Extension of log K of aqueous species to low-water density conditions and comparison with hydrothermal experiments on feldspar dissolution

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In order to obtain the thermodynamic properties of aqueous species (ions and complexes) at supercritical conditions, the Helgeson-Kirham-Flowers (HKF) electrostatic model has been widely used. However, that model cannot be applied to the region close to critical point of water and low-water density region (< 0.35 g/cm^3). In this study, we extended the logarithm of equilibrium constant (log K) data in SUPCRT92 with slop07.dat thermodynamic dataset to the vapor-like supercritical region using the density model instead of the HKF model. We extrapolated log K for 21 aqueous species and 45 representative minerals in the system of Si-Al-Ca-Na-K-H$_2$O-HCl-SO$_4$. For validating the extended log K data, we conducted the hydrothermal experiments for dissolution of feldspar (albite powder, K-feldspar-albite-quartz powder) at temperatures of 400, 420 ˚C, and pressures of 20, 25, 30, 35 MPa, respectively. We compared the extrapolated log K with the ion products (log Q) obtained from the solution chemistry of the experiments and extrapolated log K data of aqueous species. The difference between log K and log Q was almost less than 2 in logarithm unit, which is lower than that extrapolated by the HKF model in SUPCRT92. These results suggest that the density-based extended log K may be useful as the first approximation at temperatures of > 400 ˚C. In contrast, in vapor region at lower temperature of < 400 ˚C, the extrapolation is not acceptable due to large density gap at the vapor-saturated curve. Now, we have conducted the flow-through hydrothermal experiments on mineral precipitation in low-water density region using an input solution basalt- and granite-dissolved solutions. In contrast to quartz and metastable silica phases precipitated from the granite-dissolve solutions, from the basalt-dissolved solutions platy minerals and prism minerals precipitated, which are probably albite and clay minerals. We compare the experimental results with the reaction path modeling expanded log K data, and reveals the differences in granite-hosted and basalt-hosted hydrothermal systems.