EFFECT OF GEOCHEMICAL INTEGRITY OF BINDING CEMENT ON SANDSTONE PERMEABILITY AT CARBON STORAGE CONDITIONS

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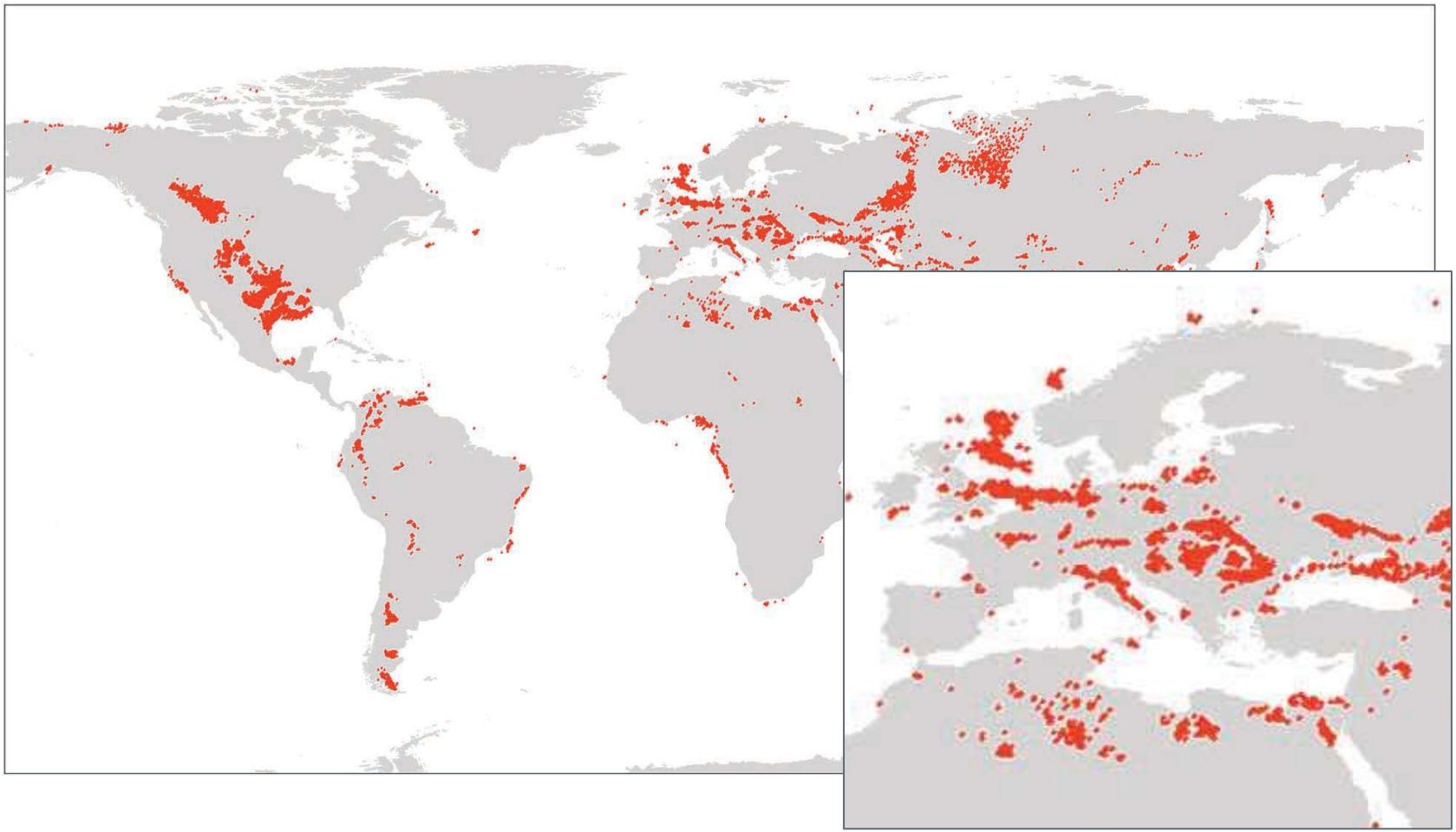
Sandstone Reservoirs: Potential for CO_2 Storage?



