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# Carn Gorm

[NH 442 629]

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## Introduction

The Carn Gorm pegmatite is the largest of the Neoproterozoic ('Knorydarian' or 'Morarian') pegmatites discovered to date in the Moine rocks of the North-west Highlands. The pegmatite contains large muscovite books, which have been the subject of much geochronological work, with appropriate repercussions for the tectonic and metamorphic history of the Moine succession. The pegmatitic granite body lies within the Ben Wyvis Pelite Formation in the Glenfinnan Group. It is particularly well exposed around the summit of Carn Gorm (Figure 6.47) due to the relatively flat-lying orientation of the adjacent gneissose pelites and semipelites.

Although L.W. Hinxman mapped the Carn Gorm area in 1903 for the Geological Survey, no particular mention was made of the pegmatite and it is not described in the related memoir for Sheet 93 (Peach *et al.*, 1912). However, during the wartime search for strategic minerals Kennedy *et al.* (1943) described several pegmatites from the Ben Wyvis area, including two localities on Can Gorm, as a potential source of commercial mica. Long and Lambert (1963) carried out pioneering Rb-Sr isotopic studies on the large muscovites present in the Carn Gorm pegmatite, and van Breemen *et al.* (1974) followed this up with further detailed isotopic dating. Both studies showed that the muscovites had Neoproterozoic ages of 700–800 Ma, thus pre-dating the Caledonian Orogeny. As a result of the dating of the Carn Gorm pegmatite and other pegmatite bodies in the Morar and Glenfinnan areas, a 'Morarian' or 'Knorydarian' orogenic event was proposed.

## Description

Carn Gorm is a rocky and heathery summit 556 m above sea level on the southern flank of Ben Wyvis. The Carn Gorm pegmatite lies within a belt of pelitic rocks approximately 5 km wide that stretches north-east from Strathconon [NH 392 570] through Tarvie [NH 423 585] and Loch Garve, to Carn Gorm and Ben Wyvis [NH 463 684]. The pelitic rocks, termed the 'Sgurr Marcasaidh Formation' in Strathconon and the 'Ben Wyvis Pelite Formation' farther north, are attributed to the Glenfinnan Group. The psammite unit that borders the pelites to the south-east, the Tarvie Psammite Formation, has been assigned to the Loch Eil Group (Holdsworth *et al.*, 1994) reducing the Glenfinnan Group rocks to a narrow outcrop. Rathbone and Harris (1979) studied grain-size reduction in Morar Group psammites along the western edge of the pelitic belt. They demonstrated an increase in strain towards inliers of Lewisianoid material, which occur along the boundary, and concluded that this junction represents a northerly extension of the Sgurr Beag Thrust (see Kinloch Hourn GCR site report, Chapter 8). The rocks in the Ben Wyvis area are generally flat-lying, which is thought to represent the pre-Caledonian disposition of the Moine assemblage (Harris, 1991). Open, upright F3 folds, considered to be of Caledonian age (e.g. Holdsworth and Roberts, 1984) clearly deform the main schistosity and the pegmatites in the Carn Gorm area.

The Carn Gorm pegmatite is exposed over an area of approximately 200 m<sup>2</sup>, and although its upper contact has been largely removed by erosion, it is at least several metres thick. It is generally concordant with the foliation in the host rocks and its lower contact is clearly exposed in several places. The pegmatite body is composed of quartz, muscovite, potash feldspar and plagioclase feldspar, biotite and garnet (Figure 6.48). Beryl and tourmaline also occur and the muscovite books are commonly up to 20 cm across and 3 cm thick. Strictly, it is a pegmatitic leucogranite. It has a primary, coarse, mineralogical layering that trends northeast, parallel to the regional strike of the country rocks, and most of the mica within the pegmatite is also aligned in this orientation. This internal layering has been enhanced by subsequent deformation and recrystallization, which becomes stronger towards the pegmatite margins. Other pegmatites in the Carn Gorm area, including the nearby body at Carn Fearn, have similar mineralogies and internal structures.

