

Experimental measurement of P-V-T data for crustal fluids around critical point

Yoshiharu Uchida[1]; Kenshiro Otsuki[2]

[1] Geoenv. Sci., Grad. Sch. Science, Tohoku Univ.; [2] Earth Sci., Tohoku Univ.

The crustal fluids are key materials governing various geological processes of metamorphism, hydraulic weakening, healing of fault zone, flow potential and etc. through water-rock interaction, material transportation, change in effective confining pressure, phase change and infiltration. The compositions of crustal fluids can be characterized by H₂O-gas (CO₂, CH₄, N₂ etc.)-salt (NaCl, KCl, CaCl₂ etc.), and the model ternary system used most often to predict P (pressure)-V (volume)-T (temperature)-X (chemical composition) behavior of crustal fluids is H₂O-CO₂-NaCl. The condition up to 200MPa and 400°C is very important state for water-rock interaction as the bright layer and ore deposition. In order to estimate and understand these geological processes, we need to calculate the thermodynamic properties of crustal fluid using equation of state, which is based on the P-V-T relation. However, the equation for ternary system is uncompleted around critical point, because there is little information on the fundamental thermodynamic properties (P-V-T-X relation) for the ternary system. Therefore we have developed apparatus for P-V-T measurement of crustal fluids up to 200MPa 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 change in volume gradient with respect to the pressure or temperature. Using this apparatus, we could reproduce the steam table of pure water within 1%. However, because the temperature was not measured directly, we had a serious problem that we could not estimate error of measurement in temperature. Therefore we set the thermocouple into the fluid in order to measure the temperature directly. It was fastened to the cylinder and the space between the thermocouple and piston was sealed by O-ring. The friction of O-ring was small. Then it was a serious problem that where we should measure the temperature. We set the thermocouple at the site where the temperature calculated by 3D-thermal conductivity analysis was the most homogeneous all over the fluid.

We verified the performance of our apparatus by comparing our experimental data for pure water and H₂O-CO₂ system over the P-T range up to 200MPa and 100°C with those in equation of state, SUPCRT92. The V and T were recorded continuously and synchronously at constant pressure in PC. The procedure was repeated with different pressure of the same sample. For both samples, our experimental data coincide with SUPCRT92 within accuracy of 1%. My apparatus inherits a high potentiality to offer an innovative method for investigating the equation of state of fluids at high P-T conditions.