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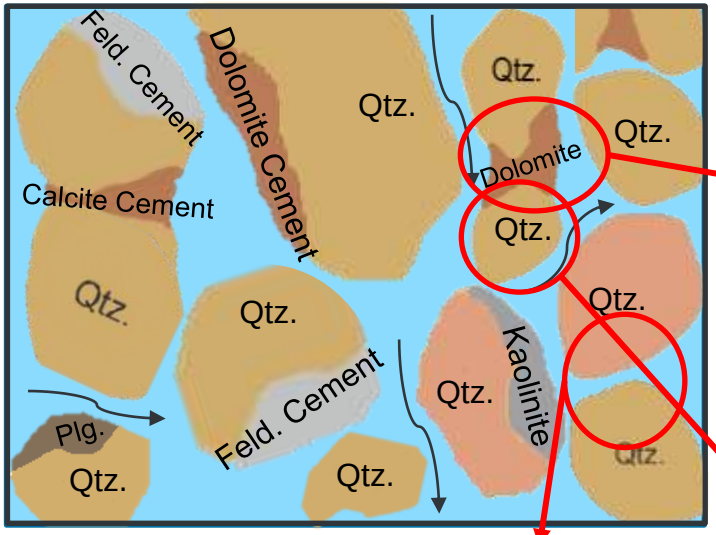
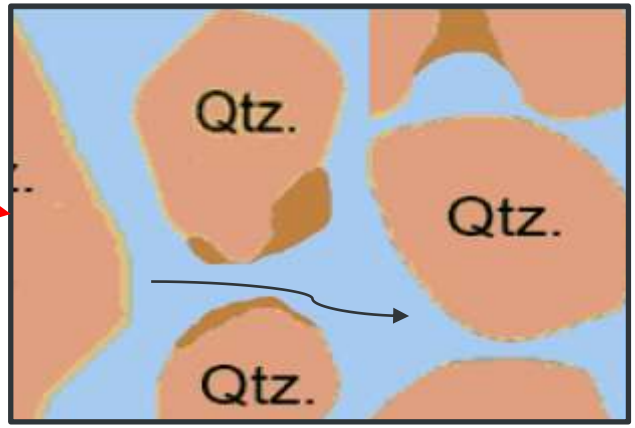
Carbonated Water Injection: An Extreme Scenario

