

Equations of state of H₂O and NaCl-H₂O fluids from Brillouin scattering in the diamond anvil cell

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Modeling fluid-rock interactions at great depths in subduction zones requires thermodynamic data on both mineral and fluids. Such data are available for a number of rock-forming minerals of the subducted lithosphere [1], but not for complex aqueous fluids containing large amounts of dissolved electrolytes [2]. Knowledge of the thermodynamical properties of high pressure aqueous fluids requires the measurement of the (P-V-T) equation of state (EOS) over the P-T range relevant for subducting slabs.

We report here the equation of state of water and chlorine-bearing solutions (NaCl 1 m) up to 400 °C and 7 GPa, determined from sound velocity measurements in the diamond anvil cell (DAC) using the Brillouin scattering technique. Pressure in the compression chamber was accurately determined using ruby and Sm²⁺-doped borate as pressure standards. The measured sound velocities in water are in excellent agreement with previous determinations using the Impulsive Stimulated Brillouin Scattering technique [3].

Using the established equations of state, we calculated the pressure and temperature dependences of thermodynamic properties of water and NaCl solutions, including thermal expansion coefficients, isothermal and adiabatic compressibilities and heat capacities. The molal volumes of water and 1m NaCl solutions are also used to evaluate the P and T dependence of the excess volume.

These results provide an internally consistent dataset for molal volumes of the most relevant aqueous systems involved in subduction process. They will also constitute the basis for the refinement of potentials controlling the intermolecular interactions in high density water, allowing the refinement of more accurate thermodynamic properties, and reasonable extrapolation down to the transition zone.

References

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In-situ determination of the partitioning of Pb, Rb, Sr between hydrous melts and aqueous fluids at high pressure and temperature

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Subduction zones are the locations at which chemical components are both recycled into the mantle and returned to the atmosphere through volcanism. Magma genesis at subduction zones is mainly induced by the migration of fluids released in large amounts from the subducted slab. These fluids may be responsible of the atypical trace-element signature of the Island Arc Basalts. The present study combined Bassett-type diamond anvil cells experiments with Synchrotron Radiation X-Ray μ Fluorescence Analyses (ESRF, Grenoble, France), to study *in situ* the partitioning of key elements (ex: Pb, Rb, Sr) between aqueous fluids (\pm Cl) and silicate melts, under subduction zones pressure and temperature conditions.

Results

Results show that the combined presence of Cl (saline solution) and K (haplogranite starting glass) favours a significant affinity of Pb, Rb, Sr for the melt phase compared to the aqueous fluid in equilibrium with it. Ex: with Cl: $D_{\text{fluid/melt}}^{\text{Pb}} < 0.2$, without Cl: $0.8 < D_{\text{fluid/melt}}^{\text{Pb}} < 0.9$.

Conclusion

Results demonstrate that a K-Cl-bearing silica-rich hydrous fluid, is likely the contaminating agent responsible for the Pb, Sr, Rb geochemical fingerprint of the subduction-related magmas.