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Plagioclase as recorder of magma-crust interaction beneath the Faroe Islands

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The opening of the North Atlantic in the early Paleogene resulted in extensive volcanism as evident in now extinct volcanic centres and large basalt piles in e.g. Scotland, Ireland, Greenland and the Faroe Islands. This volcanic region, commonly referred to as the North Atlantic Igneous Province (NAIP) is still highly active on e.g. Iceland and Jan Mayen. The Faroe Islands Basalt Group (FIBG) is itself linked to the early Icelandic hot spot (55 Ma), and decompressional melting, resulting from rifting and the eventual breakup from east Greenland.

The FIBG is up to 6 km thick and is underlain by up to 40 km continental crust intruded by mafic sills, as suggested by geophysical surveys. The exact nature of these continental rocks is unknown, though previous studies have presumed a Pre-Cambrian basement, probably overlain by sediments related to the pre-volcanic rifting. Potential onshore equivalents of the basement rocks may be found in NW Scotland and East Greenland.

Here, we employ multiple geobarometric models coupled with Sr, Pb and Nd isotope signatures in plagioclase crystals to decipher crustal influences in the Faroe basalts. Isotope analyses was performed In-situ (microdrilling) as well as on whole rock and plagioclase separates. The $^{87}Sr/^{86}Sr$ signatures range between 0.703 - 0.705. Correlation of calculated magma storage depths with geochemical contamination signatures allows us to construct “virtual geochemical boreholes” through the basalts into the underlying crustal basement. Anorthite contents in plagioclase has a bimodal distribution, separated into two populations of An_{62-72} and An_{80-90} respectively. These two compositional groups of plagioclase also correspond to two distinct magma storage levels. The high anorthite plagioclase record depths of crystallisation in the lower part of the continental crust, whereas the low anorthite plagioclase formed in upper part of the continental crust, just below the volcanic sequence.

The wide range of the isotopic signatures indicate a complex plumbing system with variable degrees and depth levels of crustal contamination. Using the available data, we attempt to construct the general lithostratigraphy of the sub-basaltic basement from the combined geobarometry and contamination patterns.