 m wide) structural conduits within the reservoir sandstone units.
- CO_2 -related calcite cement precipitation significantly reduces porosity & permeability of sandstones, restricting flow through the conduit.
- Presence of multiple paleo-leakage conduits indicative of shift of active conduits along fault zone over time'

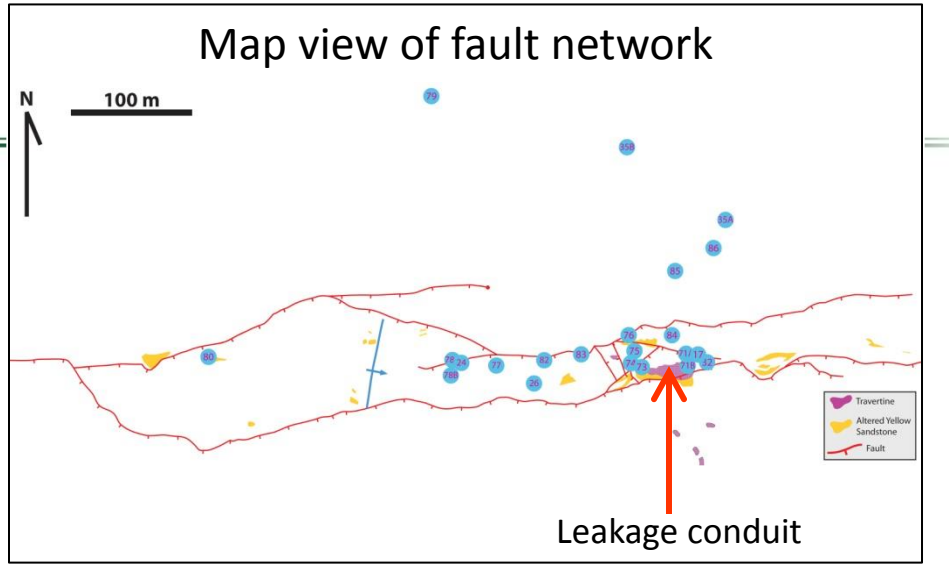


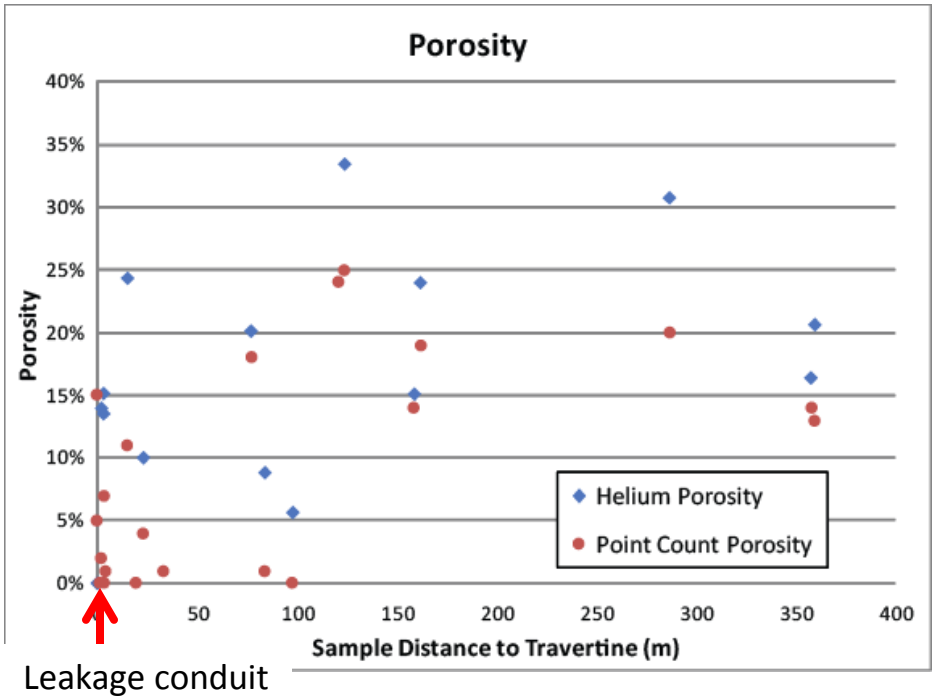
Decrease in permeability in reservoir sandstone with decreasing distance to fault CO_2 leakage conduit—Little Grand Wash fault, Utah.

