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Constraints on Magma Sources in the North Atlantic Ocean from the Isotope Geochemistry of Basalts from Jan Mayen and Snaefellsness, Iceland

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Jan Mayen lies 650 km NW of Iceland, at the northern end of the anomalously shallow Jan Mayen Ridge between the Kolbeinsey and Mohns Ridges. The exposed volcanic rocks are dominantly post-Pleistocene potassic trachybasalts which have evolved during low pressure fractionation. A geochemical and isotopic study has been performed on a suite of ankaramites (MgO = 8-15 wt%) which span the stratigraphic range of volcanism. Incompatible element abundances are higher than local MORB testifying to the enriched source region beneath Jan Mayen. The basalts show only small Sr and Nd isotopic variations (^{87}Sr/^{86}Sr = 0.7034 - 0.7036; ^{143}Nd/^{144}Nd = 0.51284 - 0.51291) which overlap those of the Jan Mayen Platform but are distinct from MORB from the southern Mohns and northern Kolbeinsey Ridges. Along with basalts from the Vesteris seamount, Sr isotopic compositions are the most radiogenic, and Nd isotopes the least radiogenic, in the North Atlantic. The Jan Mayen ankaramites appear to represent an end-member in Sr-Nd isotope space which is approached only by the most extreme values measured in Recent off-axis alkalic basalts from Snaefellsness, Iceland. The enriched alkalic basalts from Snaefellsness are often considered diagnostic of the Iceland "plume" mantle (Hemond et al. 1993). The ^{3}He/^{4}He of crush released volatiles from clinopyroxene and olivine phenocrysts from the ankaramites range from 5.3 - 6.3 R_a. These values are lower than local MORB and alkali basalts from the Jan Mayen Platform. Coexisting clinopyroxene and olivine ^{3}He/^{4}He are indistinguishable, implying that ^{4}He ingrowth during melt residence in the magma chamber or assimilation of the underlying (15-20 Ma) oceanic crust is not significant. Olivine δ^{18}O values (5.3 ‰) fall in the range measured in Iceland and show no detectable contribution from hydrated oceanic crust. The ^{3}He/^{4}He are the lowest uncontaminated magmatic values recorded for the North Atlantic basalts and are inconsistent with an origin in the Iceland "plume" source which is characterised by ^{3}He/^{4}He of up to 37 R_a (Hilton et al. 1999). The low ^{3}He/^{4}He demonstrates that the heat source responsible for melting beneath Jan Mayen is unrelated to the deep-sourced thermal anomaly beneath Iceland and tends to confirm geophysical/bathymetric evidence for the absence of a deep mantle plume, such as a linear track of volcanic islands, thermal anomaly and plume swell. Jan Mayen basalts have the most positive ΔNb values measured in the North Atlantic, a feature suggested to be diagnostic of the Iceland plume. Furthermore, the Pb isotopic compositions of four basalts (Tronnes et al. 1999) plot close to the centre of the field represented by Icelandic basalts. The isotopic homogeneity, the lack of a correlation between Sr, Nd and He isotopic composition with basalt age or degree of differentiation, and high Ce/Pb ratios, rule out the incorporation of ancient Laurentian continental crust (a fragment of which underlies the southern end of the Jan Mayen Platform) as a source of the low ^{3}He/^{4}He. The isotope and trace element data have characteristics of lithospheric mantle rather than recycled subducted sediments. In Pb-Sr and Pb-Nd isotope space, basalts from the N. Atlantic define two trends which end at distinct enriched components: one at Jan Mayen/Vesteris Seamount, the other at Snaefellsness. The Snaefellsness end of the Iceland Sr-Pb and Nd-Pb isotope trends is characterised by more radiogenic Pb isotopes (^{206}Pb/^{204}Pb = 19 - 19.2) than Jan Mayen (^{206}Pb/^{204}Pb = 18.53 - 18.71), less radiogenic ^{87}Sr/^{86}Sr and more radiogenic ^{143}Nd/^{144}Nd. If Pb-Sr-Nd isotopes behave coherently during melting, there are two enriched mantle compositions feeding magmatism in the North Atlantic. We are undertaking a He-O isotopic study of post-Pleistocene basalts from Snaefellsness in order to characterise the enriched component which is sampled by off-axis melting beneath Iceland. Preliminary data suggest that Snaefellsness basalts have ^{3}He/^{4}He which are significantly higher than Jan Mayen, although the extent to which it has been polluted by He from the Iceland plume stem remains to be determined.

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