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Pressure effect of element partition coefficients between olivine, majorite garnet and peridotite melt up to 20GPa

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We have determined partition coefficients between olivine, majorite garnet and coexisting melt at 1 atm to 10GPa and 15GPa to 20GPa, respectively, for 32 elements (Na, Ni, Mg, Fe, Mn, Ca, Al, Cr, Ga, V, Sc, In, Lu, Yb, Tm, Er, Y, Ho, Dy, Tb, Gd, Eu, Sm, Nd, Pr, Ce, La, Si, Ge, Ti, Hf and Zr) by high pressure and high temperature experiments using laser ablation ICP-MS and EPMA. Olivine/melt partition coefficients for major, minor and some trace elements (e.g.V, Y) show good agreement with previous works. The partition coefficients for trivalent and monovalent cations show significant change with pressure. Partition coefficients for trivalent cations which enters octahedral M-site in olivine (except for Al, V and Cr) are plotted against ionic radius (PC-IR diagram, or Onuma diagram). In the Onuma diagram, partition coefficients for the trivalent cations were fitted using 'lattice strain model'. The obtained peak position of parabolic curve shift from 75.3pm to 71.7pm at from 2GPa to 10GPa. Considering pressure and temperature effect of unit cell volume using Birch- Murnaghan EoS, this behavior is explained by the compressing M-site of olivine with pressure. With increasing pressure, another significant change appeared in Onuma diagram, the parabolic curve widened with pressure. According to the 'lattice strain model ', the width means E/T (E, Young's modulus of the site; T, temperature), and E decreases with pressure from 649.4GPa (at 2GPa) to 524.1GPa (10GPa). In other words, the M-site seems to become more elastic with increasing pressure. Alternative explanation was examined by assuming compression of trivalent cations while maintain E/T. However, this change can't explain observed widening of Onuma diagram with pressure. Partition coefficients between majorite garnet and melt were also obtained at 15, 18 and 20GPa. Unlike olivine, partition coefficients between majorite garnet and melt are easily influenced by the composition, so that it is difficult to discuss pressure dependence of Onuma diagram formajorite. If we focus only the results at 18GPa and 20 GPa whose composition of majorite and coexistng melt are similar, the optimum ionic radius and Young's modulus of the dodecahedral X-site in majorite garnet decreases with pressure such as in olivine.

Keywords: olivine, majorite, partition coefficient, magma ocean, trace element, high pressure