Lower crustal and possible shallow mantle samples from beneath the Hebrides: Evidence from a xenolithic dyke at Gribun, western Mull

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Abstract

A Permian (268 ± 2 Ma) olivine-nephelinite dyke cutting Proterozoic (Moinian) psammites on the west coast of Mull, contains an abundance of xenoliths inferred to be from the lower crust and possibly uppermost mantle. The majority are pargasite pyroxenites grading to hornblendites. Next most abundant are pyroxene granulite orthogneisses. High-grade meta-arenites are also relatively common. Scarce xenoliths and related megacrysts are composed of anorthoclase, ferrosalite, apatite, magnetite and ilmenite (af-cpx-ap-mt-il suite). Scarce kaersutite megacrysts are thought to be derivative from pegmatitic hornblendites. The pargasite pyroxenites are derived from ultramafic protoliths that have experienced recrystallization, model metasomatism (with introduction of amphibole) and deformation prior to entrainment. Olivines are wholly pseudomorphed but pyroxenes are diopsides (Fs7.8-9.2) with up to 12.5% Al2O3. Plagioclase (An45.6) is a rare accessory. Whether the pyroxenite protoliths were upper mantle peridotites or lower crustal ultramafic cumulates is indeterminate. The mesocratic xenoliths are granulite-facies orthogneisses comprising plagioclase (An38-22), augite (Fs16-22), pseudomorphed pigeonite (?), magnetite, ilmenite and apatite. Pb/U SHRIMP dating of zircons indicates a crystallization age of 1850 ± 50 Ma for the orthogneisses, suggesting that the Archaean/Palaeoproterozoic Lewisian gneisses were magmatically underplated by younger Proterozoic (Rhinnian or Ketilidian age) rocks. The pyroxenite and granulite gneiss xenoliths may be coeval fragments of a lower crustal and possibly uppermost mantle sequence. The most evolved of the orthogneisses are two-feldspar quartz diorites containing subordinate sanidine (Or64-74). The magmas parental to the postulated underplating intrusion are thought to have been mildly alkaline (transitional) basalts. The metasomatic introduction of amphibole that affected the ultramafic rocks is attributed to pervasive influx of Fe, Ti, K, LREE (etc.)-rich small fraction partial melts from the asthenosphere. The af-px-ap-mt-il megacryst suite, however, appears to represent a distinct younger event involving intrusion of a geochemically evolved vein system within the amphibole pyroxenites. Temperature

estimates based on coexisting (a) feldspar and (b) oxide pairs indicate establishment of equilibrium at approximately 800°C, suggesting a geothermal gradient of c. 27°C km-1.

Reference for the full paper:

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