European Current Research on Fluid Inclusions (ECROFI-XXI)
Montanuniversität Leoben, Austria, 9–11 August, 2011. Abstracts, p. 18

Composition and evolution of magmas producing alkaline salic rocks (trachydacite and pantellerite) of the Dzarta Khuduk bimodal volcanic association, Central Mongolia

Andreeva, Irina A.

Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry Russian Academy of Sciences (Igem Ras), Staromonetny 35, 119017, Moscow, Russia

The composition, evolution, and origin of the melts that produced trachydacite and pantellerite of the Late Paleozoic bimodal volcanic association at Dzarta Khuduk, central Mongolia, were studied by examining melt inclusions with the use of electron microprobe and ion probe.

The Dzarta Khuduk magmatic complex in the western part of the Northern Gobi Rift Zone is restricted to a number of narrow grabens of latitudinal strike. The complex comprises alkaline granosyenite and nordmarkite of a small (~15 km^2) massif, alkaline granitoid and basalt dikes, and volcanic piles of basalt, trachydiorite, comendite, pantellerite, alkaline and subalkaline trachydacite, and their tuffs. The age of the complex was evaluated by U-Pb, Ar-Ar, and Rb-Sr techniques at 211 Ma. The volcanic fields have a complicated facies structure, primarily because of the local predominance of mafic or acid rocks, a fact suggesting that these sites were close to corresponding volcanic centres. The complex includes three ancient volcanos and corresponding isolated volcanic fields of Dzarta Khuduk, Unege Betogin and Ulziit.

One of the largest massifs of acid volcanics is Dzarta Khuduk paleovolcano, whose fragments occur over an area of more than 120 km^2. The bottom of the volcanic pile is not exposed, and judging by rock relations observable 1.5 km north of the volcanic field boundary, the lower portions of the vertical section most probably consist of basalt. The paleovolcano is made up of alternating alkaline trachydacite, comendite, pantellerite, their tuffs and ignimbrite. The volcanic pile has a thickness of 600 m and is cut by subvolcanic comendite bodies and agpaitic syenite massifs. The rocks of the paleovolcano are dominated by fluidal and eutaxitic lavas at subordinate amounts of ignimbrite; the lavas have aphyric or porphyritic textures and are often altered and silicified (mostly in the proximity of subvolcanic bodies). The mineralogical and chemical composition of the unaltered rocks corresponds to those of acid alkaline rocks of the K-Na series, with an agpaitic coefficient (Ka) > 1 and with elevated concentrations of F, REE, Rb, and Zr. Silicified lithologies are enriched in REE (up to a few mass%).

Primary crystalline and melt inclusions were found in anorthoclase from trachydacite and quartz from pantellerite and pantellerite tuff. The identified minerals of crystalline inclusions in the trachydacite are hedenbergite, F-apatite, and pyrrhotite, and those in the pantellerite are F-arfvedsonite, fluorite, ilmenite, and the rare REE diorthosilicate chevkinite. Melt inclusions in anorthoclase from the trachydacite consist of glass, a gas phase, and daughter minerals (F-arfvedsonite, fluorite, villiaumite, and anorthoclase as a rim on the walls of the inclusions). Melt inclusions in quartz from the pantellerite contain glass, a gas phase, and fine-crystalline salt aggregates of Li, Na, and Ca fluorides (griceite, villiaumite, and fluorite) (Andreeva et. al, 2007). To our knowledge, griceite has been reported in the literature only once from sodalite inclusions in hornfels of the Mont Saint-Hilaire massif, Quebec (Canada) (Van Velthuizen J., Chao G., 1989). Melt inclusions in clasts of quartz crystals from the pantellerite tuff are originally homogeneous silicate glasses.

The thermometry of melt inclusions in phenocrysts in the trachydacite and pantellerite indicates that they crystallized at temperatures of 1060 - 1030 °C. It was also determined that inclusions in quartz from the pantellerite show evidence of immiscibility between silicate and salt (fluoride) melts at a temperature of 800 °C.

Homogeneous melt inclusions in anorthoclase from the trachydacite have a trachydacite or rhyolite composition and contain 68 to 70 mass% SiO_2, 12 to 13 mass % Al_2O_3, 0.34 to 0.74 mass% TiO_2, 5 to 7 mass% FeO, 0.4 to 0.9 mass% CaO, 9 to 12 mass% Na_2O + K_2O at a agpaitic coefficient (Ka) = 0.92 to 1.24. The glasses of homogenized melt inclusions in quartz from the pantellerite and pantellerite tuff have a rhyolite composition. Compared to the glasses of melt inclusions in anorthoclase from the trachydacite, glasses of melt inclusions in quartz from the pantellerite are richer in SiO_2 (72 to 78 mass%) and poorer in Al_2O_3 (7.8 to 10.0 mass%). They contain 0.14 to 0.26 mass% TiO_2, 2.5 to 4.9 mass% FeO, 9 to 11 mass% Na_2O + K_2O, and 0.9 to 0.15 mass% CaO. The agpaitic coefficient is 1.2 to 2.05. Homogeneous melt inclusions in quartz from the pantellerite tuff contain 69 to 72 mass% SiO_2, and the concentrations of other major components, for example, TiO_2, Al_2O_3, FeO, and CaO, are close to the concentrations of these elements in the homogeneous glasses of melt inclusions in quartz from the pantellerite. The Na_2O and K_2O concentrations are 4 to 10 mass%, the agpaitic coefficient is 1 to 1.6.

The glasses of melt inclusions of each rock group have different concentrations of volatile components. Their H_2O concentrations are 0.08 mass% (in anorthoclase from the trachydacite), 0.4 to 1.4 mass% (in quartz from the pantellerite), and up to 5 mass% (in quartz from the pantellerite tuff). The F concentrations in glasses of melt inclusions in phenocrysts of the trachydacite are not higher than 0.67 mass%, and those in quartz form the pantellerite and pantellerite tuff reach 2.8 and 1.4 mass%, respectively. The Cl concentrations in glasses of melt inclusions in minerals in the trachydacite reach 0.2 mass%, and those in glasses in inclusions in quartz from the pantellerite tuff are up to 0.5 mass%.

The trace-element composition of the glasses and homogenized melt inclusions in minerals from the rocks suggests that trachydacite and pantellerite were produced by profoundly differentiated rare-metal silicate alkaline melts with high Li, Zr, Rb, Y, Hf, Th, U, and REE concentrations. The composition of homogeneous melt inclusions in minerals from the rocks provides an insight into the magmatic processes that led to concentrating trace elements (including REE) in the rocks. The leading role there in was played by the crystal fractionation and liquid immiscibility that involved salt (fluoride) melts. It was also determined that all of the melts underwent differentiation in spatially separated magmatic chambers, which predetermined differences in the evolution of the trachydacite and pantellerite melts. Late in the course of differentiation, when the magmatic systems were saturated in ore elements, salt Na-Ca fluoride melts were segregated and extracted much Li.

REFERENCES

Andreeva I.A., Kovalenko V.I., Yarmolyuk V.V., Listratova E.N., Kononkova N.N. (2007). *Doklady Earth Sciences.* 414 (4): 655-660.

Van Velthuizen J., Chao G. (1989). *Canadian Mineralogist.* 27: 125-127.