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Structural control on plume-ridge interaction along the southern Kolbeinsey Ridge

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The presence of geochemically enriched intraplate mantle sources close to the depleted mantle upwelling underneath mid-ocean ridges provides tracers with which the processes occurring in these two geodynamic environments can be deciphered. The Arctic Kolbeinsey Ridge, extending several hundreds of kilometers north of Iceland, is one of the classic regions of plume-ridge interaction. Here, we present new major element, trace element and Sr-Nd-Pb isotope data of glasses from the 290 km long southernmost Kolbeinsey Ridge segment and its southern boundary to Iceland, the Tjörnes Fracture Zone, along with published data from the northernmost Iceland volcanoes. Along the entire southern Kolbeinsey Ridge segment, trace element (e.g., $(La/Sm)_N$, Nb/Zr, K/Ti) and Sr-Nd isotope signatures decrease from enriched intraplate signatures at northern Iceland to mid-ocean ridge like signatures at the northern segment end. On a smaller spatial scale, we can show that the incompatible element and radiogenic isotope variability of lavas erupted along the southernmost 25 km of the Ridge is similar to those from the Tjörnes Fracture Zone and Theistareykir volcanoes, whereas glasses sampled further to the north generally deviate towards trace element and isotope compositions of mid-ocean ridge basalts. The major elements MgO and SiO_2 of the Iceland lavas and those of the southernmost Kolbeinsey Ridge segment are more variably than those observed towards the North. Much of the trace element and isotope variability of the southernmost Kolbeinsey Ridge segment cannot be explained with simple mixing of melts. The peculiar enrichment and variability of trace element compositions can also not be explained by simple changes in the degree (e.g., $(Ce/Yb)_N$) or depth ($(Dy/Yb)_N$) of partial melting. Estimating the variability of degrees of partial melting using fractionation-corrected major elements (Ca_8, Na_8, Al_8) shows that the degrees of partial melting generally exceed 10-15%, too large to sufficiently fractionate the incompatible element ratios. Instead, we propose a model in which the geochemical mantle heterogeneity between the Icelandic intraplate melting and Kolbeinsey mid-ocean ridge melting regimes is preserved in melts rising along the Tjörnes Fracture Zone and the slower spreading sections of the southernmost Kolbeinsey Ridge segment. We conclude that even in plume-ridge environments in which a relatively strong mantle plume interacts with a slow spreading centre (<20 mm/a), structural crustal features may provide sufficient pathways to preserve much of the original signature of mantle heterogeneity instead of being homogenized.