

Pressure dependence of partition coefficient between olivine and peridotite melt

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In the late stage of the planet formation process, the growing planets may have covered by thick magma ocean. In the case of the Earth, even the entire planet may have molten due to the Moon-forming giant impact. Crystallization of a magma ocean would have produced the primitive mantle. Therefore, it is important to study precise phase relations and element partitioning during crystallization of global magma ocean. Taura et al. (1998) investigated pressure dependence of the partition coefficients between olivine and melt using SIMS. However, the number of elements was not sufficient to constrain the PC pattern for tri-valent cations. In this study, we determined partition coefficients for 32 elements between olivine and peridotite melt at 2, 10 and 14 GPa using natural sample KLB-1* (97wt% KLB-1 + 3wt% alkali basalt) and trace elements doped KLB-1D (doped with ca.600ppm of 27 trace elements).

High pressure melting experiments were performed using a piston-cylinder apparatus and a multi-anvil apparatus and the chemical analysis was carried out using EPMA and LA-ICP-MS. The experiments were attempted to form crystals and melt-pools large enough to be analyzed by LA-ICP-MS (more than 30 micron meter in diameter of laser spot). In most of experiments, superheating and successive gradual cooling (about 200degreeC/hour) near the liquidus of peridotite was employed. Major and some minor elements were analyzed by using EPMA. Run products suitable for LA-ICP-MS analysis were selected from EPMA measurements by carefully examining chemical heterogeneity, etc. Partition coefficients were calculated from these results. They were plotted on PC-IR diagram (Onuma et al., 1968) (see Fig.1a,b).

The results of this study (KLB-1*, KLB-1D) are in general agreement with the previous study by Taura et al.(1998). The partition coefficients for tetra- and di-valent cations are nearly constant with pressure. The partitions coefficients for mono-valent cations (Na,K) increase with pressure. In case of tri-valent cations, the partition coefficient for Al increases while that of other tri-valent elements decreases with pressure. The parabolic curves in Fig.1a,b were fitted from the new data using lattice strain model (Blundy and Wood., 1994). The optimum radius of M-site for tri-valent elements is nearly constant with pressure, while Young's modulus of the M-site was found to increase with pressure.

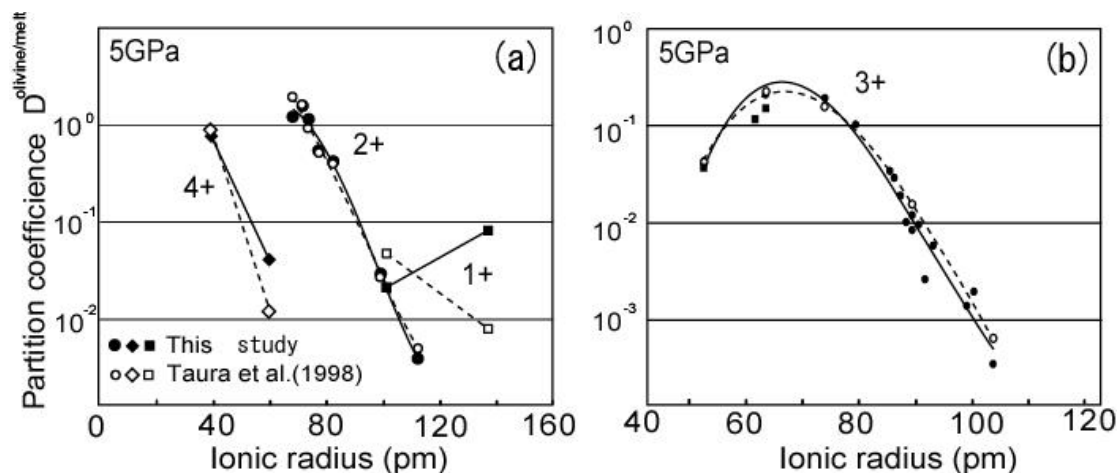


Fig.1 PC-IR diagram of olivine/melt system at 5GPa