Partitioning of trace elements between garnet and silicate melt under high pressure

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Garnet is an important constituent mineral in the Earth's transition zone. Hence, the knowledge of partitioning behavior of elements between garnet and silicate melt is required as fundamental information to resolving the chemical evolution process of the Earth' s deep interior. In this study, we performed high pressure melting experiments on basalt and Ca-rich material, and partition coefficients between garnet and silicate melt were measured.

An alkali basalt, JB1, was used as the starting material. We also prepared a Ca-rich material (mainly composed of 3:1 mixture of wollastonite and MgO) to observe the effect of Ca-component in the garnet. Trace elements (Sc, Co, Ga, Ge, Rb Sr, Zr, Nb, In, Cs, REE, Hf) were added to these materials as high purity oxides in approximately 200 ppm each. High pressure experiments were performed by using Kawai-type multi anvil press installed at Tokyo Institute of Technology (TIT). Sample was contained in a graphite capsule, and melting experiments were performed. Sample was kept for 1 hour at around liquidus temperature, and quenched isobarically. The recovered specimen was polished to a section, and major element contents were measured by EPMA, and trace elements were measure by LA-ICP-MS installed at TIT.

In the case of JB1, garnet was observed as liquidus phase from 5 to 20 GPa. With increasing pressure, partition coefficients of trivalent ions were gradually decreased while partition coefficients of monovalent ions were increased. In the case of divalent and tetravalent ions, partition coefficients of several ions were decreased with increasing pressure.

Since the ions whose radius is larger than Mg^{2+} will occupy the 8-coordinated site of garnet, their partition coefficient pattern will show a single peak on PC-IR diagram. However, there was a 'bottom' in partition coefficient pattern at around In^{3+} and Fe^{2+}.

In the case of Ca-rich material, garnet was found as liquidus phase up to 15 GPa. It was found that the optimum ionic size for 8-coordinated site slightly increased with increase of Ca-content of garnet.