GARNET-CLINOPYROXENE GEOBAROMETRY OF DEEP MANTLE ECLOGITES AND ECLOGITE PALEOGEOTHERM

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Eclogite xenoliths in kimberlites have been the subject of numerous investigations. Most of the xenoliths are clearly group A eclogites, as they were originally classified by Coleman et al. (1965). Statistic analysis for South African and Yakutian eclogites shows that amount of Ca-Ts molecule deckeases with depth (from diamond-free eclogites to diamond inclusions). Kyanite or corundum bearing eclogites show consistently the feature of excess Al^{IV} in clinopyroxene, which is interpreted as kyanite solid solution in clinopyroxene (Lappin, 1978) whereas in SiO_2 oversaturated eclogites Escoler molecule ($Ca_{0.5}AlSi_2O_6$) may play an important role (Wood & Henderson, 1978). That is why application of Ca-Ts barometer to these eclogite types is incorrect. Meanwhile the barometer could be applied to the main part of eclogite xenoliths and of African diamond inclusions.

Some models have been proposed to calibrate garnet-clinopyroxene barometer on the base of solubility Ca-Ts component in clinopyroxene coexisting with garnet. The availability of mineral data for all coexisting phases in the garnet stability field in CMAS system allows the calibration of a barometers based on a reaction :

$$\underset{\text{Gross}}{Ca_3Al_2Si_3O_{12}} + \underset{\text{Pyr}}{2Mg_3Al_2Si_3O_{12}} = \underset{\text{CaTs}}{3CaAl_2SiO_6} + \underset{\text{Cen}}{6MgSiO_3}\ .$$

An accuracy of this barometer was tested on the experimental data synthesized in the eclogite systems at temperatures 650-1700° C and pressures 20-100 kbar. Assuming normal distribution of all errors implies total uncertainty of ±27.5 %.

These method was used to determine formation conditions of eclogitic inclusions in diamonds, diamond-bearing and -free eclogites from kimberlite and lamproite pipes of South Africa, Yakutiya and Australia . The barometer gives a significantly lower T and P for the host eclogite than for the diamond (for the calculations data of Taylor et al (1996) were used). These could be the first real data on the differences in re-equilibration between the diamond inclusions and the rock xenolith. The most high P-T parameters were obtained from the calculations for Monastery and Argyle diamond inclusions.

There was an attempt to reconstruct eclogite paleogeotherms for Roberts Victor pipe on the basis of the temperature calculations only (Basu et al., 1986). P-T parameters of Roberts Victor eclogites were obtained by the same calculations, it shows that there are two P-T trends: the lower pressure-temperature (730-1150° and 19-53 kbar), which coincided essentially with the continental shield geotherm and "inflected" high pressure-temperature (1150-1550° and 53-70 kbar). These results confirm Basu et al. (1986) and MacGregor and Manton (1986) suggestion that there are two types of the Roberts Victor eclogites, which are derived from the lowest part of the lithosphere and the uppermost portion of the asthenosphere beneath southern Africa. Diamond-bearing eclogites is situated mainly on the boundary of these limbs and correspond to convective boundary layer beneath the conductive lid of the lithospheric plate.

By the .calculations it follows that eclogite crystallization in the mantle occurs at several levels of the depth from 20 up to 300 km. It's characterized by 2 main types of thermodynamic gradient, which reflects temperature growth with depth. The first one is characterized by the temperature growth of 13-19° per kbar (or 5-6° per km). The second one is more character for central parts of the cratons and reaches 35-39° per kbar (or 12-13° per km).

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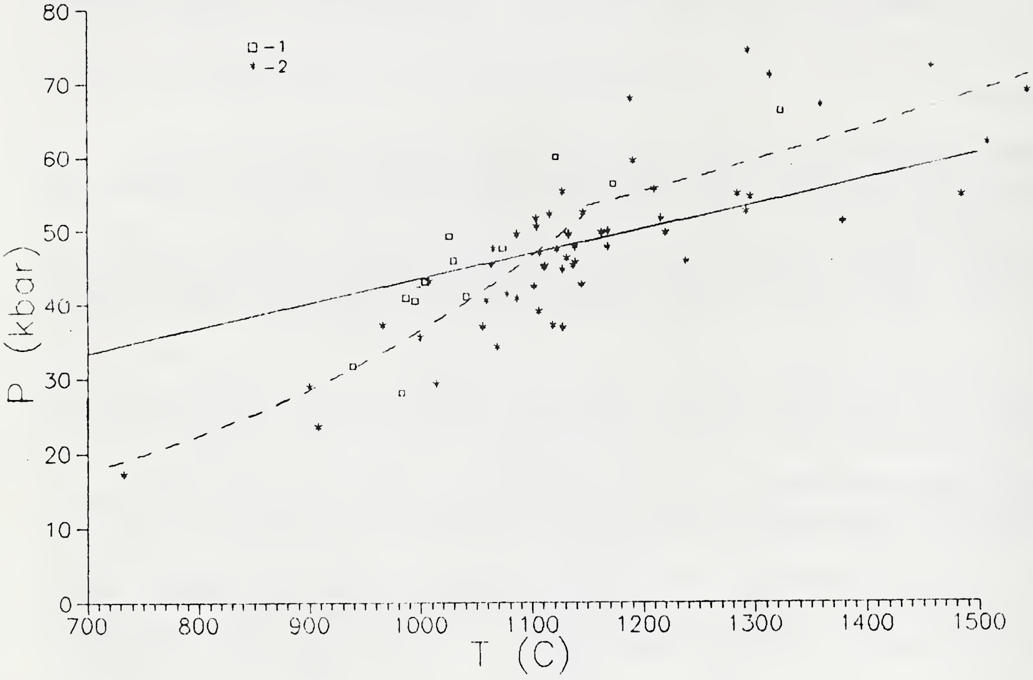

Pressure-temperature plot for eclogite xenoliths from Roberts Victor kimberlite pipe. For the estimations garnet-clinopyroxene thermometer of Ellis and Green (1979) was used, analyses for calculation were taken from (Bishop et al., 1978; Hatton & Gurney, 1979; Lappin & Dawson, 1975; MacGregor & Manton, 1986; O Hara et al., 1975; Reid et al., 1976). (a) Solid line - diamond-graphite transition curve, dashed lines - low- and high-temperature paleogeotherm limbs of the pipe, (1) and (2) - diamond-bearing and -free xenoliths correspondingly.