Kimberlite parental melts: new insights from inclusions in olivine

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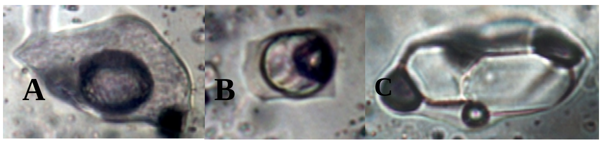
Diamond-bearing magmas that form kimberlites in intracratonic settings are widely believed to represent metasomatised lithospheric mantle sources. As such they may supply information on the processes of diamond formation and the composition and origin of deep-seated metasomatic agents. Despite significant efforts in studying kimberlitic rocks the composition of their parental magma remains largely unknown. This is hampered by several factors: large and variable amount of lithospheric and crustal xenoliths and xenocrysts in kimberlites, pre- and syn-eruptive degassing, and significant alteration. Alternative to whole-rock studies, the method of melt inclusions was applied to exceptionally fresh diamondiferous kimberlite collected from 550 m deep Udachnaya Eastern pipe, Russia.

Melt and associated fluid inclusions are abundant in both xenocrystic olivine-I and euhedral olivine-II and restricted to fractures and zones of decrepitation of precursor inclusions. Melt is mostly crystallised and contains deformed vapor bubbles. Heating experiments show that type-A melt inclusions (always irregular in shape) start melting at <300ºC and homogenise at 650-800ºC. These melts have extremely low viscosity and are not quenchable in homogeneous glass. Individual phases within these inclusions according to electron microprobe analysis are mainly chlorides, sulphates and carbonates of Na, K and Ca with minor amount of silicates (e.g. olivine and phlogopite) and oxides. Type-B melt inclusions (more regular in shape and hosted by olivine-II only) are characterised by variable starting melting temperatures (260-940ºC), and do not homogenise completely. At high temperatures these inclusions are represented by 1) homogeneous melt + large CO_2-rich bubble $\pm$ opaque phases (fig. A); 2) silicate melt with immiscible volatile-rich non-silicate globule (fig. B); 3) euhedral low Ca and high Ca pyroxenes crystals surrounded by a high silica silicate melt and high density CO_2 bubbles (fig. C). This study



demonstrates that during accent kimberlite parental melts evolve towards essentially non-silicate compositions via olivine crystallisation, melt immiscibility and melt-olivine reaction.

New insight into petrology, geochemistry and dating of the Vejen Pluton

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The Elatsite PGE-Au-Mo porphyry copper deposit in Bulgaria is genetically related to Late Cretaceous subvolcanic dykes, intruded into the host rocks of the Berkovitsa group (Cambrian) and in the granodoirites of Vejen pluton (Carboniferous). Petrology, geochemistry and isotopic age of the Vejen pluton is not well known, no matter that it is one of the important hosts of the ores.

The pluton consists of hornblende-biotite granodiorite and granite. Porphyritic varieties occur on some places, too. Mafic microgranular enclaves of gabbro and diorite are included often within the marginal part of the pluton. Aplitic veins and various dykes cut all intrusive rocks. The pluton is high-K, calc-alkaline, metaluminous to peraluminous and LILE enriched. Many peculiarities of the major and trace element variations are consistent with a fractionation. Geochemical variations (REE-patterns included) support the idea that granitoids of the Vejen pluton are derived from more primitive basic magmas. The existence of rough layering, mafic xenoliths, enclaves and cumulative packets of crystals and linear trends in the variation diagrams could serve as evidence to support also magma-mixing process. The applied discriminations are typical for volcanic-arc granites.

Rock paragenesis and mineral evolution are indicative of crystallization under moderate total pressure, high f_{O2}, high P_{H2O}, high activity of silica. The applied geothermometers and geobarometers yielded an estimation of the temperatures between 730º and 770ºC and depths of crystallization at ~18 km, ~15 km, ~13 km (Fig. 1). The subsolidus re-equilibrations are estimated at 2 kbar (~ 5 km) and at temperatures of about 600º C.

U-Pb dating on single zircons of the magmatic rocks from the pluton revealed an intrusion age of 314 ± 4.8 Ma for the granodiorite and a mantle contribution to its source.

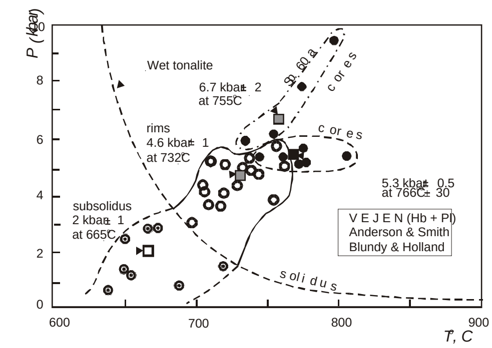

Fig.1. PT-conditions of crystallization