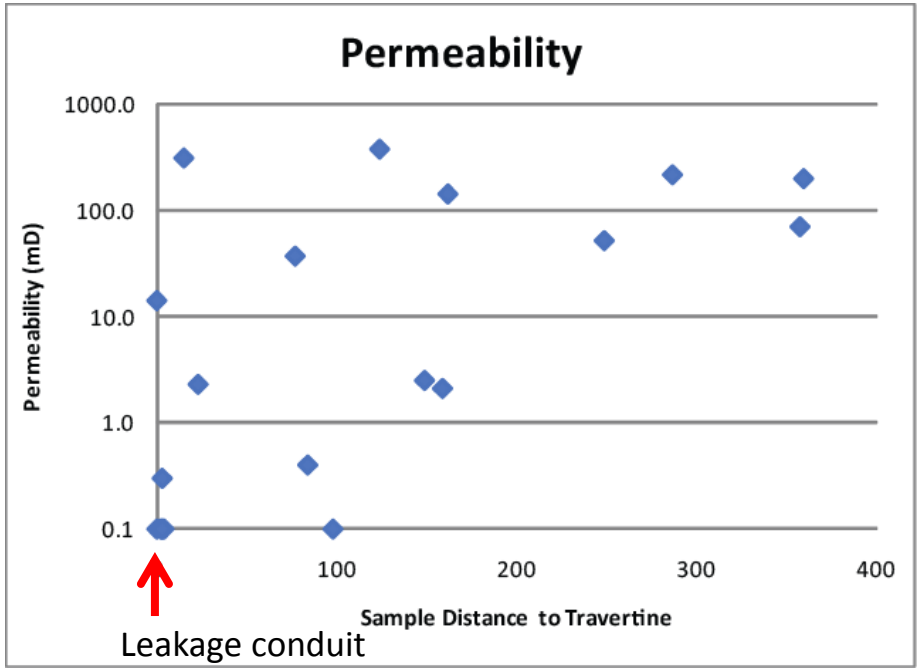
Urquhart, A., & Eichhubl. ,P., Structural and diagenetic controls on CO2 leakage in a natural long-term carbon sequestration analogue, Little Grand Wash fault, Utah. In prep.

Porosity & permeability trends

- CO_2 related cement spatially limited to vicinity of fault relay zone.
- Decrease in porosity from ~20% to ~0%.
- Decrease in permeability ~3 orders of magnitude toward leakage conduit.

