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P-T Equilibrium Conditions of Xenoliths from the Udachnaya Kimberlite Pipe: Thermal Perturbations in the Lithospheric Mantle

Nikolay Tychkov, Alexey Agashev, Elena Malygina, and Nikolay Pokhilenko
V.S.Sobolev Institute of Geology and Mineralogy, Novosibirsk, Russian Federation (tych@igm.nsc.ru, +7 (383)330-77-74)

Integrated study of 250 peridotite xenoliths from Udachnaya –East pipe show difference in mineral paragenesises and textural–structural peculiarities in the different level of cratonic lithosphere mantle (CLM). The compositions of minerals were determined using EPMA. Thermobarometric parameters (Brey, Kohller, 1990) were determined for all rocks occupying different fields on geothermal curve.
The deepest layer (the pressure interval of 5.0–7.0 GPa) contains mostly pophyroclastic lherzolites. Anyway, some rocks of this layer have an idiomorphic texture being also enriched in incompatible components.
Higher in the CLM sequence, the interval (4.2–6.3 GPa) is composed of the most depleted rocks: megacristalline ultradepleted harzburgite–dunites and depleted granular harzburgite–dunites, as well as lherzolites in a subordinate amount. They correspond strate to 35 mW/m2 and partly overlap the deeper layer in dapth. It is likely that rocks of this layer are in equilibrium and were not subject to significant secondary changes due to kimberlite magma intrusion. Thus, this interval of the CLM sequence reflects the true (relic) geotherm for the area of the Udachnaya kimberlite pipe. Moreover, it is obvious that this interval was a major supplier of diamonds into kimberlites of the Udachnaya pipe.
The interval of 4.2–2.0 GPa in the CLM sequence is also composed of coarse depleted lherzolites and harzburgites. Rocks of this interval are slightly more enriched than those of the underlying interval. This is confirmed by the distinct predominance of lherzolites over harzburgite–dunites. The heat flow in this layer varies in the range of 38–45 mW/m2 and shows a general tendency to increase with decreasing depth. According to occurrence of nonequilibrium mineral assemblages and increased heat flow relative to the major heat flow of 35 mW/m2, this interval is similar to the deepest interval of secondary enriched rocks.
Interval of less than 2.0 GPa composed of spinel lherzolites and harzburgites. The temperature range of stability of these rocks is 600–900oC (average 754oC) for the geotherm curve of 45 mW/m2.
The paleogeotherm obtained as a result of our study has a relatively complicated stepped structure. The geotherm knee in the deep part of the sequence, described for different regions, is connected with the temperature perturbations at the lithosphere–asthenosphere boundary.
The increased heat flow at the depth corresponding to a pressure of <4.2 GPa is rather unusual. It is obvious that it is not connected with deep processes on the CLM bottom. We assume, that thermal perturbations of this interval are due to large-scale crystallization and heating when going up silicate-carbonate kimberlitic magma reach the depth of peridotite+CO_2 solidus curve bend. 11-05-91060-PICS