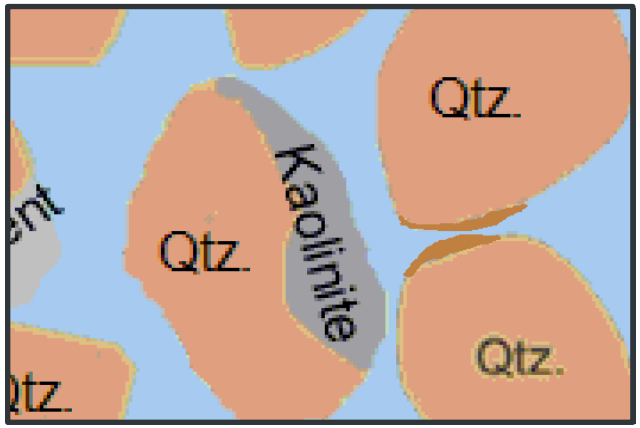
Carbonated Water Injection ΔP_i



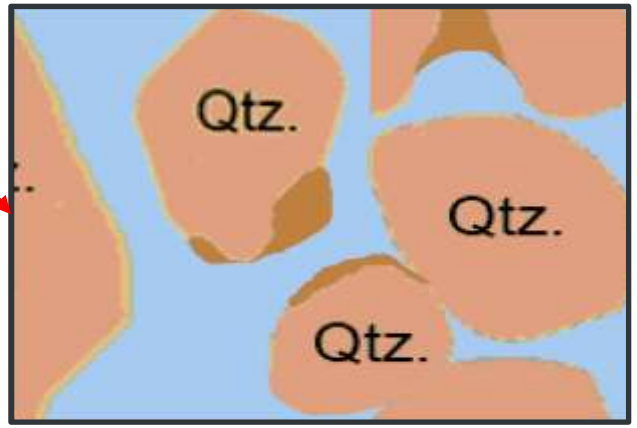
Mineral Dissolution → ΔP_l ↘



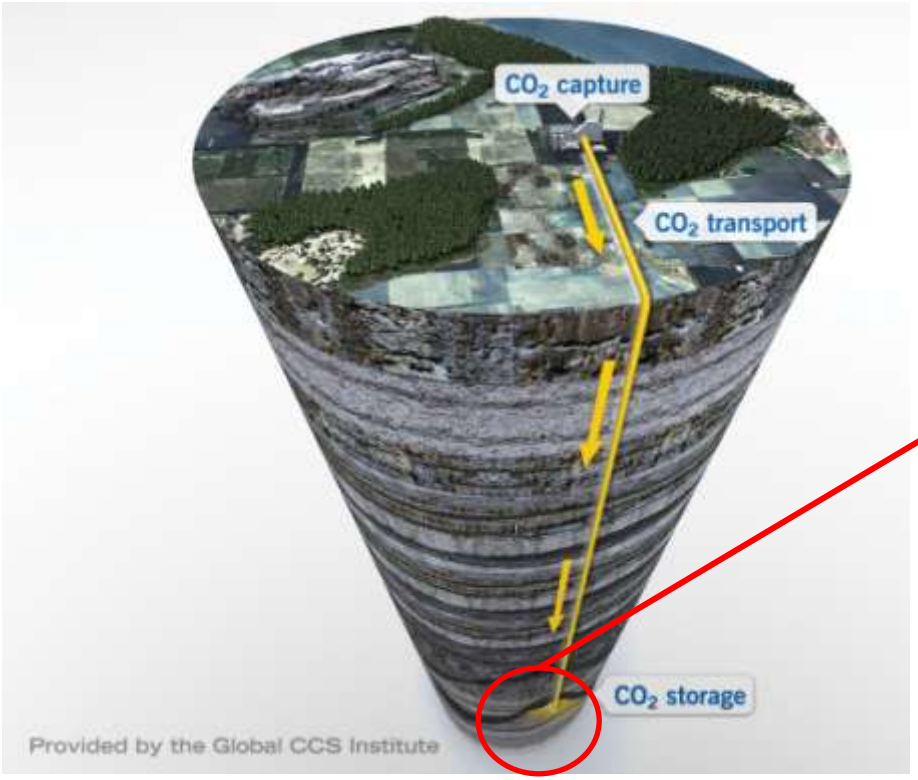
Mineral Deposition → ΔP_l ↗

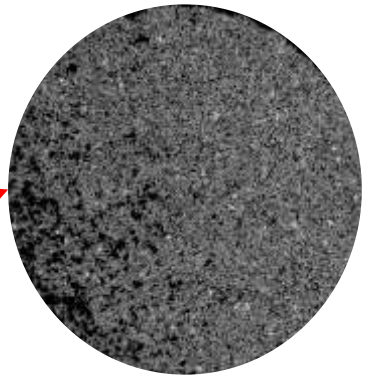


Sand Grain Mobilization → ΔP_l ↗

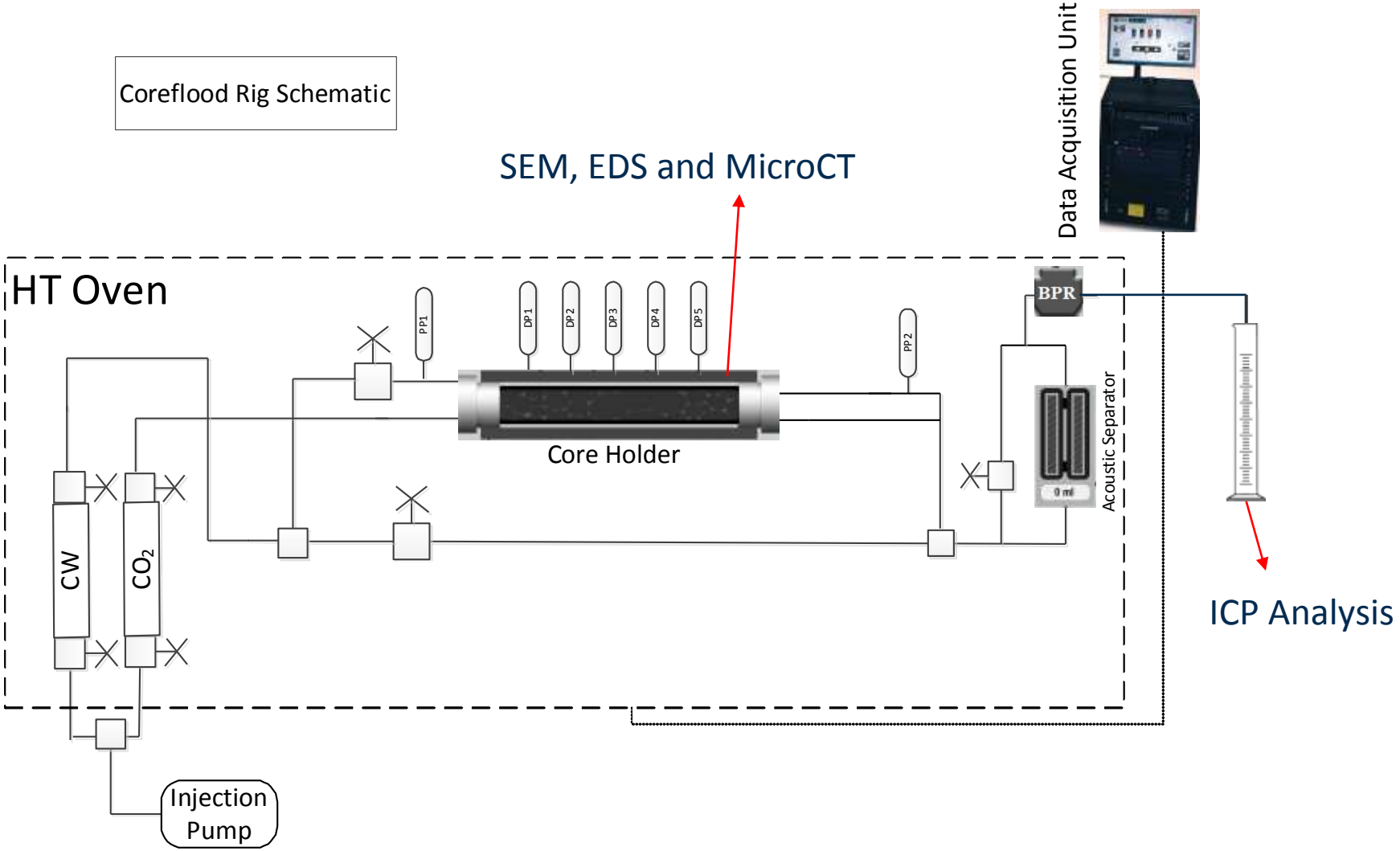


Multi-Scale Study of Permeability Evolution for CO_2 Storage

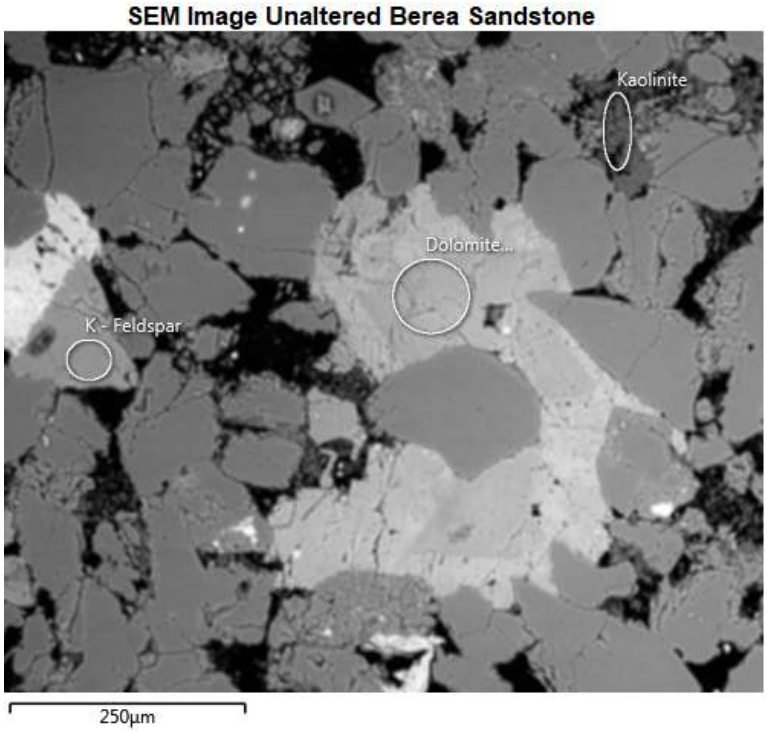




