THEME 2:
THE DYNAMIC INTERFACE

Session 2.4:
Confined fluids

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Confined fluids are a critical phase in a variety of geological systems. Transport and deformation processes in most water-bearing or partially molten rocks are mediated through small fluid pores, films or channels that are confined by the surrounding mineral grains. Confinement changes the physico-chemical properties of pore-filling fluids, including: diffusivity, viscosity, effective dielectric constant, hydrolytic weakening effects and the melting/freezing point. Confinement may also have significant effects on the saturation state of the fluid with respect to the surrounding mineral phases. Thermodynamically, confined fluids can be considered as separate 'low-dimensional' phases with properties that are particular to their environment. This session will focus on the interactions between confined fluids and their confining solid phases and the implications for transport, deformation and growth-dissolution processes.

2.4.11

The structure and dynamics of 2-dimensional aqueous fluids

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The swelling clay minerals, for example smectite and vermiculite, are layer-type aluminosilicates that are widespread in geologic deposits, soils, and sedimentary rocks They are comprised of stacks of negatively charged mica-like sheets, which are held together by charge balancing interlayer counterions, for example sodium or calcium. Since these counterions have a strong tendency to hydrate, water molecules and other polar molecules can be intercalated between the clay layers. This creates an interlayer ionic solution, which causes the clay to swell. Typically, the expanding clay passes through three discrete hydration states, and is then governed by longer-range electrical double layer interactions

The interlayer pores of swelling 2:1 clays are therefore an ideal environment in which to study 2-dimensional confined aqueous fluids, and are the site of many important hydrological and petrological processes. These include the diagenetic reactions which are a major source of water in the earth's crust, ion exchange in soils and sedimentary rocks, and primary and tertiary migration of petroleum hydrocarbons. In addition, the hydration and dehydration of expandable clays is a continuing problem for the construction, waste containment and oil-well drilling industries. To understand and predict these processes we require a detailed knowledge of clay-fluid interactions, under sedimentary basin conditions.

Here we discuss resent computer simulation[1-3] and neutron scattering studies[4,5] of clay-water systems, including research into these materials at elevated pressures and temperatures. We will show that this research provides us with detailed understanding of ion solvation and hydrogen bonding in confinement.

References

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