Melt inclusions and host olivines: What do they tell about mantle processes and sources?

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Host olivines and magmatic (melt and fluid) inclusion studies have had significant impact on petrology and geochemistry of mantle-related igneous processes in recent years. This includes better understanding of melting processes, source heterogeneities, and volatile contents of parental melts. At the same time, new results have shown possible processes (such as magma mixing and interaction with crustal materials) which appear to compromise the idea that melt inclusions represent simple primary liquids (e.g. Danyushevsky *et al*, 2003). Here I present a summary of last 5 years studies of our group concerning compositions of melt inclusions and host olivines from the mantle plume, LIP and MOR environments.

Melt inclusions in olivines are likely trapped during relatively fast growth of crystals in the environments of significant temperature and (or) compositional gradients such as magma mixing. Compositional variability of melt inclusions far exceeds variability of lavas representing end-members commonly present in bulk rock in highly attenuated form. Melt inclusions of variable compositions coexisting in a single olivine phenocryst are often trapped sequentially at different depths. This suggests complicated multistage crystallization and trapping process rather then nearly simultaneous trapping of locally heterogeneous melts.

Data suggest that each volcanic plumbing system or particular lava represents dynamic mixing of numerous parental melts and products of their fractionation and (or) interaction with crystal mashes and melts in shallow conduits. Some inclusions approach primary melt compositions much better then any studied rocks. These inclusions show extreme compositional ranges far exceeding those of bulk surface lavas. They are usually trapped in the earliest crystals formed in the deepest parts of plumbing system. The compositional and isotopic ranges of the recovered parental melts suggest highly efficient open system melting; fast melt transport and compositional heterogeneity of mantle sources in all volcanic environments studied so far. In particular the concentrations of Mn, Ni, Ca, Zn and Sc of early olivine phenocrysts from wide range of mantle derived magmas are not consistent with common peridotitic source and suggest significant amount olivine-free hybride pyroxenite source formed by melting and reaction of recycled crustal component in the convecting mantle (Sobolev *et al*, 2005, 2007).

References

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Recycled oceanic crust as a source of Siberian flood basalts

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Recent study (Sobolev *et al*, 2007) has shown that Gudchikhinskaya suit (Gd2) from the base of Siberian flood basalts in Norilsk region likely formed by melting of olivine-free hybrid pyroxenite, produced by reaction of melts from recycled crust and peridotite. Here we present new data on major and trace element compositions and volatile contents in parental melts for Gd2 basaltic suit recovered from the study of homogenised melt inclusions in olivine phenocrysts by EPMA, LA-ICP MS and SIMS. We show that the composition of trapped melt varies from similar to tholeiitic OIB (e.g. Mauna Loa, Hawaii) with notable depletion in Pb, U, Th and Rb to those enriched in these elements (Fig.1). Abundances of these elements correlate with concentrations of Si, K (positively) and Nb, Ti (negatively). This suggests significant contamination of melt by continental crust during magma fractionation. All melts are severely undersaturated by S and contain low water concentrations.

The composition of melts unaffected by crustal contamination indicate oceanic crustal component. This suggests that the recycled oceanic crust was a major source of Siberian flood basalts at the initial stage of LIP formation.

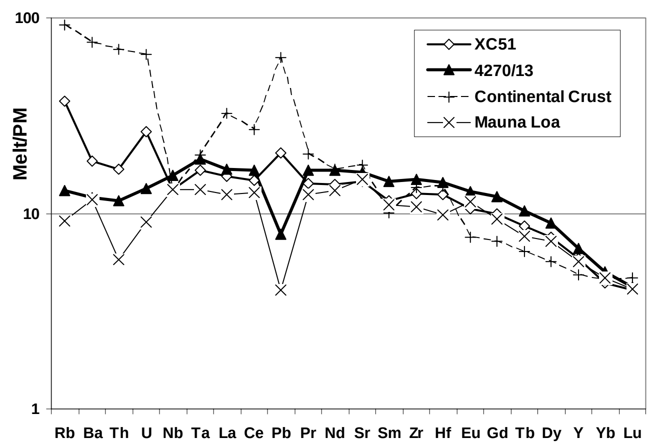

Figure 1:. Average compositions of melt inclusions in olivine from Gd2 picrites (2 samples) compared with continental crust (Rudnik, 2003) and typical Mauna Loa melt (Sobolev *et al*, 2005) normalized to primitive mantle (Hofmann, 1988).

References

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