Os-He isotope systematics of Iceland picrites: Evidence for a deep origin of the Iceland plume

ALAN D. BRANDON[1], DAVID W. GRAHAM[2], TOD WAIGHT[3] AND BJARNI GAUTASON[4]

[1]NASA, Johnson Space Center, Houston, TX 77058, USA (alan.d.brandon@nasa.gov)
[2]College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR 97331
[3]Geological Institute, Øster Voldgade 10, 1350 Copenhagen K, Denmark
[4]Orkustofnun and University of Akureyri, Rangarvellir, P.O.Box 30, 602 Akureyri, Iceland

Recent work on the origin of the Iceland hotspot suggests that it may result from upwelling upper mantle material rather than a deep plume. To constrain the depths of origins of Iceland mantle sources, Os and He isotope systematics were obtained on a suite picrites that span the compositional range observed within the neovolcanic zones.

The Iceland picrites display a range in $^{187}Os/^{188}Os$ from 0.1297 to 0.1381 (g_{Os} = 0.0 to 6.5) and uniform $^{186}Os/^{188}Os$ of 0.1198375±32 (2s). The value for $^{186}Os/^{188}Os$ is within uncertainty of the present-day value for the primitive upper mantle of 0.1198398±16. These Os isotope systematics are best explained by ancient recycled crust or melt enrichment in the mantle source region. If so, then the coupled enrichments displayed in $^{186}Os/^{188}Os$ and $^{187}Os/^{188}Os$ from lavas of other plume systems must result from an independent process, the most viable candidate at present remains core-mantle interaction. While some plumes with high $^{3}He/^{4}He$, such as Hawaii, appear to have been subjected to detectable addition of Os (and possibly He) from the outer core, others such as Iceland, appear to have not.

A positive correlation between $^{187}Os/^{188}Os$ from 0.1297 to 0.1381 and $^{3}He/^{4}He$ from 9.6 to 19 R_A in Iceland picrites is best modeled as a two stage process. In stage 1, 500 Ma or older ancient recycled crust is mixed with a primitive-like mantle for Os and He systematics, creating a hybrid source region. In stage 2, the hybrid source mixes with the convecting MORB mantle during ascent and melting. This multistage mechanism to explain these isotope systematics is consistent with ancient recycled crust juxtaposed with more primitive, relatively He-rich mantle, in convective isolation from the upper mantle, most likely in the lowermost mantle. This is inconsistent with models that propose random mixing between heterogeneities in the convecting upper mantle as a mechanism to explain the observed isotopic variation in oceanic lavas or models that produce a high $^{3}He/^{4}He$ signature in melt depleted and strongly outgassed, He-poor mantle. Instead these systematics require a deep mantle source to explain the $^{3}He/^{4}He$ signature in Iceland lavas.

The lack of a resolvable seismic signature of conduit-like plume flow under Iceland at some depths may result from sporadic flow of material from depths near the core-mantle boundary, consistent with recent dynamical models (Farnetani and Samuel, 2005, *GRL* **32**, L07311).

Modelling of phase diagrams for migmatitic paragneisses of the Epupa Complex, NW Namibia

SÖNKE BRANDT[1] AND REINER KLEMD[2]

[1]Universität Würzburg, Institut für Mineralogie, Am Hubland, D–97074 Würzburg (brandt@min.uni-kiel.de) present address: Universität Kiel, Institut für Geowissenschaften, Ludewig-Meyn-Str. 10, D-24118 Kiel
[2]Universität Würzburg, Institut für Mineralogie, Am Hubland, D–97074 Würzburg (reiner.klemd@mail.uni-wuerzburg.de)

Mesoproterozoic (1.37-1.32 Ga) migmatitic metapelites and metagreywackes (Orue Unit) of the Epupa Complex, NW Namibia, record several melt-producing reactions. Partial melting of the paragneisses and the evolution of their mineral assemblages can be adequately interpreted by calculated phase diagrams in the Na_2O-CaO-K_2O-FeO-MgO-Al_2O_3-SiO_2-H_2O (NCKFMASH) system. The development of the different observed mineral assemblages reflects variations of the bulk-rock composition but also indicates regional differences in the metamorphic grade between the various structural parts of the Orue Unit. The evolution of the mineral assemblages is interpreted in terms of simple heating-cooling *P-T* paths at different crustal levels: early mineral assemblages of Bt-Sil-Qtz in the metapelites and of Bt-Qtz in the metagreywackes, preserved as mineral inclusions in peak-metamorphic porphyroblasts, break down via melt-producing reactions to higher-temperature garnet-bearing and/or cordierite-bearing assemblages under upper-amphibolite facies conditions. According to the calculations, melting occurs at uniform temperatures of 650-700°C, close to the thermal peak of metamorphism. The relatively Fe-rich (*X*Mg: 0.36-0.28) cordierite-bearing metapelites with or without garnet which are restricted to the northern part of the study area equilibrated at peak-temperatures of 700-750°C and low pressures of 3-4 kbar as constrained from geothermobarometry and calculated mineral isopleths. The slightly more magnesian Grt-Bt-Sil gneisses (*X*Mg: 0.43-0.32) which are exposed in the southern part of the study area record similar peak-temperatures (670-750°C) but higher pressures of 5.5-6.5 kbar. Retrograde back-reactions between restite and *in situ* crystallising melts are recorded by the replacement of garnet by Bt-Sil (Al-rich samples) and/or Bt-Ms intergrowths (Al-poor samples).

The P-T paths are interpreted to result from a regional scaled thermal perturbation of the normal geotherm in mid-to upper crustal levels induced by magmatic accretion of mantle-derived melts. This process is presumably related to the emplacement of the c. 1.38 Ga anorthositic Kunene Intrusive Complex. A contact metamorphic overprint is restricted to a narrow reaction zone along the margin of the Kunene Intrusive Complex and is recorded by highly aluminous metapelitic Grt-Crd-Sil hornfelses which equilibrated at peak-conditions of 700°C and 5-6 kbar .