Experimental Procedure



Core Characterization



Initial Porosity	Initial Permeability	Mineralogy	Length	Diameter
12.5%	50mD	**Sandstone** with **Dolomitic** and **Silica Cements**	30.48cm	3.81cm

Brine Characterization

Ion	Concentration (ppm)
Na^{+}	8658
Ca^{2+}	382
Mg^{2+}	1205
K^{+}	580

pH	Viscosity@ Test Conditions
5.98	1.06 mPa.s

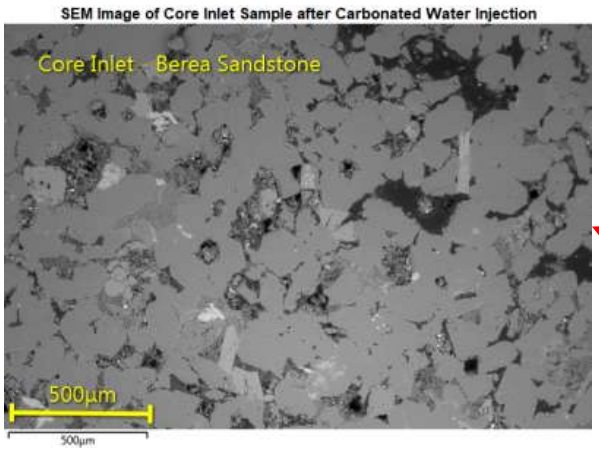
Test Conditions		
P	T	Injection Rate
260 bars	50°C	6cc/hr

