GARNET - PYROXENE AND ORTHOPYROXENE - CLINOPYROXENE EQUILIBRIA IN THE SYSTEM SiO_2 - MgO - Al_2O_3 - CaO - Cr_2O_3 (SMACCR): A NEW GEOBAROMETER

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Experiments have been carried out in the system SMACCR from 900 to 1400°C and 15 to 35 kb. Equilibrium compositions for Al- and Cr-contents of both ortho- and clinopyroxene have been approached from different directions. The results allow an evaluation of the influence of Cr in the two pyroxenes and in garnet on solubilities of Al and Ca in pyroxenes. The behaviour of the quarternary solid solutions is thermodynamically complex.

Even in this simple, Na-free system clinopyroxene dissolves more Cr then orthopyroxene at a given condition, but Cr/Al exchange between ortho- and clinopyroxene or between pyroxenes and spinel is not sufficiently P- or T-dependent to be used for geothermobarometry. The Cr-solubility in orthopyroxene coexisting with garnet presents however an alternative to geobarometry based on Al-solubilities in orthopyroxene. The reaction

$$\underset{\text{enstatite}}{2\ Mg_2Si_2O_6} + \underset{\text{Mg-Cr-tschermak's}}{2\ MgCrAlSiO_6} = \underset{\text{pyrope}}{Mg_3Al_2Si_3O_{12}} + \underset{\text{knorringite}}{Mg_3Cr_2Si_3O_{12}}$$

is similarly pressure- (and temperature-) dependent as conventional Al-barometry. Using recently developed non-ideality expressions for Ca-Mg mixing in garnets (Brey et al., 1986) and the cross-site interaction due to the reaction pyrope + uvarovite = grossular + knorringite (Nickel, 1986) values of ΔH° = 15193 cals, ΔS° = -5.06 cals/K and ΔV° = -371 cals/kb are obtained to satisfy the experimental data in the system SMACCR. Corrections for the influence of Fe on the reaction are checked with the aid of experiments in natural systems (Brey and Nickel, this volume). The use of independent barometric methods increases the precision of P-estimates for garnet-bearing nodules from kimberlite.

REFERENCES

BREY, G.P. and NICKEL, K.G. (this volume). Experimental calibration of geothermobarometers in natural lherzolitic systems at high pressure.

BREY, G.P., Nickel, K.G. and Kogarko, L. 1986. Garnet-pyroxene equilibria in the system CaO - MgO - Al_2O_3 - SiO_2 (CMAS): prospects for simplified ('T-dependent') lherzolite barometry and an eclogite barometer. **Contrib. Mineral. Petrol.** 92, 448-455.

NICKEL, K.G. 1986. Phase equilibria in the system SiO_2 - MgO - Al_2O_3 - CaO - Cr_2O_3 (SMACCR) and their bearing on spinel/garnet lherzolite relationships. **N.Jb.Min. Abh.** 155 (2). In press.