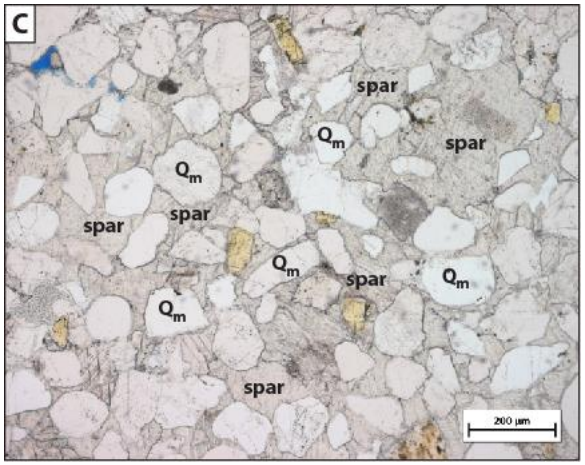




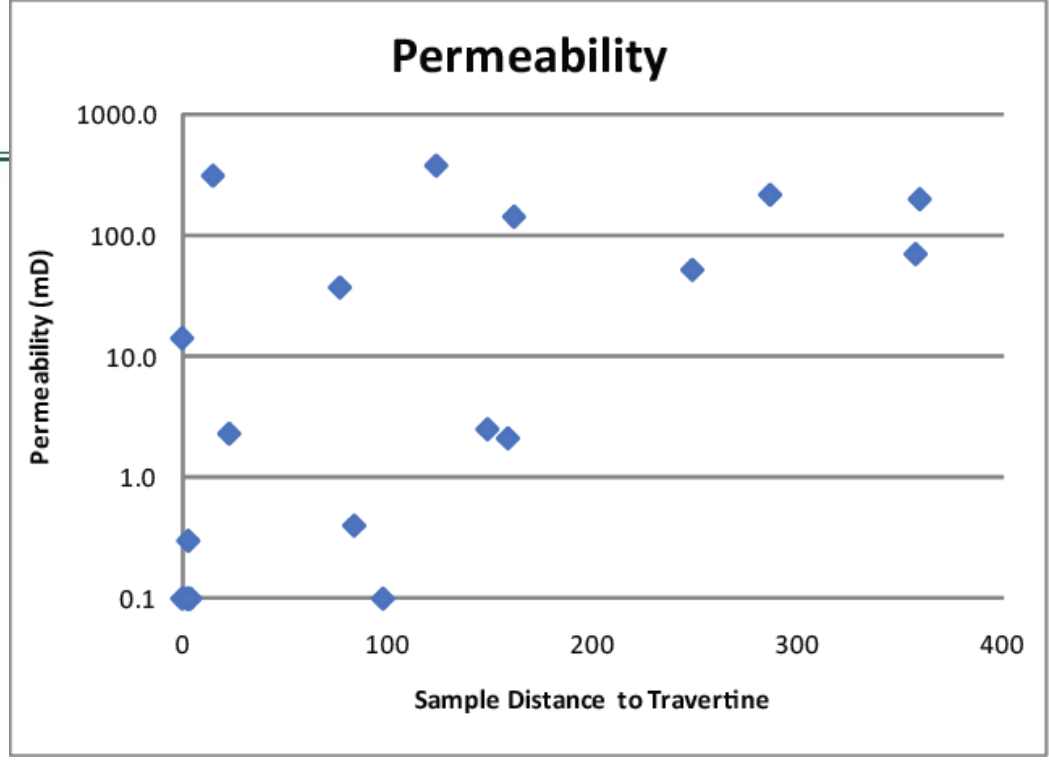


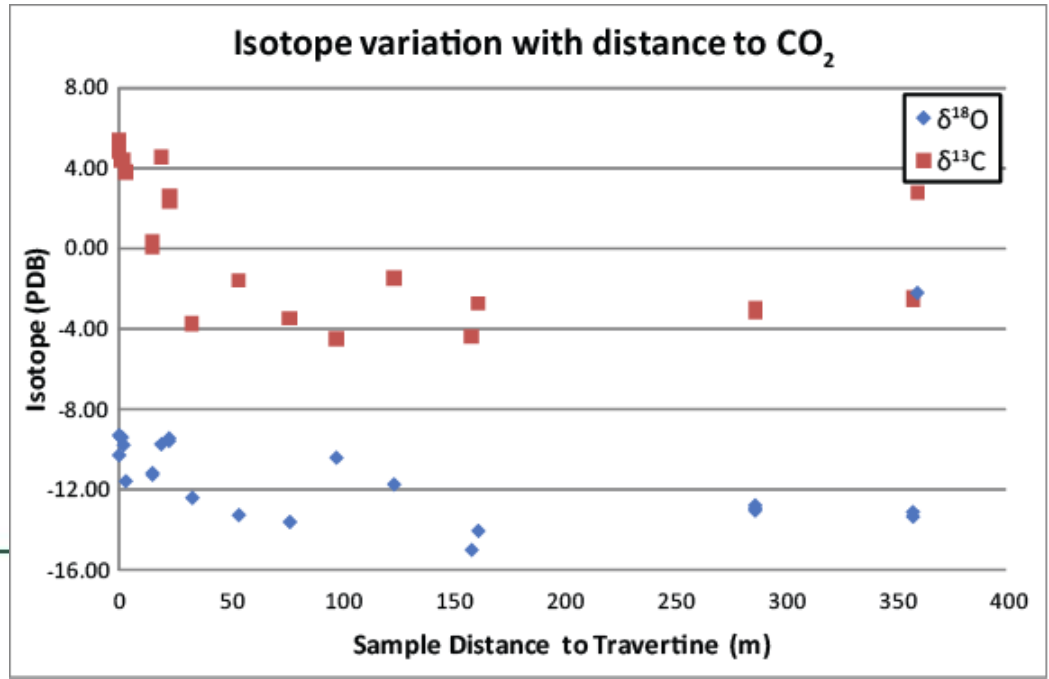
Carbonate cementation around CO_2 flow conduit

- Sandstone pores occluded with calcite cement
- ^{16}O depletion of carbonate pore cement adjacent to flow conduits due to CO_2 phase separation
- Width of CO_2 conduit ~10-50 m



Petrographic thin section of reservoir sandstone with pore space occluded by calcite mineral cement.





