

5.1.P08

Chlorine in oceanic intraplate basalts: Constraints on mantle sources and recycling processes

N. A. STRONCIK AND K. HAASE

Institut für Geowissenschaften, Universität Kiel, Olshausenstr. 40, D-24118 Kiel (nst@gpi.uni-kiel.de; kh@gpi.uni-kiel.de)

The investigation of volatile elements in magmatic systems is of primary importance, because magmatic volatiles not only influence mantle melting, magmatic crystallisation and volcanic eruptions, but they also have a strong impact on the Earth's exosphere. In this context the magnitude of Cl-recycling into the mantle via subduction of altered oceanic lithosphere and its impact on mantle geochemistry still remains a matter of debate. We present a detailed geochemical investigation of a suite of undegassed and uncontaminated oceanic intraplate basalt glasses from the St. Helena, Society, Macdonald, Pitcairn, Reunion, Azores, Easter and Foundation Hotspots, representing different mantle endmembers, such as EM1 and EM2 (enriched mantle) and HIMU (high $^{238}\text{U}/^{204}\text{Pb}$). The enriched mantle endmembers are thought to contain either recycled sediments or continental lithospheric mantle, whereas HIMU is generally believed to form from parts of the subducted altered basaltic oceanic crust.

As Cl is quite susceptible to changes induced by magmatic degassing or assimilation of altered oceanic crust during magmatic evolution Cl/K-ratios, K exhibiting the same behaviour during magma generation and evolution as Cl, rather than Cl-concentrations are used to determine Cl behaviour. Our results show that both, the Cl inventory of the mantle as well as the mantle Cl/K, are variable. In general EM-type basalts have lower Cl/K (around 0.02) and seem to contain less Cl than the basalts derived from a common mantle source (e.g. FOZO) or a HIMU-type source. HIMU-type basalts generally have higher Cl/K (around 0.08) than those associated with a common mantle source, which exhibit Cl/K around 0.04 to 0.05. As the Cl/K of average depleted mid-ocean ridge basalt (MORB) is considered to be around 0.01 [1], the high mantle Cl/K observed in oceanic intraplate basalts demonstrate that a significant amount of Cl is recycled into the deep mantle, although Cl is also driven out of the slab during subduction, as shown by high Cl/K of island arc lavas. The differences in Cl/K observed between the various mantle components also show that the quantity of Cl recycled into the mantle via subduction is not uniform and that the recycling of Cl in general is depending on the parameters influencing the subduction process itself, e.g. alteration stage of the oceanic crust, subducted material, subduction velocity.

References

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5.1.P09

Two low- μ components in the Iceland mantle plume

A.C. SKOVGAARD

Geological Museum of Copenhagen; Øster Voldgade 5-7, DK-1350 Copenhagen K (acs@savik.geomus.ku.dk)

New Pb isotope data on strongly LREE depleted High MgO lavas from Theistareykir and Reykjanes show a larger variability in $\Delta 7/4\text{Pb}$ (+0.1 to - 4.7) at a certain $^{206}\text{Pb}/^{204}\text{Pb}$ ratio than previously reported for Icelandic lavas. The Pb isotope data are mass fractionation corrected by a double spike method [1] and have similar precision and accuracy to that of Thirlwall [2]. The higher resolution in Pb isotopes at low $^{206}\text{Pb}/^{204}\text{Pb}$ indicates the presence of an ancient low- μ component to explain the large variability in $\Delta 7/4\text{Pb}$.

Two low- μ components are proposed, whereof one have strongly negative $\Delta 7/4\text{Pb}$ and positive $\Delta 8/4\text{Pb}$ and is similar to Archean Granulite Facies gneiss. The other low- μ component has both positive $\Delta 7/4\text{Pb}$ and $\Delta 8/4\text{Pb}$ and is interpreted to represent ancient recycled pelagic sediments. A maximum recycling age is constrained from the Pb isotopic signature of basalts from Örefajökull [3], which show the highest $\Delta 7/4\text{Pb}$ and $\Delta 8/4\text{Pb}$ values on Iceland.

The effect of admixture of the proposed low- μ components is illustrated in a four component mixing scenario, with recycled depleted oceanic lithospheric mantle (harzburgite) and a plume component as defined in Hanan *et al.* [4] being the major constituents of the mantle source. Mixing calculations indicates a total of <0.2% of the proposed low- μ components in the mantle source which gives similar mixing proportions for $^{206}\text{Pb}/^{204}\text{Pb}$, $^{207}\text{Pb}/^{204}\text{Pb}$ and $^{208}\text{Pb}/^{204}\text{Pb}$ ratios.

Systematic co variations between Pb isotopes and other isotope ratios ($^{87}\text{Sr}/^{86}\text{Sr}$, $^{143}\text{Nd}/^{144}\text{Nd}$, $^{187}\text{Os}/^{188}\text{Os}$, $\delta^{18}\text{O}_{\text{olivine}}$) and trace elemental ratios (Sr/Sr*, Eu/Eu*, Ce/Pb, La/Nb, Zr/Nb, Ba_N/Th_N) support the identities of the proposed low- μ components.

The higher resolution of Pb isotopes in this sample collection possibly reflect that the small volume lavas from Theistareykir and Reykjanes escaped homogenization in the crust before emplacement.

References

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