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Evolution of a large Palaeocene igneous complex; insights from Ardnamurchan, NW Scotland.

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The peninsula of Ardnamurchan is the most westerly point of the British mainland. The igneous complex is part of the British-Irish Palaeocene Igneous Province, which formed (around 60 Ma) within a zone of crustal stretching and thinning prior to the opening of the North Atlantic. This deeply eroded igneous complex intrudes Proterozoic metasediments ('Moine schists') and a thin overlying cover of Mesozoic sediments. The igneous complex is divided into three different centres, mostly composed of gabbro, dolerite and numerous cone sheets, many being composite in nature. A selection of composite intrusions and samples from the central gabbro bodies of the Ardnamurchan igneous complex, as well as local Moine metasedimentary country rocks were collected and analysised for Sr, Nd and Pb isotopes to define the role of crustal contamination as well as the igneous evolution of this Palaeocene igneous complex.

The Ardnamurchan igneous complex also comprises a network of intersecting radial and concentric structure i.e. dykes and faults, attesting to several stages of magma chamber inflation and deflation. The sampled cone sheets tend to be enriched to strongly enriched in radiogenic 87Sr/86Sr (0.7046 - 0.7149) and show a range of 143Nd/144Nd isotope values (0.5114 - 0.5129) with a displacement of the samples away from MORB-like values. The Ardnamurchan isotope data show two distinct linear trends in isotope space. Magma mixing would seem to have been an integral part of the igneous activity throughout the evolution of the complex. The occurrence of composite intrusions with basaltic margins and more felsic andesitic to rhyolitic cores highlights the existence of magma reservoirs, of varying composition, underneath Ardnamurchan and evidence for liquid-liquid mixing imply that these melts were molten at the same time and ascended together. The majority of the cone sheets and a large portion of the Ardnamurchan igneous complex underwent a two step crustal contamination process. Within the composite intrusions sampled the more mafic rocks, which are consistently found at the margins, are dominantly contaminated in the lower crust by granulite-facies Archean gneisses, not currently exposed at the surface. The more felsic magmas, found in the core of the composite intrusions, show varying amounts of Moine metasedimentary incorporation as do the youngest mafic intrusions. There appears to be a very close temporal connection between the felsic and the more mafic rocks. The igneous rocks sampled provide a probe into the deep crustal structure beneath the Ardnamurchan igneous complex as the active magmatic system migrated upwards through time progressively sampling higher crustal levels.