

Hf and Pb isotope systematics in basalts from the Iceland Neovolcanic Zones

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As part of a comprehensive Hf-Pb-Sr-Nd isotope and geochemical study of the nature and origin of the Iceland mantle plume, we report new Hf and Pb isotope ratios for fifty relatively primitive basalts from central Iceland and the three Neovolcanic Zones (NZ, <700 ky), along with one hundred Lu/Hf, Sm/Nd, Th/U, U/Pb and Rb/Sr parent/daughter (P/D) ratios. Previously reported Pb-Sr-Nd isotope data on the same samples have indicated that variations in these basalts are the result of ternary mixing between DMM, an enriched C-type component, considered to represent the Iceland plume, and an EM-I type component, predominantly detected in the NE-NZ, whose origin remains uncertain and debatable.

ϵ_{Hf} is well correlated with Pb-Sr-Nd isotope ratios. Of these four isotope systems $^{176}\text{Hf}/^{177}\text{Hf}$ best reveals, and without overlap, the following petrologic types of Iceland basalts: picritic basalts from Central Iceland have the highest ϵ_{Hf} (+17.5 to +17.7), tholeiites from the SW-NZ, SE-NZ and NE-NZ have intermediate ϵ_{Hf} (+13.1 to +16.8), and alkali basalts from the SE-NZ have the lowest ϵ_{Hf} (+10.3 to +11.5). In ϵ_{Hf} vs. Pb, Sr and Nd isotope space, alkali basalts from the SE-NZ form a distinct group showing no overlap with tholeiites and picrites. For a given ϵ_{Hf} , tholeiites from the SE-NZ, NE-NZ and Central Iceland's eastern part clearly have lower $^{206}\text{Pb}/^{204}\text{Pb}$ than tholeiites from the SW-NZ and its extension over Central Iceland's western part. This geographic distinction is not apparent in Hf-(Sr,Nd) and Pb-Sr-Nd isotope spaces.

In isochron diagrams, P/D ratios show considerably more overlap between the petrologic basalt types and between the Neovolcanic Zones, Sm/Nd and Rb/Sr the most, Th/Pb the least, thus reflecting the difference in degree of incompatibility between parent and daughter. The challenge will be to sort out factors related to partial melting conditions during the formation of these basalts (i.e. thermal effects) from P/D signatures of possible recycled lithologic units preserved in and inherent to the Iceland mantle plume.

Constraints on melting and osmium isotopic sources in the ophiolitic upper mantle: evidence from Ru-Os sulfides and Os-Ir-Ru alloys

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Primary Os-rich platinum-group minerals (PGM) (e.g., laurite-erlichmanite series ($\text{RuS}_2\text{-OsS}_2$) and Os-Ir-Ru alloys) are potentially the best tracers of mantle melting events, which may be unequivocally recognised during ultramafic protoliths formation. The advantage of the Re-Os system, applied to Os-rich minerals, is that PGM contain Os as a main or trace element, while at the same time almost lack Re. This feature permits accurate initial Os isotope ratios to be determined, assuming that the Os isotopic composition of PGM has not changed after their formation and, therefore, reflects that of the source.

The extensive data set of bedrock and detrital PGM grains from Early Palaeozoic and Late Proterozoic ophiolite complexes (the Speik Complex, Austria and the Kunar Complex, Russia, respectively), permits, for the first time, the evaluation of Os isotopic composition of Ru-Os sulfides and Os-Ir-Ru alloys by (1) laser ablation (LA) attached to multiple collector inductively coupled plasma mass spectrometry (MC-ICP-MS) and (2) negative thermal ionization mass spectrometry (NTI-MS).

Ru-Os sulfides of podiform chromitites from ophiolitic mantle sections at Kraubath and Hochgrössen (Speik Complex) are characterised by 'unradiogenic' $^{187}\text{Os}/^{188}\text{Os}$ and $\gamma_{\text{Os}(T=0)}$ values, indicative of a subchondritic mantle source of PGE. These values yield a very wide range of $^{187}\text{Os}/^{188}\text{Os}$ (0.1158 ± 0.0015 to 0.1244 ± 0.0005 , $n=18$, NTI-MS and LA MC-ICP-MS data) and $\gamma_{\text{Os}(T=0)}$ (-9.08 to -2.35), which is almost identical to Os isotopic composition of detrital Os-Ir-Ru alloys (NTI-MS data, $n=19$) derived from the Kunar Complex (Taimyr Peninsula, Russia). These results are consistent with the model involving a prolonged melting-event history of parent ultramafic source rocks in the residual mantle.

In contrast, Ru-Os sulfides from banded chromitite, which has been recognised closely above the typical mantle section at Kraubath, show high $^{187}\text{Os}/^{188}\text{Os}$ (0.1308 ± 0.0001 to 0.1321 ± 0.0006) and γ_{Os} (2.70-3.73) values, indicative of a suprachondritic source of PGE. This signature is interpreted as an evidence of a 'radiogenic' crustal component, which was introduced during a subduction-related event.

The high Os-isotopic heterogeneity obtained imply that comprehensive sets of Os isotope data can only provide a valid understanding of Os-isotopic behaviour in the ophiolitic mantle. Therefore, a restricted number of Os-isotope analyses should be treated with caution. Os isotopic composition of PGM can be employed to test the validity of various petrological models.