EVALUATION OF P-T CONDITIONS OF DIAMOND FORMATION WITH REFERENCE TO CHROME-BEARING GARNET STABILITY

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Among minerals included in diamond crystals chrome-bearing garnets are of special interest (Nixon et al., 1963, Sobolev, Sobolev,1967, Meyer,Boyd,1972, Sobolev,1974, Sobolev et al.1976) The experimental studies of the system:pyrope (Py)-grossularite (Gros)-knorringite (Kn)-uvarovite (Uv) at T=1200°C, P=30 kbar (Malinovsky et al., 1974) showed that the stability field of garnets is confined to the region of Py-Gros-Uv (Fig.1). The effect of T=1000-1500°C and P=25-50 kbar on chrome-garnet stability has been studied at the Py-Kn section (Malinovsky et al.1975). When T=1200°C the limiting Kn-component contents in garnets gradually increases from 3-4 mol % at P=25 kbar to 23-25 mol % at P=50 kbar. With rising temperature the solubility of Kn-component increases by 1-2 mol % for each 100°C. According to the preliminary experimental data obtained in the cubic apparatus (Ran, Malinovsky,1975) the limiting Kn-component contents in the garnets increases to 70-72 mol % at P=100 kbar and T=1300-1400°C (a_o=11.5602(6)Å, N=1.800(5), violet colour),while enstatite and Cr_2O_3 are formed instead of pure knorringite. Coesite and stishovite are present in the products of pyrophyllite decomposition enclosing the heating device from outside. At T=1000-1200°C knorringite has not formed even at P>150-160 kbar, which was controlled by the calibration point of ZnS (Yagi,Akimoto, 1976). However, it is not unprobable that the stability field of knorringite is situated in higher-temperature regions.

The stability of chrome-garnets contained in peridotite parageneses has been studied on harzburgite assemblage as an example Ga_{ss} + En_{ss} + Spl_{ss} + Fo in the system: MgO-Al_2O_3-Cr_2O_3 - SiO_2 (Malinovsky, Doroshev,1975). The Kn-component contents in garnets from this assemblage is by 1-2 mol % below compared to

the limiting garnets at equal T and P. The Cr-component of spinels increases with rising P but unlike in garnets it decreases with falling T (Fig. 2).

The experimental data provide a possibility to evaluate the P-T conditions of the diamond formation by composition of garnets and spinels included in diamond crystals. The Kn-component content in those garnets is usually within 15-50 mol % (Sobolev,1974,Sobolev et al.,1976). The harzburgite assemblage with garnet Py_{85} Kn_{15} together with diamond becomes stable beginning with 45 kbar (Fig.2). The admixtures of additional components up to 15-20% does not seem to affect significantly the stability of chrome-garnets. Therefore it may be concluded that the lower pressure limits of natural diamond crystallization do not usually drop lower than 45 kbar. The pressure above 75-80 kbar is required for Kn-richest garnets (40-50 mol %) to form at T=1200-1300°C. Thus the diamonds are formed in a very wide range of pressures Δ P=30-40 kbar. The spinels included in diamonds contain usually 80-90 mol % of Cr-component, which according to the plot of Fig. 2 corresponds to T=900-1100°C at P=40-80 kbar. These estimates,however, do not take into account the possible effect of Fe-component,whose contents in natural spinels sometimes attain 30-50 mol %.

