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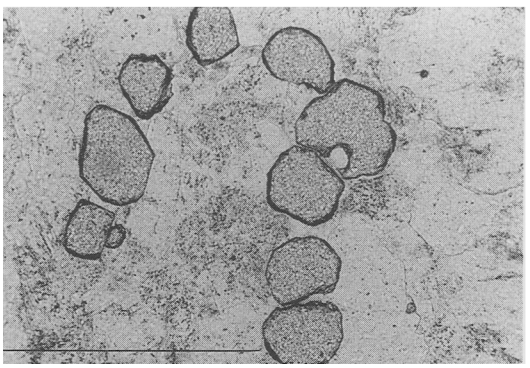
Zoned manganiferous garnets of magmatic origin from the Southern Uplands of Scotland

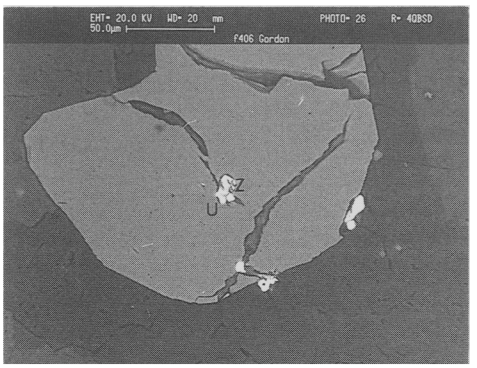
MANGANESE-ENRICHED garnets of magmatic origin have been reported as occurring in the Newer Caledonian Cairngorm Granite of Scotland; the garnets ranged in composition from 32 to 52 mol.% spessartine, and were found within the granite itself, and an aplitic sheet associated with the granite (Harrison, 1988). There are only four other known localities of spessartine garnet in Scotland: two localities on south Harris, both of which are in pegmatites; one locality in Glen Cosaidh Inverness-shire in segregation pods in gneiss; finally in eulysite at a locality at Loch Duich in Ross and Cromarty (Nicholson, 1989). Manganiferous garnets have also been noted in the Caledonian Donegal Granite and its associated pegmatites and aplites (Hall, 1965).

Small garnets (<1 mm) have now been found in a pegmatitic and aplitic vein associated with the Cairnsmore of Fleet Granite, in the Southern Uplands of Scotland. The Cairnsmore of Fleet Granite is a late Devonian granite that is thought to have formed by a complex series of magmatic injection processes, which in turn produced a hybrid biotite and biotite–muscovite granite (Gardiner and Reynolds, 1937). Pegmatite and aplite veins were noted coming from, and passing through, the granite itself, and garnets were noted in both the pegmatites and the aplites (Gardiner and Reynolds, 1937). The vein outcrops in a small disused quarry (NX546754), near to Loch Clatteringshaws, and consists of a pegmatitic vein up to 1 m in thickness containing a thin (25 cm) band of fine grained aplitic material. Although the garnets can be found within the pegmatite they are mostly concentrated in the aplite.

Studied in transmitted light the garnets are commonly blood red, but are occasionally dark yellow. They range in size from 95 μm to 400 μm and are commonly subhedral but occasionally euhedral (Fig. 1). The garnets are often seen to be lined up in a row, almost touching (Fig. 1). The length of the line of garnets can be up to thirteen separate garnet crystals, and is an unusual texture within igneous rocks. A similar texture for chromite grains has been called the train texture, and is thought to be related to the magnetic properties of the grains (A. J. Hall, pers. comm., 1991). The garnets hosted within the aplite are held in a matrix of mainly quartz, albite and microcline, with occasional oligoclase, biotite and muscovite. Secondary chlorite is also present in the matrix. The aplite matrix displays a typical micrographic texture. The lack of muscovite may be due to the pegmatite being derived from the muscovite-deficient granitic magma of the Cairnsmore of Fleet pluton.

The garnets are gradually zoned, and an electron microprobe analysis of the 20 garnets, based on 24 oxygen atoms, gives an average composition for the cores of 59.4 mol.% spessartine, 35.8 mol.% almandine, 1.1 mol.% pyrope and 3.7 mol.% andradite. A similar averaged composition for the rim of the garnets is 48.4





FIGS. 1 and 2. FIG. 1 (*left*). Subhedral garnets within the aplite displaying a train texture; scale bar = 700 µm. FIG. 2 (*right*). Backscattered electron image of a subhedral garnet containing an uranium phase (U) and a zircon phase (Z).

mol.% spessartine, 46.4 mol.% almandine, 2.8 mol.% pyrope and 2.6 mol.% andradite.

Inclusions in the garnets are not uncommon, and back-scattered electron imagery coupled with energy-dispersive X-ray analysis revealed the inclusions as zircons which were often associated with an uranium-rich phase (Fig. 2). Within the matrix hosting the garnets, phases enriched with uranium, hafnium, dyprosium, gadolinium and other REEs were found.

The garnets are subhedral and they are apparently concentrically zoned. They are enriched in Mn in the cores and enriched in Fe at the rims of the crystals. This has been related to a formation of magmatic garnets from a melt by Rayleigh fractionation on cooling (Leake, 1967). The inclusions of an uranium phase in the garnets suggest strongly that the garnets are magmatic in origin. Similarily the train texture of the garnets can be related to their formation in a melt, possibly being related to the magnetic properties of the garnets due to an iron presence in the lattice, particularly at the rims of the crystals.

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