Geophysical Research Abstracts, Vol. 7, 09364, 2005
SRef-ID: 1607-7962/gra/EGU05-A-09364

Recycled materials in mantle plumes and LIPs: evidence from olivine phenocrysts

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Quantitative estimates of the proportions of recycled crust in mantle plumes are commonly based on incompatible trace elements and isotope ratios in OIB. This approach is significantly compromised by the great variability of subducted materials and involved fractionation processes. An alternative approach is to use major elements and compatible trace elements, because these are more uniform in the mantle and are strongly controlled by the phase petrology of melting. Specifically, we show that the deep melting of typical recycled oceanic crust and reaction of melt with peridotite produces olivine free secondary pyroxenite rich in Ni, Mg and Si. Melting of this pyroxenite in the absence of residual olivine creates parental melts enriched in Ni, Si and having elevated Mn/Fe ratios. Here we propose the use composition of early olivine phenocrysts, and especially their Ni, Mn and Fe contents, together with the composition of melt inclusions to identify this component and thus to constrain the amount of recycled oceanic crust in a variety of mantle plumes and LIPs.

We show that secondary pyroxenite sources are visible in all tested mantle plumes emplaced beneath thick lithosphere (>90-100 km): e.g. Hawaii, E. Siberian LIP, W.Greenland, Gorgona, Canaries. In contrast, a secondary pyroxenite source is nearly invisible in mantle plumes emplaced beneath thin lithosphere (e.g. Iceland, Azores, Detroit seamount) and typical MORB. On Hawaii and in the Siberian Flood Basalt province, melting of secondary pyroxenite generates the largest fraction of the bulk lava production, indicating high amounts of recycled oceanic crustal component (over 20%) in the plume. This high amount of recycled component may be an important reason for the extreme magma production rates of these plumes.