The Carn Gorm pegmatite contains inclusions of pelitic and psammitic country rock, which occur as enclaves commonly several metres long by about 1 m wide, and which maintain the regional strike of the country rocks. The pelitic inclusions consist of biotite-rich gneissose pelite or more commonly muscovite-rich schistose semipelite, that contains concordant quartz veins, small lenticular pegmatites and abundant tourmaline. Adjacent to the pegmatite the pelitic country rocks are particularly muscovite-rich with abundant quartz veins and lensoid quartz-feldspar segregations. Muscovite is common as small flakes throughout the pelitic matrix, as well as forming individual porphyroblasts typically c. 1 cm in size. Kennedy *et al.* (1943) noted the increasing amount of muscovite in the pelite as the main pegmatite body is approached, and described the immediate host rock as 'highly injected', becoming saturated with pegmatite material giving a transitional pelite–pegmatite boundary. Within the pegmatitic body itself muscovite is best developed near its margins and adjacent to the country rock inclusions, suggesting reaction between the pegmatite and host rocks during pegmatite crystallization.

## Interpretation

The Carn Gorm pegmatite is one of a suite of pegmatite bodies in the Ben Wyvis area, several of which have produced Neoproterozoic isotopic ages. These pegmatites are similar to other Neoproterozoic pegmatites identified from across the Moine outcrop, and their origin has been the subject of much debate. The intimate relationship between the Carn Gorm pegmatite and its country rocks, in particular the gradational margins and the presence of pegmatite material in the host rocks, indicate that it is unlikely to have been emplaced by discrete injection of an igneous melt from depth. Rather the evidence suggests that the pegmatite formed as a result of recrystallization and locally segregated neosome development from the surrounding country rocks.

In an early Rb-Sr isotopic survey of the Moine assemblage, Long and Lambert (1963) examined several pegmatite bodies from the Carn Gorm area. A sample of muscovite from a concordant pegmatite 6 m by 4 m in size gave an Rb-Sr age of  $705 \pm 25$  Ma, and a second muscovite from a 'small feldspar-muscovite segregation' gave an age of  $625 \pm 20$  Ma. An Rb-Sr muscovite age of  $680 \pm 10$  Ma was also obtained from a larger pegmatite at nearby Carn Fearnha [NH 426 614]. These ages were interpreted to show that the muscovites formed initially at around 700–800 Ma, but their Rb-Sr isotopic systems were reset to younger ages by the later Caledonian deformation and metamorphism. Initial Sr ratios from this study imply that the pegmatites were derived from the local Moine country rock. The pegmatite suite at Carn Gorm was correlated with other 'early pegmatites' from the Moine, where similar Neoproterozoic ages have been obtained, for example at Sgurr Breac in Morar (see North Morar GCR site report, Chapter 8), in Knoydart (see Knoydart Mica Mine GCR site report, Chapter 8), and by Loch Eilt (see Fassfern to Lochailort Road Cuttings GCR site report, Chapter 8) (van Breemen *et al.*, 1974).

Van Breemen *et al.* (1974) carried out a more-detailed geochronological investigation of the Carn Gorm pegmatite. They obtained nine Rb-Sr ages ranging from 700–800 Ma from four muscovite books from a single pegmatite. The detailed pattern of Rb-Sr ages within individual muscovite books was also examined, showing that the oldest ages were obtained from the centres of books, with younger ages towards the margins. These age variations were attributed to minor movement of radiogenic Sr and Rb within some mica books and the loss of radiogenic Sr from others, both caused by post-crystallization Caledonian deformation and metamorphism of the pegmatite. These authors followed Long and Lambert (1963) in correlating the Carn Gorm pegmatite with a suite of pegmatites of similar age from throughout the Moine assemblage, and concluded that they had formed as a result of a period of tectonometamorphism at this time.