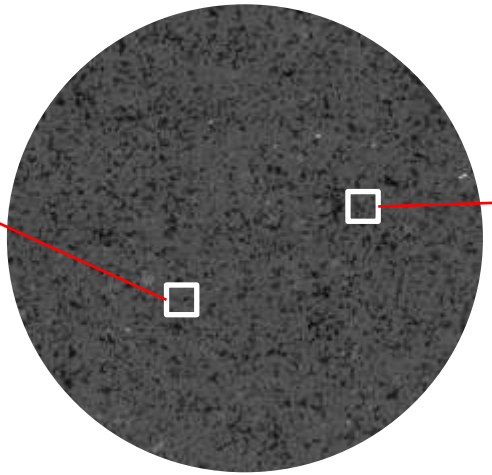
Mineralogy

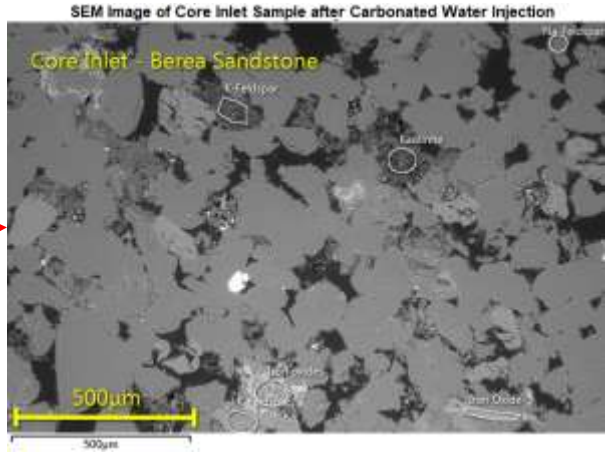
A: Unaltered Berea Sandstone

B: Core Inlet after Carbonated Water Injection

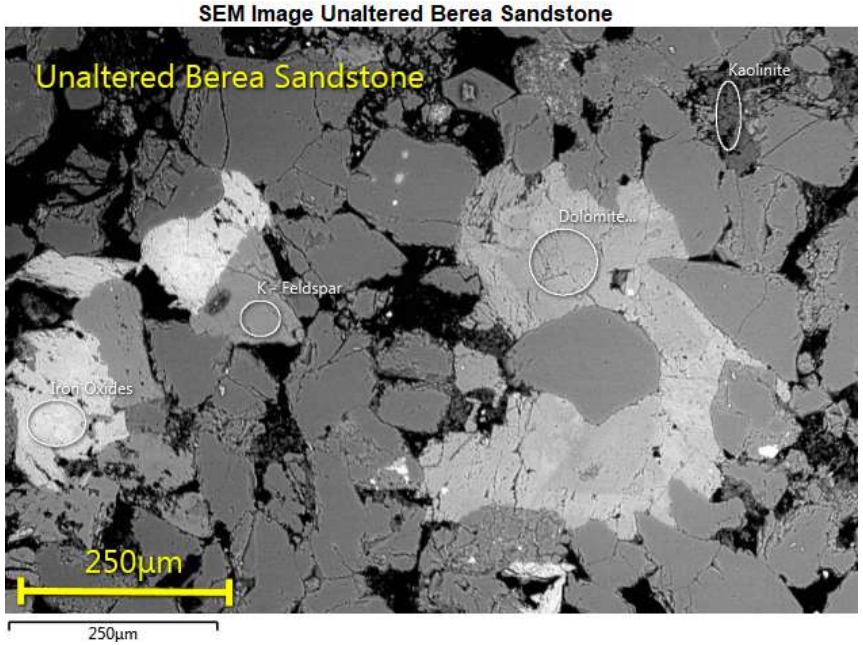
C: Core Outlet after Carbonated Water Injection

