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Compositions of magmatic melts at formation of chemically heterogeneous rare-metal felsic dike in the East Kalguty dike belt (Gorny Altai, Russia)

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Introduction

East Kalguty dike belt is a part of Kalguty ore-magmatic system along with biotite granite pluton, leukogranite stocks and Mo-W ore deposit. The belt consists of more than a hundred dikes, extends by about 10-15 km and spatially overlaps with Mo-W hydrothermal vein stockwork. The ages of the dike rocks, determined by SHRIMP on magmatic zircon (200 Ma) are close to the Ar-Ar ages of hydrothermal mineralization (200-204 Ma). This makes an opportunity to consider the dikes as a manifestation of deep magmatic source of rare metals for the hydrothermal deposit.

According to Na_2O/K_2O ratio the dike belt rocks are traditionally divided into ongonites (Na-rich) and elvans (K-rich). In the majority of dikes concentrations of Li are higher than 100 ppm with elevated amounts of Cs, Rb, Ta and Nb. Unlike typical Li-F granites and ongonites these rocks are low in F (0.3 – 0.4 mass%) and enriched in P (up to 0.4 mass% P_2O_5). One dike in the axial part of the belt differs from others by extreme enrichment in rare alkalis (up to 2500 ppm Li, 1050 ppm Cs and 1700 ppm Rb) and P (up to 0.79 mass% P_2O_5). The rocks of this dike show strong heterogeneity in Na_2O/K_2O ratio and appeared to belong both to ongonites and elvans. Elvan part of the dike is depleted in rare lithophyle elements compared to the ongonite one. No petrographic evidences for greisenization process were recorded. Such coexistence of K-rich and Na-rich magmatic rocks within the same magmatic body is unusual in nature. In this work the study of melt inclusions in quartz phenocrysts was aimed at the chemical features of melts, which are parental for chemically heterogeneous magmatic body.

Melt and fluid inclusions

Quartz phenocrysts from ongonite and elvan portions of the dike contain numerous fluid (FI) and melt (MI) inclusions. MI are filled with aggregate of daughter crystals and fluid segregation which typically is distributed within interstices between crystalline phases. Mica (muscovite), feldspars, apatite and monazite were identified among crystalline phases in MIs before heating (Fig.1a). Primary aqueous FI that appear in the same part of crystals with MI are believed to represent the fluid phase, coexisting immiscibly with the melt when quartz phenocrysts were growing.

The entrapment temperature for melt inclusions was estimated within 600-670 °C after their heating in autoclave under external D_2O pressure 1-3 kbar. After the high temperature exposure inclusions were quenched along the isochore. Quenched inclusions were checked for leak-tightness by FTIR spectroscopy within D-O vibration region.

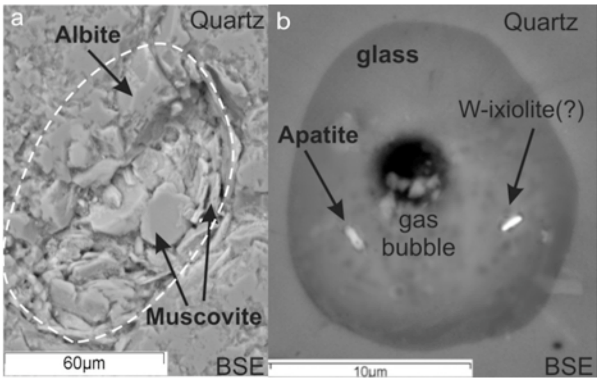

Fig.1. (a) Melt inclusion before heating. Dash line marks border of inclusion. (b) Melt inclusion after heating under 640 °C and 1 kbar.

The heated inclusions contain transparent silicate glass, sometimes with remnants of crystalline phases (muscovite, feldspar, apatite, Fe-Ti and

Ta-Nb oxides) and fluid bubble (Fig.1b). Homogeneous glasses were studied by EMPA and SIMS analyzes.

The quench glasses of MI show major element compositions typical for granites: SiO_2 70-74 mass%, Al_2O_3 12.3-13.5 mass%, total alkali 6.0-6.6 mass%. The silica, alumina, P and F contents in general are comparable with concentrations in the dike rocks. Alkali contents are somewhat lower than in the rock. It is important to note that Na_2O/K_2O ratio of the quenched glasses is close to 1. The MI glasses in elvan and ongonite quartz phenocrysts are comparable in K_2O content but elvan MIs are depleted in Na_2O. F and P contents in elvan MIs are higher than in ongonite MIs. Mis from elvan quartz have lower totals, suggesting possible higher water contents in comparison to ongonite melts.

Trace element analyzes shows that MI glasses are enriched in Li (350-500ppm), Rb (300-400 ppm), Cs (30-130 ppm), Ta (2-8 ppm) and Nb (7-35 ppm). However, it is easy to see that MI glasses are depleted in rare lithophyle elements in comparison with the host rocks. On the other hand concentrations of these elements in the MI glasses from both types of rocks are similar.

Discussion

The data obtained on melt inclusions show that compositions of entrapped melts differ from compositions of the rocks. This suggests that the dike and inclusions represent different stages of evolution of magmatic source, which produced East Kalguty dike belt. In the previous study it was shown that quartz phenocrysts from the dike belt rocks crystallized from the water-saturated rare-metal felsic magma in the chamber that was located at the level of the bottom part of the Kalguty biotite granite pluton (Sokolova et al., 2011). Quartz phenocrysts from the studied dike have similar crystallization T-P range. Primary fluid inclusions that accompany the studied melt inclusions indicate that crystallization of quartz proceeds in the system where water-saturated silicate melt coexisted with aqueous fluid. Thus we suggest that despite the composition difference the rare-element-enriched dike originated from the same magmatic source as for other dikes in the belt. This is supported by large overlaps between MI compositions from quartz in the studied dike and from other dikes showing less enrichment in rare elements. The depletion of MIs in rare elements compared to the bulk rock suggests that the studied inclusions do not represent the primitive melts. Some elements like Ta and Nb can be extracted from initial melt by crystallization of Ta-Nb oxides, while other like Li and Cs may not reach high concentration levels at the quartz phenocryst crystallization.

On the basis of the studied MI compositions one can come to the conclusion that the difference between ongonite and elvan melts already existed at the quartz phenocryst crystallization. The most important differences between MI and the bulk rock composition are in the K-content and Na/K ratio. Elvans are more enriched in K_2O than MI. There are no reasonable ways for K enrichment of the residual melts, as K-feldspar and muscovite exist as phenocrysts in the rocks. Thus we should suggest K enrichment in the course of process, which took place after the MI entrapment and before solidification of dikes.

The most possible agent for K enrichment is a fluid phase which coexists with the melt in the magmatic source. However, the absence of evidences for greisenization leads us to conclude that K enrichment occurred as a result of element exchange between aqueous fluid and crystallizing felsic melt. High viscosity of the felsic melt and fast crystallization prevented uniform change of the melt composition within the dike. This resulted in formation of K-rich elvan portions, slightly depleted in rare-elements from strongly altered melt and Na-rich ongonite portions enriched in rare-elements from less altered melt.

Conclusion

The formation of chemically heterogeneous ongonite-elvan dike strongly enriched in rare elements occurred from magmas, which originated from the same source, but were subjected to interaction with K-rich fluid before solidification.

REFERENCES

Sokolova E.N., Smirnov S.Z. Astrelina E.I., et al (2011). *Russian Geol. and Geoph.* (in press).

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