

Geology of the Ross of Mull

The Ross of Mull is a world-renowned geological site that exhibits regionally metamorphosed rocks of the Moine Supergroup, late Caledonian granites, Tertiary basalts and metabasic bodies. The south coast exposes the Moinian inlier with a complex, multi-phase deformation history and associated amphibolite grade metamorphism. The regionally metamorphosed rocks within the thermal aureole of the Ross of Mull pluton display disequilibrium textures that offer a rare chance to study how contact metamorphism affects rocks previously regionally metamorphosed to high grade.

Within the inlier, the Ardalanish striped and banded formation hosts two generations of metabasites, granodioritic intrusions and a band of kyanite-bearing schist. To the west, the Ross of Mull plutonic granite obliquely cuts bedding and internal fabric in the schists. To the east lies the mainly psammitic Shiaba group.

A minimum of three deformation events are evident from structures within the striped and banded Ardalanish formation, with evidence of a fourth event in the Shiaba group in the east. Structures from the first phase of deformation (D1) have been largely overprinted by structures belonging to the second phase of deformation (D2) (Holdsworth *et al.*, 1987) however, D1 structures



An upright F3 anticline exposed in a cliff face at the base of Aird Dub 'h, on the south coast of the Ross of Mull.



Garnet porphyroblasts up to 15 mm in diameter within a first-generation metabasite.

may be observed in areas of weak D2 strain. An outcrop along the beach of Ardalanish Bay reveals rocks with a quartzo-feldspathic fabric which have been folded isoclinally (F2) within the second phase of deformation. The same D2 deformation developed the dominant schistosity (S2) that is observed throughout the striped and banded formation; it is axial planar to recumbent isoclinal folds. Common within the striped and banded formation is the displacement of D2 folds and foliation by D3 structures. Folds (F3) formed by D3 are upright open-to-tight folds plunging around 21° to the southsouthwest. Well-developed, axial planar, crenulation cleavage (S3) is particularly common in F3 hinge zones.

A variety of lithologies within the Ardalanish striped and banded formation gives rise to several key mineral assemblages. Metasediment assemblages outside the thermal aureole consist of:

biotite + muscovite + quartz ± garnet ± tourmaline
± kyanite ± chlorite (retrogressive).

Observed assemblages for metabasites are:

garnet + hornblende + plagioclase + quartz ± biotite.

Plagioclase crystals form coronas around the garnet porphyroblasts, particularly within the second-generation metabasites, and are interpreted to be retrogressive from peak metamorphism. These peak assemblages are typical of kyanite Barrovian-zone amphibolite facies that is accompanied by later retrogressive minerals.

Due to the high-grade nature of these rocks, some interesting textures and mineral assemblages are preserved within the thermal aureole of the Ross of Mull pluton. The aureole is divided into four zones, based on their mineralogy (also see Wheeler *et al.*, 2004).

Zone 1, against the outer margin of the aureole, has much of the regional assemblage preserved, though

The beautiful exposure of red granite along the coast at the western end of the Ross of Mull.



kyanite porphyroblasts have developed a muscovite-cordierite corona. There is no alignment of minerals within the corona, so this is interpreted to be a product of processes other than regional metamorphism.

Zone 2 perhaps produced some of the most unusual textures within the aureole. In hand specimen many blue kyanite crystals have pink andalusite cores. The andalusite pseudomorphs kyanite in this way because it requires less energy than nucleating a new crystal; however, within this zone temperatures were not high enough, for long enough, for the reaction to complete, therefore producing the cored textures. New prismatic andalusite crystals occur at some localities to suggest a variation in thermodynamics within the zone. Muscovite coronas are more developed in this zone.

Zone 3 introduces sillimanite in its acicular form, fibrolite. Garnet is no longer stable, and is pseudomorphed by cordierite aggregates in calc-silicate layers.



A hand specimen of kyanite schist from the Ross of Mull peninsula, with typical large laths of blue kyanite.

Zone 4 is in contact with the pluton. Euhedral garnet crystals formed under its high temperatures, along with knots of aluminosilicates. These knots contain relict kyanite, andalusite and prismatic sillimanite, emphasising the extent of disequilibrium within the thermal aureole.

References

- Wheeler, J., 2004. Disequilibrium in the Ross of Mull contact metamorphic aureole, Scotland: a consequence of polymetamorphism. *J. Petrology*, **45**, 835-853.
 Holdsworth, R., Harris, A. & Roberts, A., 1987. The stratigraphy, structure and regional significance of the Moine Rocks of Mull, Argyllshire, W. Scotland. *Geol. J.*, **22**, 83-107.

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A knot of aluminosilicate minerals within the schist; the pink crystals are andalusite, and the white crystals are sillimanite: the scale bar is 20 mm long.