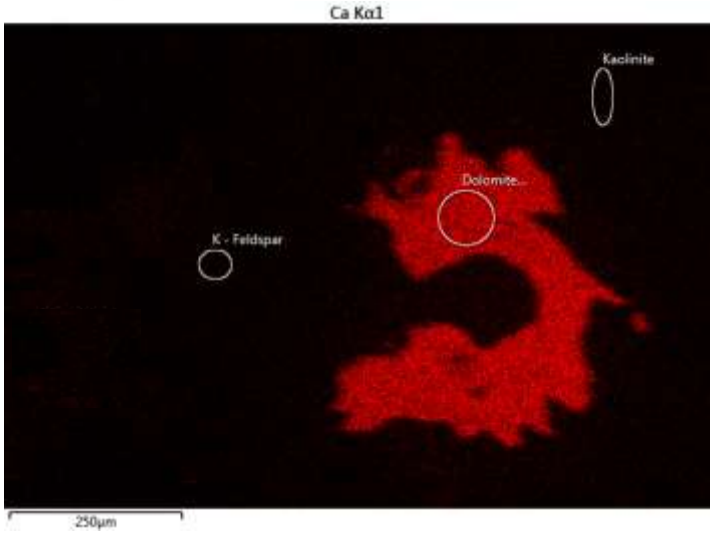


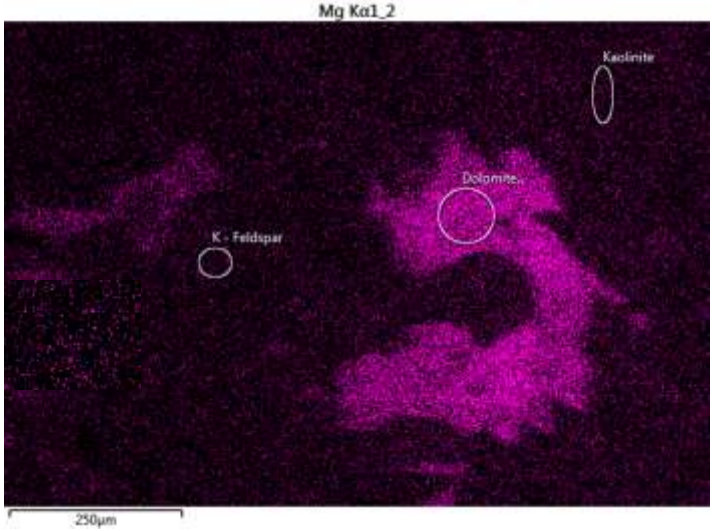




Presence of Dolomitic Cement in Sample A

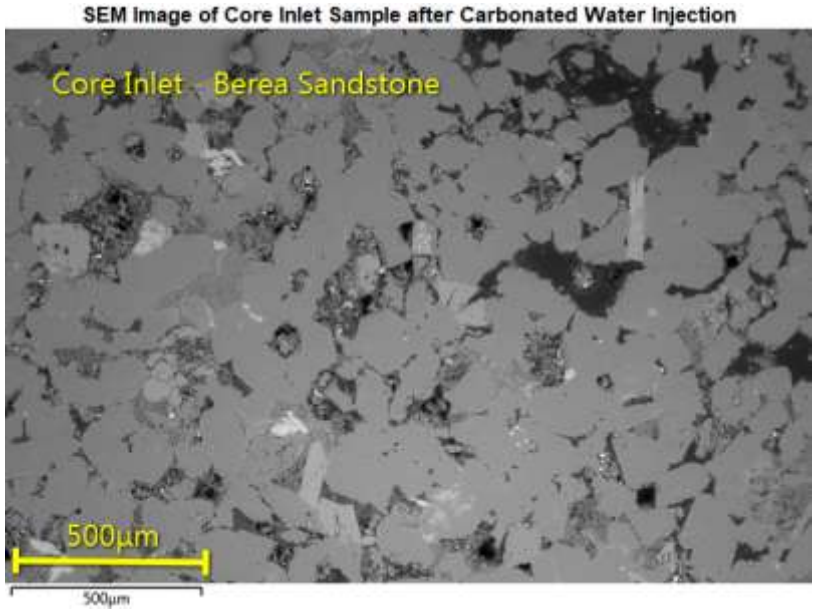


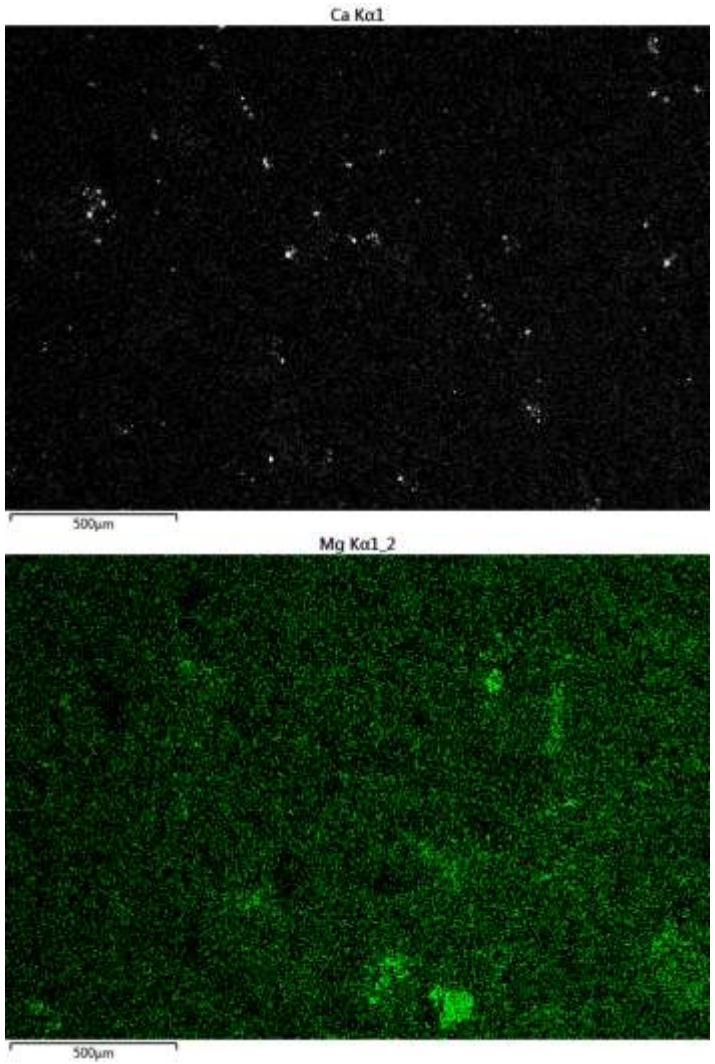




