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# Knockvologan to Eilean a'Chalmain

[NM 309 175]–[NM 309 204]

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## Introduction

The coastal exposures on the eastern side of Erraid sound, on Eilean Dubh and on Eilean a' Chalmain, which comprise this GCR site, encompass the central part of the Ross of Mull granitic pluton (Figure 8.13). The general features of the pluton are described in the Cnoc Mor to Rubh' Ardalanish GCR site report. Here, heterogeneous hybrid granitic rocks contain chilled enclaves of gabbroic and dioritic rocks ('appinites'). These enclaves have high-K basalt to basaltic andesite compositions and themselves contain mafic microgranular enclaves and xenocrysts. The hybrid rocks grade over several hundreds of metres into the inner porphyritic biotite granite of the Ross of Mull pluton, which still contains mafic enclaves up to 3 km beyond the site. Of special interest are textures and lithologies resulting from the generation of these hybrid rocks through the incorporation of the basic to intermediate material into the granitic host. The site also preserves a 'ghost stratigraphy' of the Moine country rocks, which can be traced through the granitic rocks in the metasedimentary xenoliths.

## Description

Although dioritic rocks form a small component of the Ross of Mull pluton, their abundance within this GCR site is considerable. The basic enclaves range in size from a few centimetres to several hundreds of metres and the largest discrete mass of basic rock comprises most of Eilean a' Chalmain. Rocks within this outcrop are heterogeneous, ranging from medium-grained diorite to coarse-grained appinitic monzodiorite characterized by poikilitic crystals of orthoclase and pale-coloured biotite. The outcrop is cut by numerous sheets and apophyses of biotite granite, but with little development of hybrid rocks.

Exposures on the small island to the north of Eilean Dubh at [NM 3064 1894] and on the west-facing shore of Erraid Sound at [NM 3077 2012] provide good examples of the mafic enclave-rich hybrid granitic rocks and of their heterogeneous textures. The hybrid host rock is predominantly a biotite-rich granite ( $\pm$  rare primary amphibole), with a significant accessory mineral component (titanite, allanite and magnetite). However, there is a range of compositions from mafic granodiorite to quartz-diorite. The enclaves range in size from a few centimetres to several metres across, and in composition from fine-grained hornblende gabbro or microgabbro to microdiorite. Their distribution is variable, but locally they comprise up to 10% of the granite. Larger enclaves are typically surrounded by numerous smaller fragments (Figure 8.14). Most are rounded in form, and commonly show finely lobate contacts with their host. The contacts vary from sharp with fine-grained 'chilled' margins, to diffuse. Where contacts are diffuse, the enclaves are either enclosed by discrete coronas of hornblende quartz-diorite or grade over several tens of centimetres into the host biotite-rich granite. Quartz-diorite with small hornblende-rich aggregates similar to the corona material also occurs as small rounded blobs within the hybrid granite. Veining or development of small areas of net-veined hybrid rocks are common. The veins, of fine-grained leucotonalite to microgranodiorite, cut both host and enclaves. Glomerocrysts of quartz and plagioclase are common in the hybrid rocks, while K-feldspar mesocrysts occur in all lithologies.

A weak to moderately developed mineral fabric is present in most of the igneous rocks of the site. This partially wraps the enclaves, which take on an ellipsoidal shape in areas where the fabric is strongly developed.

The metasedimentary inclusions in the granite define a 'ghost stratigraphy'. K-feldspar-rich arkosic psammites and finely laminated psammites of the Upper Shiaba Psammite crop out within the northern part of the GCR site, e.g. [NM 3095 1952], and on islands in the Erraid Sound, while striped psammites and semipelites of the Assapol Group occur elsewhere. The xenolith populations have a clearly definable distribution, with little intermixing. Structures and fabrics in the larger inclusions, for example at Cnoc an t-Suidhe, to the SW of Torr Mor a' Chonaist, at Port nan Ròn and on Eilean

Dubh, are comparable in orientation to those in the country rocks. Hence, these are probably close to in-situ roof pendants. Examples of thermal overprinting, partial melting and assimilation into the granite are common. Within the inclusions of Assapol Group rocks to the west of Port nan Ròn, sillimanite forms knots that both overprint all fabrics, and mimetically replace the biotite that forms crenulation cleavages axial planar to minor folds in semipelitic lithologies.

