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Development of solubility measurement technique of rare earth element (Ce) in super critical aqueous fluids

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Mineral solubility in supercritical aqueous fluids has been determined mainly with ”single crystal weight-loss method” (e.g. Manning, 1994). The detection limit of the weight loss (typically 10 micro gram) produces relatively large errors for nominally insoluble minerals (e.g. Antignano and Manning, 2008). In this study, we have been developing two different methods for measuring the solubility of Ce-monazite in aqueous fluids in the lower crustal conditions.

Firstly, synthetic fluid inclusion method was tested. We synthesized fluid inclusions in a gem-quality quartz single crystal at 0.8-1.2 GPa and 700-900 degC using a piston cylinder apparatus. The volume fractions of synthesized fluid inclusions were determined by using X-ray CT. The quartz crystals were dissolved with HF acid and the solution was analyzed with ICP-MS. The concentration of the fluid inclusion was then calculated by subtracting the amount of Ce in the background quartz.

Secondly, we conducted direct analyses of solute recovered from runs at 1 GPa and 800 degC. In order to separate the fluid from the starting material, we put $CePO_4$ powder with deionized distilled water into a gold inner capsule with one end welded shut and the crimped lightly. The fluid was expected to be equilibrated diffusively during the run duration (24 hours). The weight of water in the outer capsule was measured after quenching and the quenched crystals only in the outer capsule were dissolved with HNO_3 acid for ICP-MS analyses.

In the synthetic fluid inclusion method, solubility in the SiO_2-saturated system was determined, but the minimum Ce concentration that can be determined with this method is large due to small volume fraction of the synthetic fluid inclusions. The preliminary results obtained with the direct solute analyses method were consistent with the result reported by a previous study (Tropper et al., 2011).

Keywords: weight loss method, synthetic fluid inclusion method, solute trap method