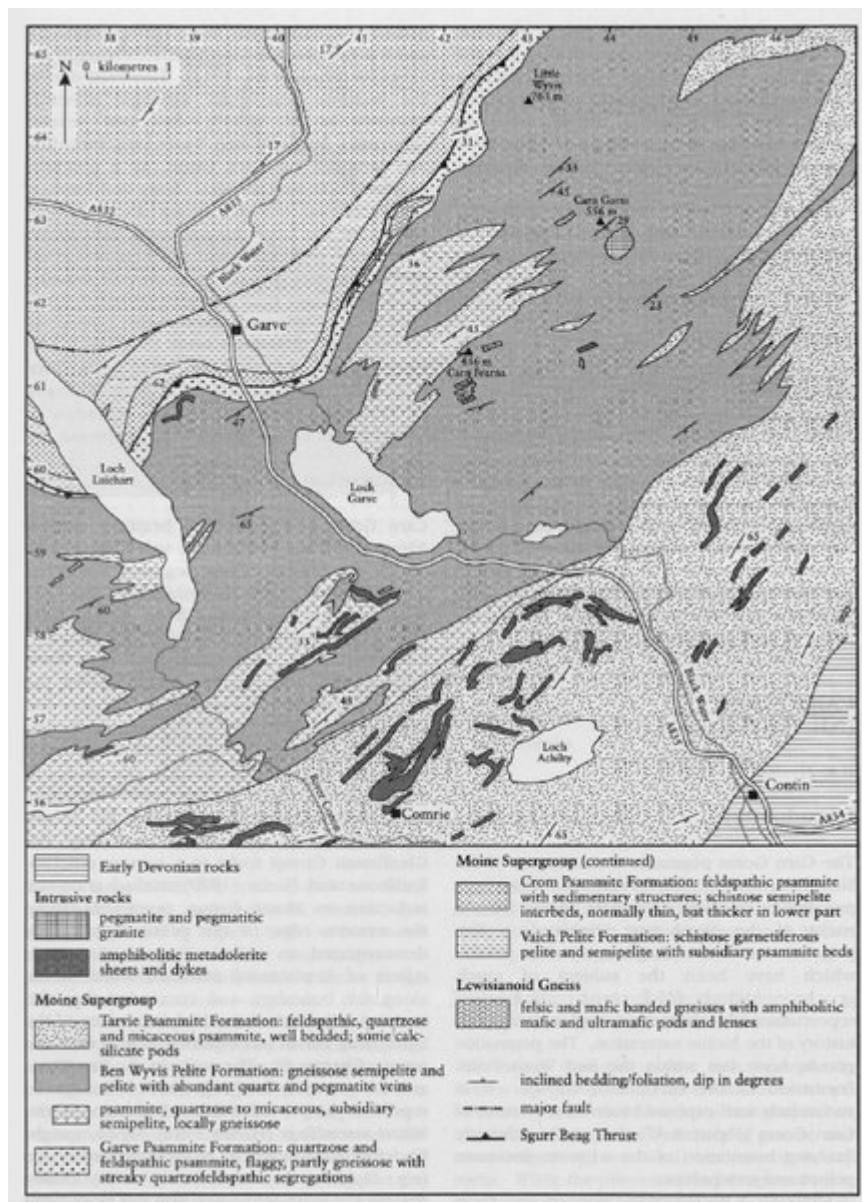
The fact that the smallest pegmatites record the youngest ages, and that the centres of muscovite books retain the oldest ages, supports this proposal of pegmatite formation during the Neoproterozoic (c. 800 Ma) followed by later disruptive isotopic disturbance. This interpretation is supported by more-precise U-Pb zircon and monazite ages of c. 800 Ma for pegmatites from the western Moine succession (Rogers *et al.*, 1998), and evidence documenting isotopic disturbance of Neoproterozoic pegmatites during Caledonian deformation (Powell *et al.*, 1983). The presence of upright D3 folds throughout the Carn Gorm area, which disrupt the pegmatites, indicates that later deformation and recrystallization of probable Caledonian age occurred widely in these Glenfinnan Group rocks.