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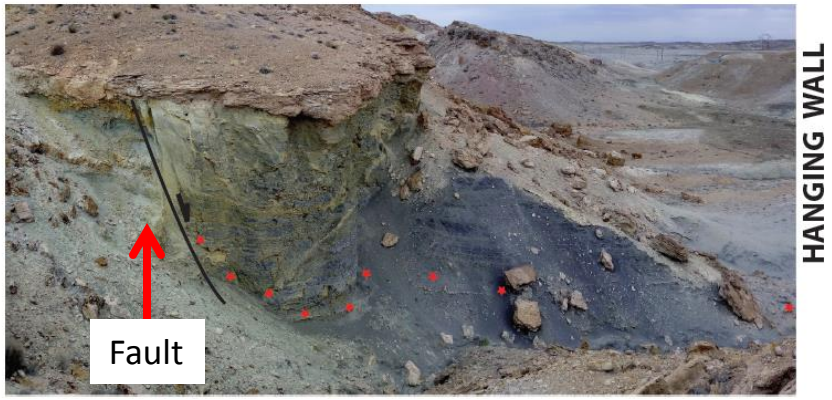
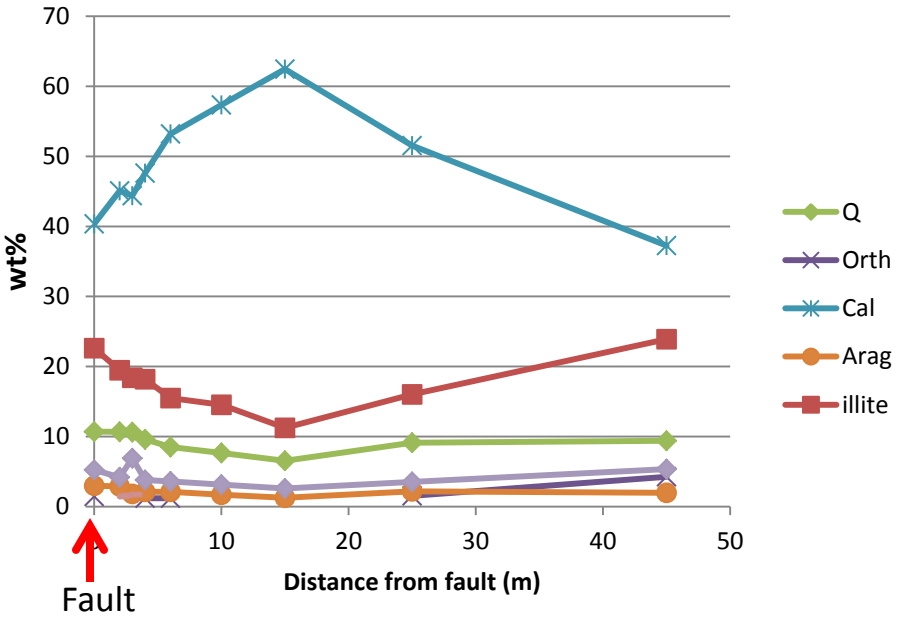
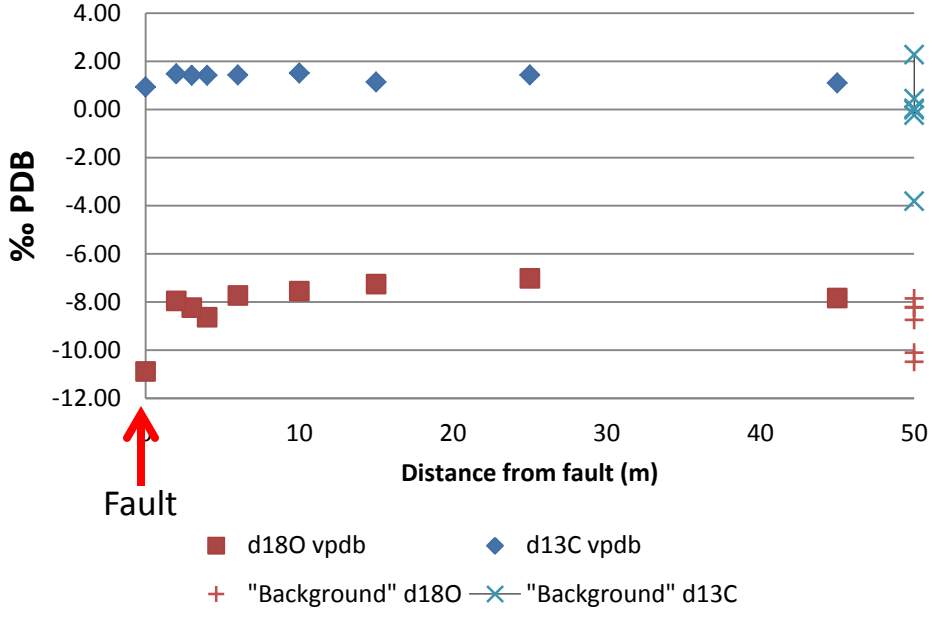
CO_2 leakage footprint in shale caprock (Mancos Shale)



XRD bulk sample mineralogy



Bulk sample (matrix) stable isotopes



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TEXAS

Sandia National Laboratories

CFSES

Mudrock topseal failure by chemically assisted fracture