## Interpretation

The age of the mafic enclaves and meladiorite bodies within the Ross of Mull pluton has been interpreted in several ways. Cunningham-Craig *et al.* (1911), suggested that they represent a disrupted diorite complex intruded as a precursor to emplacement of the pluton. Recent studies (R. H. Hunter, University of Liverpool, pers. comm.) suggest that the lobate fine-grained 'chilled' margins to many enclaves result from quenching during the interaction of penecontemporaneously emplaced basic to intermediate and acid magmas. Physical mixing, with thermal equilibration between the magma types, resulted in the formation of the heterogeneous hybrid rocks. The presence of enclaves of similar composition to these hybrid rocks within the main porphyritic biotite granite indicates local dispersion and mingling of the hybrid liquids. The more basic magmas are probably contemporaneous with the suite of calc-alkaline lamprophyre and microdiorite dykes present within the envelope. However, the linear trains of enclaves recognized in other Caledonian plutons, e.g. Strontian (see the Loch Sunart GCR site report) have not been recorded.

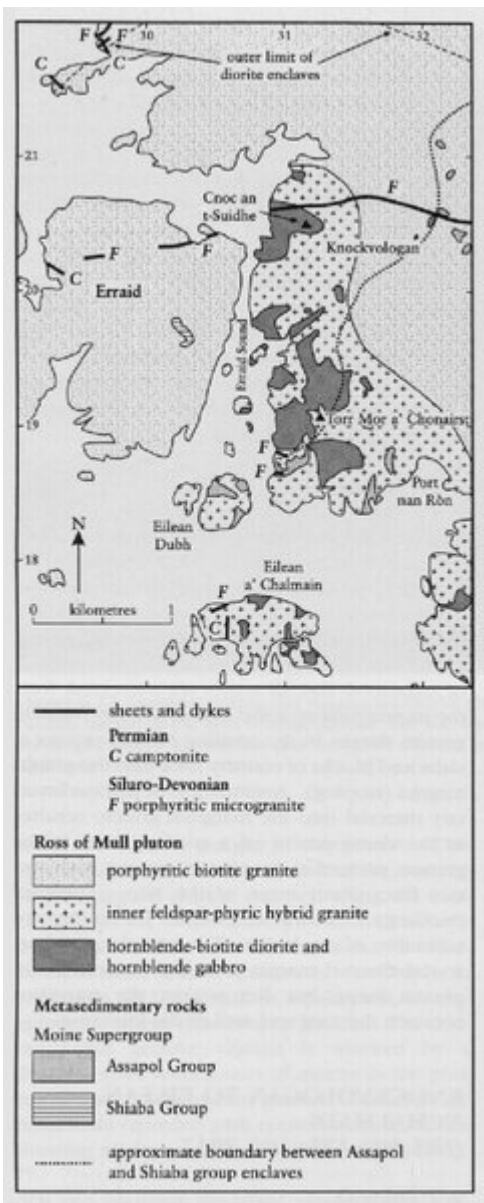
The origin of the internal foliation is equivocal. The enclaves show little evidence of significant deformation indicative of high syn-emplacement strains. Hence the fabric may be magmatic in part.

The distribution pattern of the metasedimentary xenoliths follows predicted stratigraphical lines. The lack of fragmentary dispersal, with only local intermixing, and the lack of significant re-orientation suggests a passive emplacement mechanism into the envelope and close proximity to the roof of the pluton.