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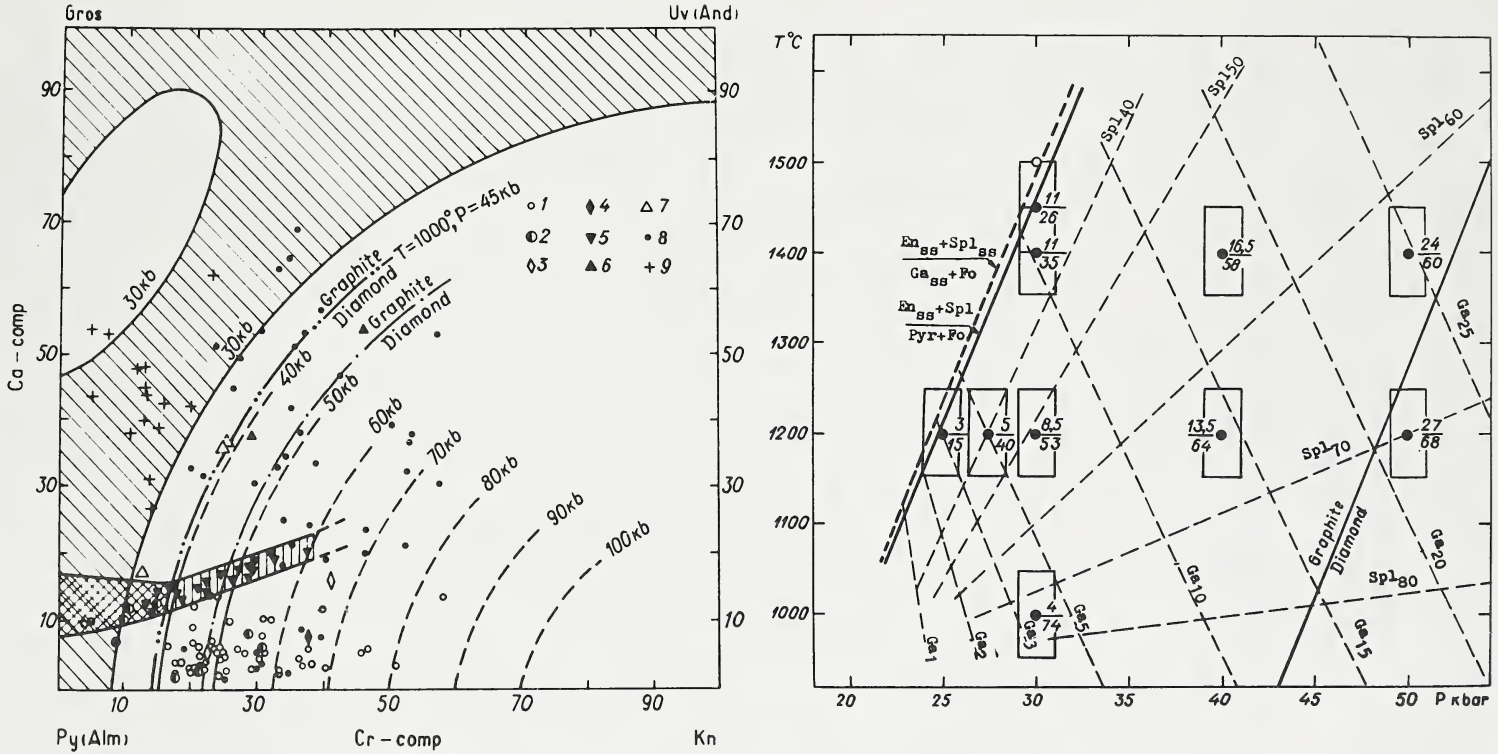

Fig.1. Compositions of chrome-bearing garnets from the kimberlitic pipes(after Sobolev, 1974,1976) and isobar position in the system:pyrope-grossularite-knorringite-uvarovite at T=1200°C. Garnets from: 1,7- diamonds; 2,3- intergrowths with diamonds; 4,5,6- peridotites; 8- kimberlitic concentrate, 9- grospydites and kyanitic eclogites.

Fig.2. Effect of P and T on garnet and spinel compositions from harzburgite assemblage Ga_{ss} + En_{ss} + Spl_{ss} + Fo of the systems $MgO-Al_2O_3-Cr_2O_3-SiO_2$. The numerator stands for knorringite contents in garnets, the denominator stands for chrome content in spinel.