- SEM images and EDX maps indicate considerable amount of dolomitic cement distribution among sand grains.

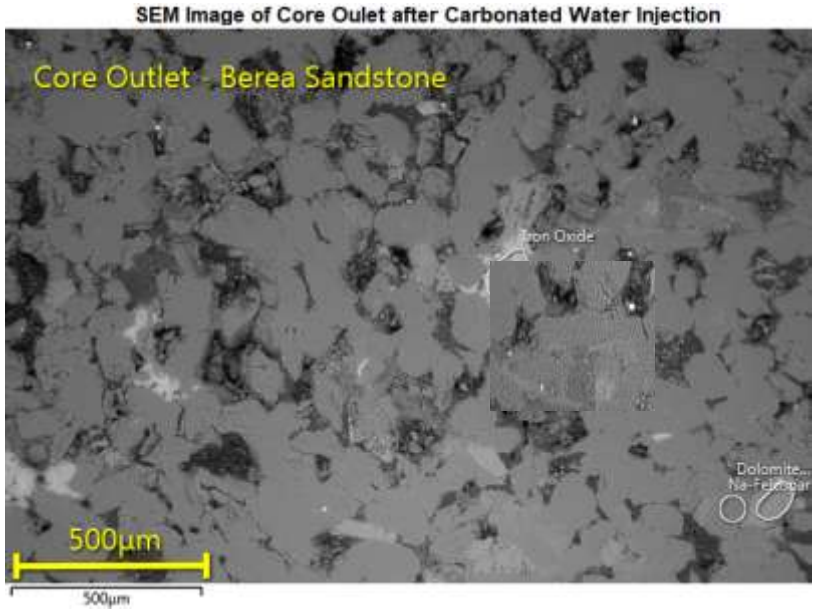
Dissolution of Dolomitic Cement at Core Inlet (Sample B)

