MAFIC AND ULTRAMAFIC XENOLITHS FROM RUDDON'S POINT BASANITE – INSIGHTS INTO LITHOSPHERE BENEATH CENTRAL SCOTLAND (MIDLAND VALLEY TERRANE)

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Scotland consists of five terranes bounded by faults trending SSW–NNE. The age of the terranes tends to increase from SW to NE. Carboniferous–Permian intraplate volcanism related to Variscan lithospheric extension was predominantly basaltic. Basanitic magmas erupted in late Carboniferous, ca. 315 Ma, gave rise to phreatomagmatic diatremes and small dykes. The basanites host upper mantle and lower crustal xenoliths. Those at Ruddon's Point embrace a wide range of xenolith types and affillated megacrysts that have received little study.

The mafic/ultramafic xenoliths at Ruddon's Point comprise anhydrous spinel lherzolites and wehrlite, clinopyroxenites (± Ol), websterite and gabbro. Most of the xenoliths is infiltrated by host basanite or is strongly affected by weathering processes. The lherzolites have protogranular to porphyroclastic textures. Clinopyroxenites, websterites and wherlite have adcumulative textures, and commonly contain pseudomorphs after mica (?).

Lherzolites consist of forsterite-rich olivine (Fo_{87-90}), Al-rich pyroxenes (Al = 0.25–0.31 apfu in Cpx and 0.15–0.19 apfu in Opx) and Cr-poor spinel (Cr# = 0.15–0.20, Mg# = 0.70). In wehrlite the cumulus olivine has Fo_{83-84} and the Mg# of intercumulus clinopyroxene is 0.83–0.86 (Al=0.23–0.29 apfu). Olivine in the clinopyroxenites is less magnesian- Fo_{78-82}, clinopyroxenes have Mg-number from 0.75 to 0.85 with Al ranging from 0.17 to 0.30 apfu.

REE-normalized patterns for the clinopyroxenes in lherzolites and wehrlite are flat for the HREE whilst they are slightly depleted to slightly enriched in LREE ($(La/Lu)_N$=0.4–2.5). The only significant anomalies in their multi-trace element patterns occur at Th–U (positive) and Nb–Ta (negative) contents. Orthopyroxenes in the lherzolites contain elevated amounts of Th, U, Zr, Hf and Ti. Clinopyroxene in the clinopyroxenites has a concave downward REE pattern ($(La/Lu)_N$=2.3–2.4 in clinopyroxenites and $(La/Lu)_N$=4.8 and 8.7 in Ol-clinopyroxenite and websterite, respectively) and there is a slight negative Ti anomaly in the olivine clinopyroxenite and websterite.

Ortho- and clinopyroxenes in the lherzolites and websterites are in chemical equilibrium. The pyroxene equilibration temperature for one of the lherzolites is 970–1010°C, while in the other lherzolites and websterite it is slightly lower (930–960°C and 970–990°C, respectively, [1]).

The spinel lherzolites are not untypical of spinel lherzolites known world-wide from the lithospheric mantle. The Mg# of their spinels indicative for strong depletion of the lithospheric mantle beneath Ruddon's Point. Their clinopyroxene compositions suggests a melt extraction between 1 and 7%, whereas the orthopyroxene composition points to stronger depletion of 10–15%. In addition to melt extraction we conclude that the lherzolites have undergone cryptic metasomatism by subduction-related hydrous fluids that enriched the pyroxenes in Th and U. Although the clinopyroxene in the wehrlite is texturally later than olivine, its trace elements exhibits the same characteristics as those in the lherzolites. Accoridingly the wehrlite may be precipitate from the metasomatic medium. In such a reaction, orthopyroxene was resorped and secondary clinopyroxene precipitated.

Subduction-related metasomatism seems to be widespread in Scottish lithosphere south from Moine Thrust Zone, but with numerous local variations ([2] [3] [4]).

The low Mg# in clinopyroxes and olivines forming clinopyroxenites, together with their textural relationships and and convex downward REE patterns suggests that these rocks formed as lower crustal cumulates. Probably during the Carboniferous, rift-controlled magmatism and possibly from magmas closely allied to those of their basanite host. By contrast, the age of melt-extraction from lherzolites and acquisition of their protogranular to porphyroclastic textures is inferred to be older, probably associated with Lower Palaeozoic orogeneisis. Nevertheless both the peridotitc and pyroxenotic suites are considered to have subsequently undergone equilibration under similar P/T conditions.

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