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Elemental partitioning between fluids and magmas: First synchrotron XRF analysis with large volume HPHT apparatus

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Synchrotron X-ray fluorescence analysis is conducted to know elemental distribution between aqueous fluids and magmas under high-pressure and high-temperature conditions using SPEED 1500 Kawai-type large volume press installed at BL04B1, SPring-8, Japan. SR-XRF spectra covering from Cs, Ba, La, Sm, Gd, Ho, Yb, Pb, Th and U are collected using an SSD detector with 6 degrees to incident X-rays. Calibration lines are available for Cs, Ba, La, Sm, Gd, Ho, and Yb with concentrations from 0.1 wt. % to 1 wt. % under atmospheric pressure. High background for Pb makes rather difficult to obtain a calibration line for this element, but the background is reduced under high-pressure and high-temperature conditions. The calibration should be conducted at least for Pb under high-pressure conditions. It is not feasible to detect Th and U at 0.1 wt. % order abundance. For Th and U, a detector with higher sensitivity with this energy region is required. The first result carried out under high-pressure and temperature experiment suggests that aqueous fluids are enriched in Cs than coexisting high Mg andesitic melt and are free of the other detectable elements (Ba, La, Sm, Gd, Ho, Yb) at 1.5 GPa and approximately 1000 degree C. This observation can be partially consistent with the previous works: Rb and K rich fluid with moderate partition characteristics of Sr and Ba, and low partition characteristics of rare earth elements based on quench experiments using an (Na, K) Cl rich solution and an andesitic melt at 1.5 GPa (Keppler, 1996, Nature). At 1.5 GPa, we need to assess a temperature effect on this partitioning behaviour. Pressure and concentrations of NaCl in aqueous fluids can have large effects on the elemental partitioning based on the quench experiments (Keppler, 1995 Nature, Ayers and Eggler, 1995, Geochimi Cosmochimi Acta, Bureau et al., 2007, High Pressure Res) and should be understood by in-situ observation.

Keywords: fluid, magma, high-pressure and high-temperature, chemical composition, synchrotron X-ray, subduction zone