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Thermodynamic modeling of supercritical fluid composition at high temperatures (380-600°C) and low pressures (p <0.3 kbar)

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Supercritical hydrothermal reservoirs with ~380-600°C fluids have been encountered in active geothermal systems worldwide. Such fluid temperatures are observed at the boundary of conventional subcritical geothermal systems and the volcanic intrusion. Isotope studies indicate the supercritical fluid originate from the surrounding geothermal groundwater of meteoric or seawater origin with variable input of magmatic gases. However, the chemical compositions of such supercritical fluids are largely unknown and current thermodynamic formulations (for example HKF model) do not apply at these extreme temperatures (>380-600°C) and low pressures conditions (P < 0.3 kbar). Here an attempt to simulate the chemical composition of such supercritical fluids was made using the available literature and newly generated data on mineral solubility in water for the chemical system Si-Na-K-Ca-Mg-Fe-Al-Cl-S-O-H. The calculations revile that supercritical fluids at 380-600°C and P <0.3 kbar are characterized by low non-volatile element (or solute) concentrations (Si, Na, K, Ca, Mg, Al) controlled by salt, oxide and aluminum silicate solubility, where volatile element (C, S, Cl) abundances were predicted to be similar to the source water. Volcanic gas input signatures are very different and depicted by sharp increase of C, S and Cl concentrations. The solute concentrations in supercritical water are mainly pressure (or density) rather than temperature dependent with the speciation dominated by uncharged and associated compounds. The project has received funding from the European Union's Horizon 2020 under Grant Agreement #818169 (GeoPro).