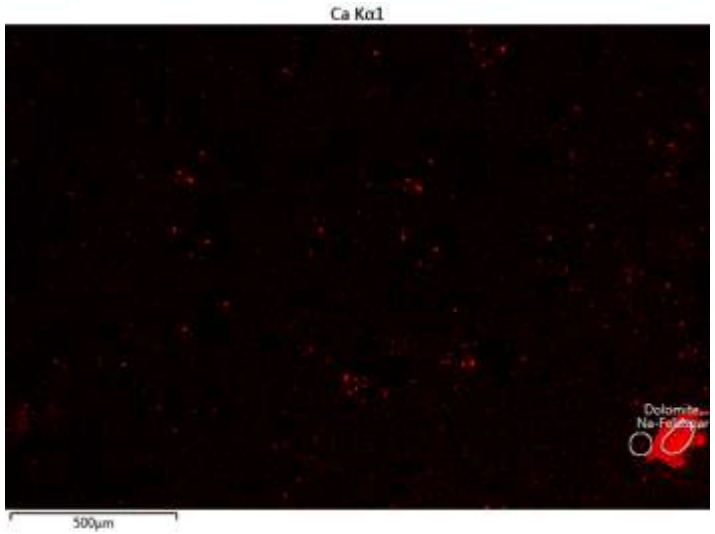


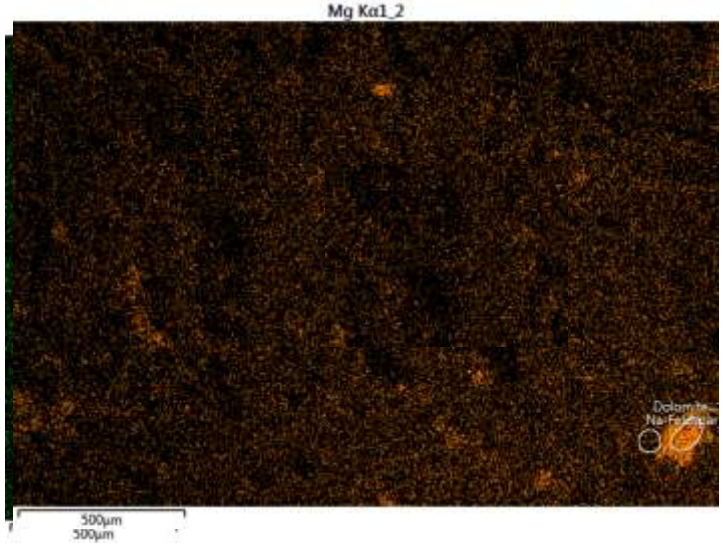


- This cement was sparsely present out core inlet that came into contact with fresh carbonated brine.

Remaining Dolomitic Cement at Core Outlet (Sample C)

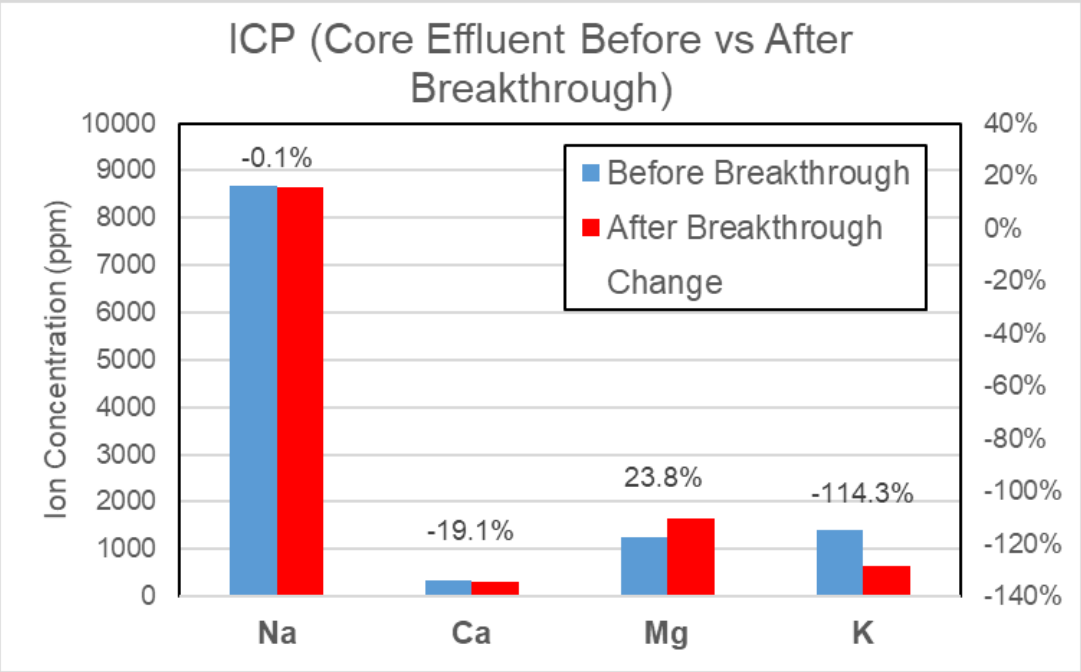






- At outlet a smaller proportion of this cement remained intact in isolated spaces where contact with carbonated brine was minimal.

Effluent Analysis



- No significant change in Na^+ concentration.
- The change in Ca^{2+} concentration: possibly related with calcite deposition at BPR upon exsolution of CO_2 (under investigation).
- Increase in Mg^{2+} confirms dolomitic cement dissolution.
- More chemical weathering of K-feldspars are expected in lower pH levels, (further investigation required.).

Permeability Measurement vs Time

Time:	Before Carbonated Water Injection	0.4 Pore Volume Injected (Breakthrough)	0.8 Pore Volume Injected (**Sand** Production **Starts**)	2.8 Pore Volume Injected (Sand Production **Stops**)
Permeability:	50 mD	20 mD	DP Fluctuations	110 mD

Conclusions and Limitations

- Ionic concentrations measured in atmospheric conditions. Back calculation via modelling is required.

- SEM analysis can be affected by mineral deposition at increased pH caused by exsolution of CO_2 from carbonated brine.

- The observed permeability evolution after sand production is more representative of near wellbore flow conditions.

Further Investigations

- High Resolution μCT image analysis of the rock before and after contact with carbonated water injection.
- SEM analysis of produced sand grains and solid residues.
- Porosity measurement (μCT vs Helium).
- Geochemical modelling of the experiment to back calculate ion concentrations and pH at HPHT.

Acknowledgements

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