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Determination of Fe^{3+} and Fe^{2+} partition coefficients between pyroxenes and basaltic melt with in-situ synchrotron Mössbauer spectroscopy

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The redox variations during magmatic processes are mainly controlled by the partition coefficients of Fe^{3+} and Fe^{2+} between minerals and melts (DFe^{3+}, DFe^{2+} and DFe^{3+}/DFe^{2+}). However, the mineral/melt DFe^{3+} and DFe^{2+} are sparsely reported due to the difficulties in determining Fe^{3+} content of the minerals in quenched experimental run products. Recent progress in the use of synchrotron radiation sources has developed new frontiers in the study of Fe^{3+} partitioning between minerals and melts. In this study, we analyzed Fe^{3+} content of experimental pyroxenes and melt with the in-situ synchrotron Mössbauer spectroscopy using a beam size as small as < 10 μm and determined accurate DFe^{3+} and DFe^{2+} for orthopyroxene (opx), clinopyroxene (cpx) and spinel (spl) crystallized at the equilibrium P and T of 1.3 GPa and 1200 °C. The results show that the DFe^{3+}/DFe^{2+} are < 1 for opx and > 1 for cpx and spl. It is, therefore, expected that during partial melting of mantle spinel peridotite, the consumption of opx will decrease Fe^{3+}/FeT and fO_2 of the magma, while the consumption of cpx and spl has the opposite effect. In contrast, the crystallization of opx from basaltic magma tends to increase Fe^{3+}/Fe_T and fO_2 of the magma.