PETROCHEMICAL AND THERMODYNAMIC EVIDENCE OF THE ORIGIN OF KIMBERLITES

L. L. Perchuk, V. I. Vaganov, J. P. Ilupin (Institute of Experimental Mineralogy, Academy of Sciences, Moscow, USSR).

The petrochemistry of kimberlites from Yakutia and Lesotho has been studied on a silicate melt model with the SiO_2, CO_2 and H_2O derivatives as the main anions.

The dissolution of H_2O in an ultramafic melt results in orthosilicates, ($H_2SiO_4^{2-}$, $H_2SiO_4^-$, H_4SiO_4 etc.) rather than metasilicates, while the dissolution of CO_2 produces additional hydrocarbonate complexes. At high $P^{fl}_{CO_2}$, and where the orthosilicic calcium salt clusters are present in the magma, the kimberlite melt can break down into carbonate and silicate liquids. Therefore, the composition of kimberlite magma will be determined by the H_2O/CO_2 ratio under the relatively constant fluid pressure. This can be seen from the distinct "fluid" trend in the H_2O--CO_2-SiO_2 diagram for the Yakutia and Lesotho Palaeozoic kimberlites. The H_2O/CO_2 ratio changes with the liquidus temperature along this trend (Perchuk a. Vahanov, 1977) which suggests that the liquation process predominates over the simple CO_2 solubility in the melts of kimberlite composition. The well-known Boyd's diagrams for the equilibrium PT-conditions in peridotites have been applied to natural Cpx and Opx, and the PT-parameters were correlated for peridotite inclusions in kimberlite pipes in Yakutia and Lesotho.

The liquidus temperatures for the extrapolated area of these correlations gave depths (pressures) at which kimberlite magmas are formed (200-250km).

The hypothesis on SiO_2 partitioning between the melt and the fluid was used to calculate the average composition of the dry initial kimberlite, which characterised the average mantle composition: SiO_2 - 45,12; TiO_2 - 2,49; Al_2O_3 - 3,58; Gr_2O_3 - 0.12; FeO - 9.32; MnO - 0.16; CoO - 0.11; MgO - 23.47; CaO - 13.44; Na_2O - 0.20; K O - 1.12; P_2O_5 - 0.69; S - 0.18; sum - 100 wt. %. This kimberlite is close to verlite in composition.