The 383th Geodynamics Seminar

Excess mixing volume, microstrain, and exsolution of pyrope-grossular garnets

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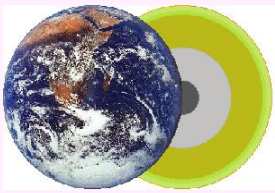

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Abstract

Aluminosilicate garnet has a general formula $X_3Al_2(SiO_4)_3$, and the *X* dodecahedral site is occupied by divalent cations. The biggest polyhedra (e.g. Mg/Ca/Fe dodecahedra) in the garnet cell contribute about one third to the cell volume. Unlike pyrope-almandine substitution of Mg for Fe, which shows near-ideal mixing properties because the small size difference of Mg^{2+} and Fe^{2+} (1.03 vs. 1.08 Å), the large size mismatch between divalent Mg^{2+} (1.03 Å) and Ca^{2+} (1.26 Å) make pyrope-grossular solid solution great candidates for studies of non-ideal mixing properties.

Synchrotron X-ray diffraction was used to measure the unit cell parameters of synthetic pyrope ($Mg_3Al_2Si_3O_{12}$), grossular ($Ca_3Al_2Si_3O_{12}$) and four intermediate garnet solid solutions. Garnets synthesized in multi-anvil (MA) apparatus show regular asymmetric positive quenchable excess volumes. X-ray diffraction profiles of these garnet solid solutions were analyzed using Williamson-Hall plots. The XRD peak width of these garnets changes with composition and microstrain in the garnet structure is the principle reason for the observed XRD peak broadening. Further synthesis and annealing experiments at 6 GPa but different temperatures with different heating time show that there is a correlation between synthesis temperature, heating time, and microstrain. These correlations reflect the different orderings of Ca and Mg achieved under different synthesis conditions.

The excess volumes we measured from MA-synthesized garnets are large and quenchable, indicating that the experimental observation of a solvus in pyrope-grossular garnets could be achieved by laboratory experiments at pressure less than 10 GPa. And more annealing experiments at high pressure and high temperature show direct observations of the immiscibility of pyrope-grossular garnet at 8 GPa and 1200 ºC, suggesting that the MA-garnet excess volumes represent internal equilibrium values.

詳細は当センターホームページ：http://www.ehime-u.ac.jp/~grc/をご覧ください
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