

Panel #5

Geochemistry of Fluids at Depth: Anticipated Conditions and Characterizing the Conditions

Moderator: Susan Brantley, Board Member

Panelists:

D. Kirk Nordstrom (U.S. Geological Survey)

Shaun Frape (University of Waterloo, Canada),

Jennifer McIntosh (University of Arizona)

Questions related to deep borehole disposal

- What does the global experience from geochemistry of fluids, fracture mineralogy, and fluid inclusions tell us about subsurface conditions and parameters at 3-5 km in crystalline rock?
- What characterization techniques are best suited to determine the geochemistry of fluids at depth?
- What are the implications of the expected saline and reducing groundwater conditions at 3-5 km for solubilities of minerals and retardation factors of radionuclides?

Panel #5 Summary: Geochemistry

- ✓ Major challenges associated with collecting and analyzing fluid/microbial samples, as well as modeling relevant (bio)geochemical processes. Careful planning is required
- ✓ Understanding of contaminant mobility requires geochemical modeling, which is severely limited by inadequate databases and equilibrium conditions may not apply
- ✓ Most likely fluids will be Ca – Na, Cl (SO₄), saline (greater than 50 gL⁻¹ TDS), and have distinct isotopic signatures, different from formation waters in sedimentary basins and meteoric waters
- ✓ Fluids most likely will be old, isolated from the atmosphere, and in ‘chemical’ equilibrium with the host rock and fracture minerals. Exact age dating of fluids will be difficult. Best to use multiple age tracers.

Panel #5 Summary: Geochemistry

- ✓ Temperatures and Pressures will be elevated: $T > 100\text{ }^{\circ}\text{C}$ and $P \sim$ Lithostatic, Anisotropic
- ✓ Large hydrologically active fault systems could be present. Major permeable “crushed rock” zones often found and not predicted to occur
- ✓ Substantial quantities of hydrocarbons and other gases will likely be present
- ✓ Microbes will likely be present; drilling activities may contaminate/perturb microbial communities
- ✓ High salinities, temp, and sulfide concentrations will greatly increase corrosion rates of canister materials
- ✓ Chloride, sulfide, bicarbonate, and organic complexes can be expected to form and keep radionuclides and other metals dissolved and highly mobile

Panel #5 Summary: Geochemistry

- ✓ Fracture filling materials will be useful indicators of redox, paleo T-P conditions, and direct & indirect age and stability indicators
- ✓ Dual porosity (i.e. leading to variable water compositions) may be important
- ✓ May need to consider impacts of future glaciations if siting repositories in glaciated area