## Conclusions

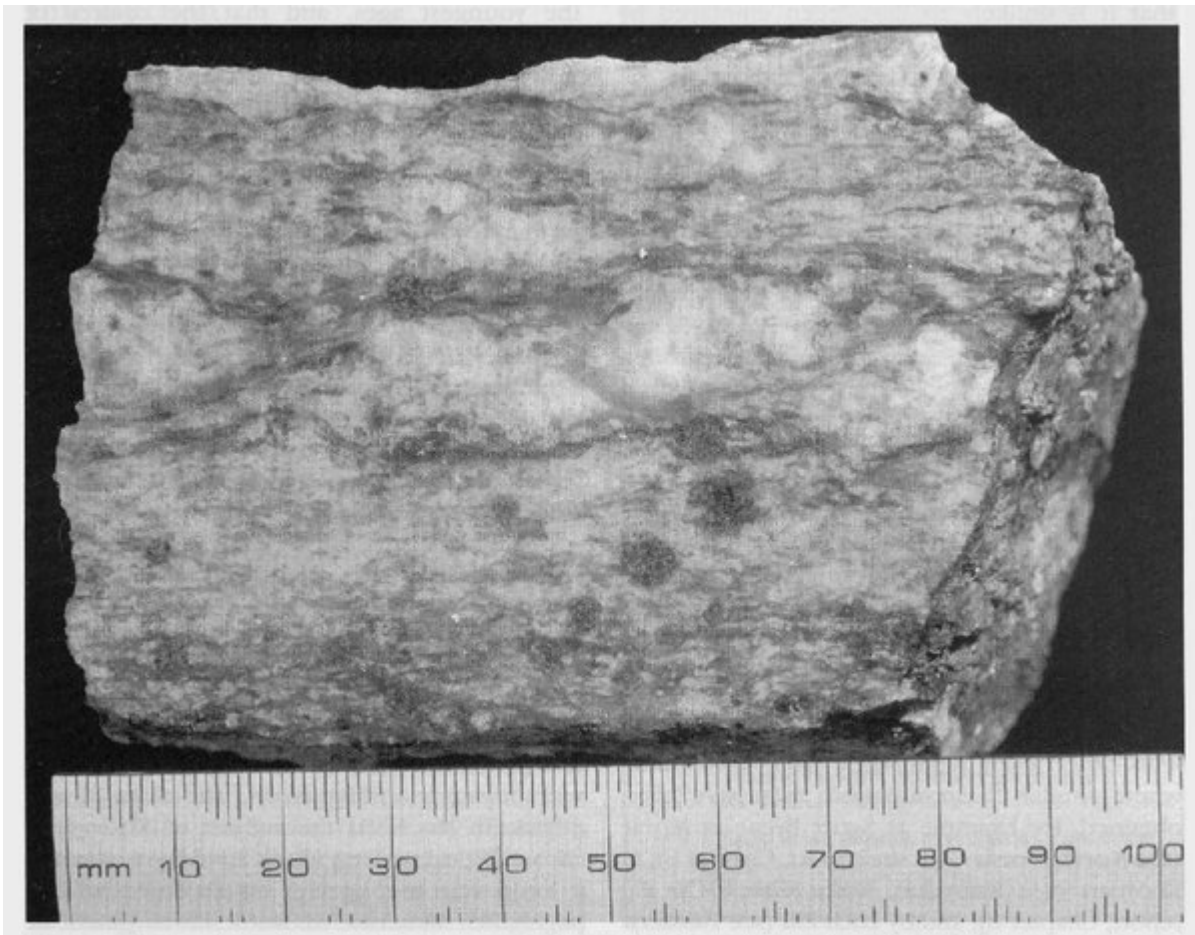
The Carn Gorm pegmatite is the largest and possibly the best exposed of the Neoproterozoic ('Knoydartian' or 'Morarian') pegmatites, the older suite of pegmatites in the Moine succession that pre-date Caledonian deformation. Together with its surrounding rocks, the Carn Gorm pegmatite has been the subject of Rb-Sr geo-chronological studies, which have demonstrated a Neoproterozoic age for emplacement of the pegmatite. Extensive neosome development in the country rocks, and the gradational nature of the pegmatite boundaries, suggest that the Carn Gorm pegmatites formed as a result of in-situ recrystallization and segregation during a Knoydartian or Morarian (c. 800 Ma) tectonometamorphic event.

The Carn Gorm pegmatite is particularly valuable because of its well-exposed state, and the low intensity of D3 Caledonian deformation, preserving much of its original character. The site is of national importance as it demonstrates how isotopic dating has been used to elucidate the tectonic history of the Moine succession. It also shows that Neoproterozoic metamorphic events affected the Moine rocks several hundred million years before Caledonian orogenic activity in Ordovician and Silurian times.

## References



(Figure 6.47) Geological map of the Garve area showing the location of Carn Gorm. Compiled from BGS 1:50 000 sheets 83W Strathconon (British Geological Survey, 2001) and 93W, Ben Wyvis (British Geological Survey, 2004a).



*(Figure 6.48) Specimen of pegmatitic leucogranite from Carn Gorm. The crude foliation, defined by quartz and muscovite, encloses lenticular aggregates of white feldspar and subsidiary pale-grey quartz. Dark-red garnets up to 5 mm across are prominent. (Photo: E.K. Hyslop.)*