Metastable Phase Equilibria for the Marine Sedimentary Deep Brine Enriched with Potassium

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Besides salt lake brine, underground brine is another kind of important liquid mineral resource. Pingluoba underground brine, located in the west of Sichuan basin, is famous for its high concentration of sodium, potassium, lithium, borate, and rubidium. The potassium reserves of Pingluoba underground brine is about 4.55 million ton. The exploitation of this brine can reduce the burden of potassium requirement in China.

The Pingluoba underground brine belongs to a marine sedimentary deep brine, with distinguishing features of deep buried depth (over 4500 m), high pressure (about 97 MPa), high temperature (about 393 K), and high salinity (over 420 g/L). [1] The hydrochemistry of Pingluoba underground brine is a chloride type and the main component of the brine can be simplified as the complex system $Li^+ + K^+ + Rb^+ + Mg^{2+} + Cl^-$ + borate + H_2O. In this six-component system, magnesium chloride can form various hydrate salts and a solid solution can be easily formed between potassium and rubidium in chloride solution.

To exploit brine resources, the studies on the phase equilibria about the water-salt system at multi-temperature are necessary. Up to now, a series of researches about the metastable phase equilibria of the salt – water system enriched with potassium focused on Pingluoba underground brine have been done at 298 K, 323 K, 348 K by our research group.[2-6] These research results give us good information about the crystalloid forms, crystallization zones, and crystallization order of different salts, which are useful for the exploiting of brine. Neverless, most of the exiting research focused on the ternary and quaternary subsystems, the results are not enough for the comprehensive utilization of the brine, the investigation about the more complex system are necessary.

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Remains of ancient precursor of perennial springs in the High Arctic

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Saline springs in the Canadian high Arctic where water flows perennially at constant temperatures, despite the presence of deep (>400 m) permafrost, are being studied as possible environments for the development of bacterial life as an analogue for similar situations in other planets. Most documented spring activity occurs marginal to large evaporite diapirs (e.g. salt domes), and have been interpreted to represent recent phenomena related to deglaciation [1].

A relict of an ancient precursor of the active springs was found in 2005 on a steep west flank eroded by White Glacier (WG) at Expedition Fiord, Axel Heiberg Island (79.44˚N; 90.70˚W; 350 m.a.s.l.). A network of veins, mineralized fractures, layered masses and breccias is exposed across an area of ca. 350 x 50 m, where the host rock is brecciated dolomitic limestone and sandstone, anhydrite-gypsum, and intrusive igneous rocks (altered basalt). Mineralization consists of calcite in acicular, radial aggregates lining fractures and cavities, with textures wholly reminiscent of brownish calcite in active springs at Colour Peak, only 13.7 km southwest of this site. Iceland spar calcite fills the centre of larger cavities. Abundant crystalline Fe sulfides (FeS_2 marcasite, pyrite) occur in the veins and as alteration of basalt. Quartz occurs in some veins, and epidote and chlorite rim some veins where the host rock is igneous.

Fluid inclusions in calcite (5-10 μm) have salinities that fall into two distinct groups: one very low, ca. 1.5 and another ca. 16 NaCl wt% equivalent. Inclusions that occupy growth zones in some of the coarser acicular calcite crystals and deemed primary, have T_h ranging from 100˚C to 300˚C (n = 26, average 207˚C; independent of salinity), hence orders of magnitude higher than the average ca. 6˚C [2] of the brines in the active springs. Despite the similarities of the WG site with perennial springs at nearby Colour Peak [2], these results cannot be explained by models invoking shallow circulation of fluids related to deglaciation [e.g. 1]. We propose a model by which deeply-circulating hot basinal fluids associated with evaporite structures mixed with low-salinity surficial waters, in recurrent pulses. Low-temperature thermochronology (apatite fission tracks) indicates that the rocks now exposed at the surface at WG were at several km depth and temperatures of ca. 100°C until ca. 10 Ma, thus compatible with long-lasting circulation of warm fluids well before the Quaternary and ample opportunity for microbial colonization.

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