

Thermodynamic properties and phase equilibrium of crustal fluids around critical point

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The thermodynamic properties (pressure (P) - volume (V) - temperature (T) - chemical composition(X)) of crustal fluids (the ternary system of H₂O-CO₂-NaCl) and phase equilibrium are very important in the study for various geochemical systems of ore deposition, metamorphism, hydraulic weakening, healing of fault zone, flow potential and etc. These properties can be derived from equation of state (PVTX relation). However, that equation for the ternary system is uncompleted around critical point, because there is little information on the fundamental thermodynamic properties for the ternary system at high CO₂ concentration and salinity. Therefore, we have developed a new experimental technique that can control P and T independently up to 200 MPa and 600°C.

It is our measuring concept that the changes in volume of the simulated crustal fluids are measured following the changes of the pressure and temperature and phase equilibration is determined from the volume gradient with respect to the pressure or temperature. Simulated crustal fluids are confined in the piston/cylinder, and pressurized CO₂ (liquid) is injected into the fluid using CO₂ injector. The V and T are recorded in PC at constant pressure continuously and synchronously. The procedure was repeated with different pressure of the same sample.

The volume change of the piston/cylinder system is calibrated as a function of temperature and pressure with thermal expansion coefficient and volume elasticity of it. The accuracy of the volume of the fluid is better than 0.1% on the experimental P-T condition. The fluid composition is to be accurate to 0.1mol%. The error of measurements for P,V and T is less than 1%.

We verified the performance of our technique by comparing our experimental data for pure water and H₂O-10 and 20 mol.% CO₂ systems over the P-T range up to 200MPa and 600°C with those in equation of state. For all systems, our experimental data are consistent with the equation of state within accuracy of 3%. Our technique inherits a high potentiality to offer an innovative method for determination of P-V-T-X relation of crustal fluids around critical region. We can also determine the phase equilibrium from the volume gradient with respect to the pressure or temperature. The phase boundary between the heterogeneous and homogeneous region is consisted with previous experimental studies. Additionally, we can derive the higher or lower density region from homogeneous phase.