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Boundary layer contribution to the composition of melt inclusions in olivine

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Problem

Melt inclusion studies are based on the assumption that the composition of the inclusion is representative of a significant amount of melt in the plumbing system rather than some small and specific heterogeneous portions, such as a boundary layer (BL) around the crystal. Based on the study of olivine-glass interfaces in naturally quenched basaltic glasses, we have previously shown that natural olivines are surrounded by 1-3 micron wide layers which possess significant relative enrichment in incompatible elements, increasing in the following order: Ca, Ti, Al, Na, K [1]. It was demonstrated that elemental ratios (e.g. Al/Ca) could be used as powerful criteria to test the potential effect of BL entrapment on the composition of melt inclusions in olivine. Using these criteria in this paper we estimate the maximal size of melt inclusions in olivine phenocrysts whose composition has been affected by BL effects.

Results

The composition of a few thousand melt inclusions in olivine phenocrysts from Icelandic basalts and picrites ranging in size from 3 to 300 micrometers were analyzed by JEOL 8200 electron microprobe. Special emphasis has been placed on obtaining a high external precision of measurements. Data suggest that the main process that modifies the composition of melt inclusions is extensive crystallization of olivine on the inclusion walls. The smallest inclusions are mostly affected by this process. This process could easily be reversed by numerical modeling. Non reversible effects are indicated by elevated Al/Ca and Na/Ca ratios in melt inclusions less than 10-15 micrometers in size. Modeling shows that this effect could be accounted by trapping of a submicron BL. The thicker (1-3 micrometers in size) BL surrounding naturally quenched olivines could therefore be the result of fast olivine crystallization during slow quenching.

Conclusion

We conclude therefore that melt inclusions in olivine larger than 20 micrometers are almost free of BL effects and in this respect do represent parental melt of growing crystals.

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Timing of metamorphic history- the Lapland Granulite and the Tanaelv belts: U-Pb and Sm-Nd data

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In order to compare an evolution of metamorphism in the Lapland granulite belt (LGB) and the Tanaelv belt the boundary zone of these two structures - Yavr - Pados rivers district (Kola Peninsula, Russia) was studied. U-Pb and Sm-Nd dating was carried out for samples which provide information on metamorphic pressure and temperature [1,2]. Main attention was paid to the Korvatunturi sequence distinguished within the Tanaelv belt, which is less studied geochronologically. U-Pb zircon (2.1 Ga) and Sm-Nd model ages (2.32-2.61 Ga) of felsic and mafic metavolcanics indicate Palaeoproterozoic age of the Korvatunturi sequence. Sm-Nd model ages of metasediments range from 2.90 to 3.33 Ga and testify to Archaean age of terrigenous material source - probably Belomorian granito-gneisses [2]. Schists of the Korvatunturi sequence recorded progressive and regressive stages of metamorphism [1,2], while only regressive metamorphism (2-4 stages, according to different authors) is established in LGB and the Tanaelv belt. The peak of granulite metamorphism is estimated at 1925±1 Ma in LGB [3] and is limited by an interval 1945 -1928 Ma in the Tanaelv belt. Sm-Nd age of an early stage of progressive metamorphism in the Korvatunturi sequence is 1940±34 Ma. Culmination of this metamorphism (T_{max}=650°C, P=7.5 kb) was between 1940 and 1917 Ma. U-Pb study of metamorphic zircons and Sm-Nd dating of minerals from LGB and the Tanaelv belt show, that the cooling and decompression caused by starting uplift occurred at 1918-1912 Ma. The next stage of metamorphism in LGB and the Tanaelv belt happened in the period of 1909-1902 Ma (U-Pb zircon ages). Regressive stage of metamorphism in the Korvatunturi sequence is dated with high uncertainty - 1868±82 Ma (Sm-Nd). But it is clearly seen that metamorphic stages in LGB, Tanaelv and Korvatunturi sequence are synchronous. This is in accordance to the conclusion [1] that there is the causative connection between immersion and following uplift of the Korvatunturi sequence within the Tanaelv belt and exhumation of LGB.

References

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