Anomalous properties of H_2O-NaCl fluids in the critical region

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Mass and energy transfer in hydrothermal systems is controlled by the physical (density) and thermodynamic (enthalpy) properties of the fluid. Johnson and Norton [1] documented that pure H_2O shows large variations in these properties with small changes in temperature (T) or pressure (P) in a PT region that extends from the critical point (CP) of H_2O to higher T and P along the critical isochore (critical wedge). In this study, we used the SoWat model [2] to estimate the properties of H_2O-NaCl in the vicinity of the CP for compositions ranging from 0 to 30 wt. % NaCl.

The relative change in density of a fluid as a function of T at constant P is defined by the coefficient of thermal expansion, α. Along the critical isobar for H_2O, α approaches infinity at the CP and shows large variation with small changes in P or T near the CP. Our results show that addition of NaCl to H_2O causes the critical wedge to migrate to higher PT conditions as the CP migrates to higher P and T, as shown for a 15 wt.% H_2O-NaCl composition in Fig. 1. Compared to H_2O, the critical wedge for H_2O-NaCl compositions is asymmetrical because the wedge is truncated on the high T, low P side by the two-phase (liquid+vapor) region. The region of anomolous fluid properties is stretched from the CP of H_2O along the two phase boundary towards the critical isochore for a given salinity. Our results suggest that the PT region in which enhanced mass and energy transport occurs in hydrothermal systems is significantly influenced by the fluid composition, as suggested by [3].

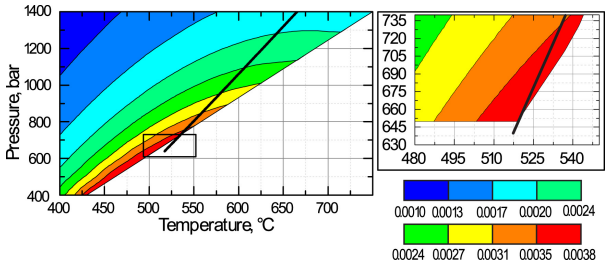

Figure 1: α ($°C^{-1}$) for 15 wt.% H_2O-NaCl. Inset shows detailed area near CP, black line indicates critical isochore.

[1] Johnson & Norton (1991) *Am. J. Sci.* **291,** 541-648 [2] Dreisner (2007) *Geochim. Cosmochim. Ac.* **71,** 4902-4919 [3] Bodnar & Costain (1991) *Geop. Res. Lett.* **18**, 983-986