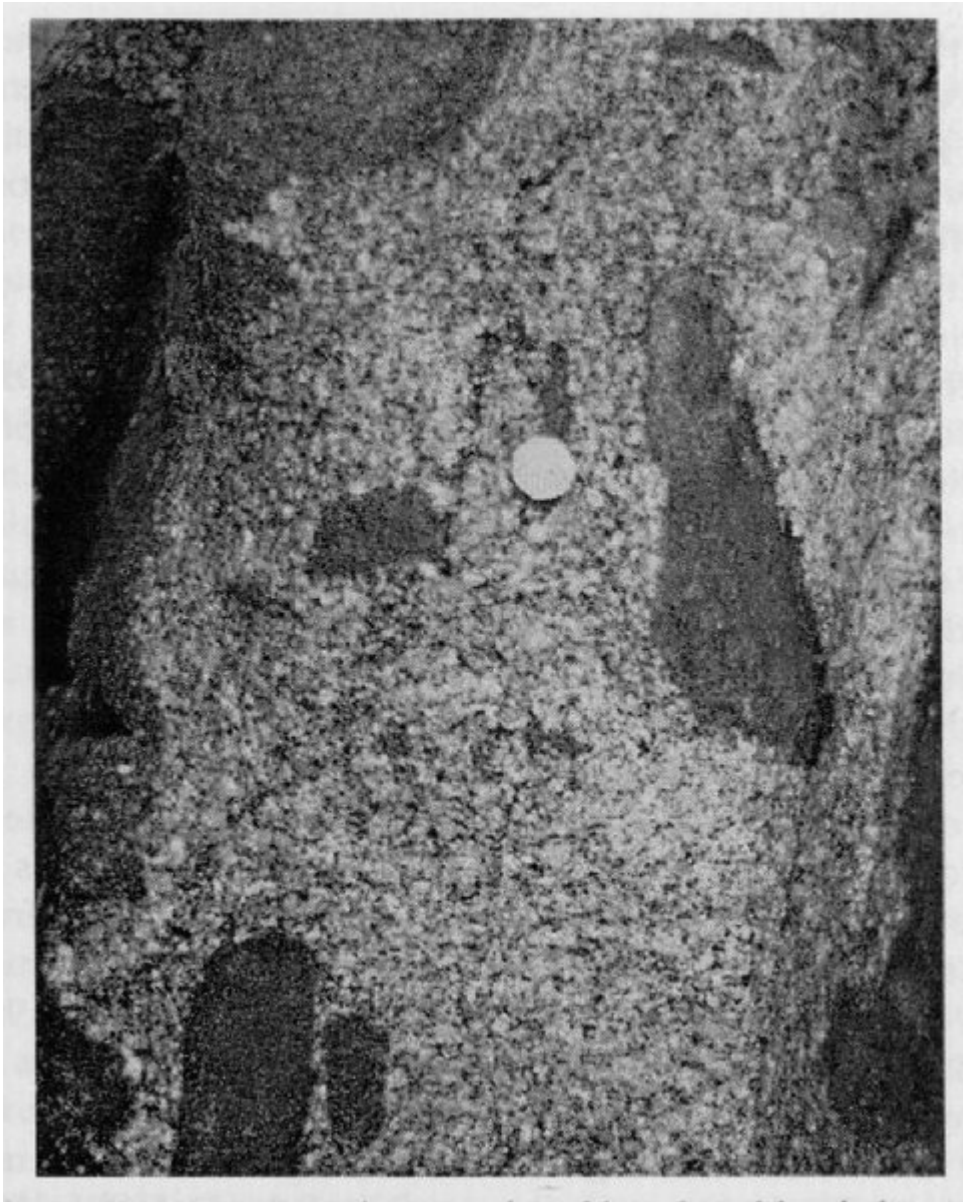
## Conclusions

The Ross of Mull pluton is notable among the Caledonian plutons for the preservation of one of the finest examples of 'ghost' country rock stratigraphy within an intrusion. This demonstrates that the pluton was intruded through a process of passive emplacement with little disruption of the metasedimentary country rocks. The 'ghost stratigraphy' is best preserved within this GCR site, which imparts an international significance to the site and to the pluton as a whole. The hybrid rocks featured in this site provide an example of the co-existence of basic to intermediate and granitic magmas in the pluton. Features are typical of magma mixing and mingling, with dispersed rounded enclaves of both basic and hybrid material in the porphyritic biotite granite host. It is considered that the basic and granitic magmas were intruded at the same time and their interaction has given rise to zoning within the pluton, with more basic rocks passing outwards to more acid rocks (reverse zoning).

## [References](#)



(Figure 8.13) Map of the area around the Knockvologan to Eilean a' Chalmain GCR site, Ross of Mull pluton, adapted from BGS 1:50 000 Sheet 43 and unpublished work, University of Liverpool.



*(Figure 8.14) Small meladiorite ('appinite) enclaves enclosed by a hornblende-biotite granodiorite hybrid host, centre of the Ross of Mull pluton, west of Port nan Ròn [NM 3124 1858]. (Photo: A.J. Highton.)*