Mineral precipitation from ascending brine and resultant fissure closure

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Mineral precipitation from ascending brine in fissures has been numerically simulated to investigate an effective depth for fissure closure. Three simplified fluid ascending processes have been modeled in the present study: (a) fluids ascend slowly with their temperatures following a geothermal gradient (28^{o}C/km), (b) fluids ascend rapidly with their enthalpy loss of 450 cal/mol/km (i.e., 1 mole of water losses 450 calories during 1 km ascending) and (c) with the enthalpy loss of 300 cal/mol/km. Since there have been no reliable equation of state of brine at high temperatures and pressures, the enthalpy of water derived by SUPCRT92 (Johnson et al., 1992) was also taken for 1 molar NaCl brine.

The results are compared with those of our previous simulations for quartz precipitation from ascending water (Hoshino and Fujita, 2011). They noted that water ascending with the enthalpy loss less than 235 cal/mol/km boils at the bottom where water begins to ascend, while it boils at around the top (near surface) when the loss is from 236 to 446 cal/mol/km. Therefore, there may be no condition for water to boil at intermediate depths. They also concluded that fissures may close mostly at their bottoms, since the precipitation rates (mole/kg-water/km, i.e., moles of mineral precipitated in 1 kg of water during 1 km ascending) are largest at the bottoms in all simulated models.

Although the precipitation rates from brine are also largest at the bottom in later stages (i.e., fractures are almost closed, and resultant fluid pressures increase to lithostatic ones), the rates at around 400-300^{o}C (14-12 km depths for the ascending model (a) and 13-9 km for the model (b)) are larger than those of bottoms in early stages (i.e., almost at hydrostatic pressures). This is because the apparent dielectric constants of brine at around the above temperatures under low pressures are larger than those of water. Hence, the fluid pressures at around the depths increase much more rapidly than the previous results for water ascending (Fig. 1).

Keywords: brine, mineral precipitation, fissure closure, apparent dielectric constant

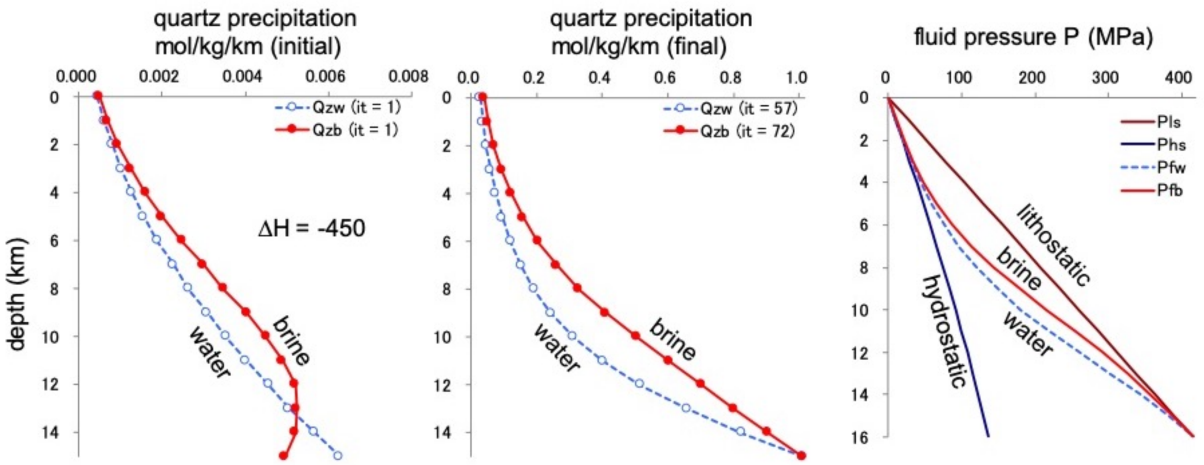

Fig. 1 Quartz precipitation from ascending fluids (mol/kg/km) at initial (left) and final (center) stages and resultant fluid pressures (right) for water (dashed lines) and brine (solid lines) .