2 Scalloway

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2.1 Introduction

The sea cliffs and rocky foreshore west from Scalloway, around Point of the Pund and northwards into Bur Wick, provide a continuously exposed and accessible traverse across the gneissose Colla Firth Permeation Belt and the non-gneissose rocks on either side. The belt of gneisses has developed within the psammitic Colla Firth Formation of the Whiteness Group and extends from Colsay (north of Fitful Head), northwards for 20 km to Scalloway and then for another 30 km north to Delting where it is cut off by the Nesting Fault. The belt varies between one and two kilometres wide, while the outcrop of the Whiteness Group is about 6 km wide. The layering throughout the outcrop is approximately vertical and strikes north-north-east. The gneisses and their adjacent areas are very variably intruded by granitic sheets, which are characteristically less than a metre thick but in several places they form substantial bodies.

The importance of the Scalloway GCR site is that it provides the only complete traverse across the Colla Firth Permeation Belt and illustrates its relationship with the non-gneissose rocks of the Whiteness Group to either side. The relative timing of gneiss development and intrusion of the granitic sheets is of great importance in assessing the wider tectonometamorphic history of the Shetland Dalradian and the radiometric age of the granitic sheets was investigated by Flinn and Pringle (1976). A detailed account of the geology of this area was given by May (1970) and it is included within the Geological Survey's one-inch Sheet 126 (Southern Shetland, 1978). Other parts of the Colla Firth Permeation Belt, included within the Geological Survey's one-inch sheet 128 (Central Shetland, 1981), have been described by Flinn (1954, 1967).

2.2 Description

The easily accessible coastal section to the west of Scalloway, exposes about 1.5 km of strata, part of the Colla Firth Formation of the Whiteness Group, much of which has been rendered gneissose during the development of the Colla Firth Permeation Belt (Figure 7.4). Throughout the section, granitic sheets are intruded into both the gneissose and non-gneissose rocks, and they merge into a more-substantial foliated granitic mass at the eastern margin of the gneiss belt.

Between the edge of the built-up area of Scalloway and the headland of Maa Ness, the first *c*. 100 m of section is composed of rather flaggy or laminated and lineated, fine-grained semipelitic rocks alternating with sheets of pinkish or white aplitic microgranite that have both a clear schistose foliation and a lineation. The sheets are up to a metre thick and are mostly conformable with or obliquely cross-cut the metasedimentary layering. They are accompanied by pegmatitic streaks. A 300 m-wide outcrop of granite follows, in which there are only very minor semipelitic screens. Granitic sheets occur the length of the gneiss belt, both within it and for up to 100 m or more on either side. Exposure is poor inland, but elsewhere they seem to be very unevenly distributed, very rarely as closely packed as here and generally less than a metre thick.

Gneissose development is first seen on the east side of Maa Ness, to the west of the large granite sheet. It takes the form of a coarsening of the grain size resulting in a loss of sharpness of the schistosity, the lineation and the muscovitic laminations of the flaggy semipelites. The rocks are also homogenized, so that all evidence of bedding is lost and minor compositional differences are destroyed. The transformation is very patchy and generally partial in the east, but by the Point of the Pund the rock is a magnificent example of the homogenous granoblastic gneiss that is characteristic of the permeation belt as a whole (Figure 7.5). However, even here it is just possible to find ghostly patches of gneiss that retain traces of their original semipelitic character. Such 'semigneiss' relics serve to distinguish this paragneiss from orthogneiss, which it closely resembles.

North of Point of the Pund, granitic sheets and pegmatitic veins cut both the gneisses and relics of psammite and semipelite and also cut across small folds associated with local shears. Beds and lenses of metalimestone and calcsilicate rock become more common, together with bands of fine-grained hornblende schist. The gneiss formation has had no apparent effect on the non-psammitic rocks, although pelitic beds, which become more common to the north and west, tend to develop an array of small quartzofeldspathic leucosomes. Where the coast turns west at Burwick, areas of non-gneissose semipelite and of semipelite with only streaks and areas of partial recrystallization ('semigneiss') become increasingly common. The western edge of the island of Burwick Holm and the rock supporting the Burwick Broch [HU 3880 4058] are barely affected by the recrystallization. The western edge of the gneiss belt is just offshore to the west of the Ness of Burwick, and intersects the coast a kilometre or so to the north of Burwick.

The first deformation episode to affect the rocks (the so-called 'Main Deformation') resulted in the formation of minor folds and a strong fabric, which ranges from planar to linear (Flinn, 1967). Small, tight to isoclinal, intrafolial folds of bedding are common but no larger scale folds are seen. The foliation of the rock is determined by the schistosity, which is parallel to lithological banding and lamination (bedding). The foliation encloses lenses of hornblende schist. Most of the rocks display a prominent rodding or mineral lineation that plunges to the south-south-west at about 40° in the area of the GCR site but at lesser angles to the north and south.

The development of the gneissose fabric in the permeation belt was controlled locally by the nature of the protolith, which was generally banded and laminated with layers of mica-rich pelite and mica-poor semipelite and psammite. Pelitic layers have been almost entirely converted to gneisses by the segregation of diffuse quartzofeldspathic leucosomes and the development of a strong schistose fabric enclosing microaugen of large andesine crystals, 1-3 mm across. An inclusion of deformed kyanite in one of these microaugen was suggested by May (1970) to be evidence for an early phase of metamorphism prior to the development of gneisses (see below). By contrast, in the dominant more-psammitic lithologies the coarsening of the texture weakens the preferred orientation of the mica flakes and hence weakens the schistosity, so that the rocks are generally transformed into homogeneous granofelsic gneisses; quartzofeldspathic leucosomes locally give a *lit-par-lit* appearance and tend to merge with the cross-cutting granitic sheets in places.

Important features of the Colla Firth Permeation Belt that are not immediately obvious from field inspection are the mineralogical effects of the gneiss formation. These have been described by May (1970) for the area of the Scalloway GCR site and by Flinn (1954, 1967) for areas to the north and south. Microscope examination has shown that, although minerals of higher grade than biotite, blue-green amphibole, epidote etc are extremely rare in the Whiteness Group of the Scalloway area, microcline and diopside occur in calcsilicate bands and metalimestones within and adjacent to the permeation belt. May (1970) has also found a kyanite-staurolite-bearing rock within the belt to the south of Scalloway, and both Flinn (1954) and May (1970) have reported fibrolite and garnet as present within the belt, in particular in Delting and also in a small area some 10 km south of Scalloway. It is apparent that the formation of the gneisses took place at a higher temperature than the metamorphism in the adjoining parts of the Whiteness Group. Late-stage, retrogressive effects include sericitization of feldspar and chloritization of biotite.

The most widespread effect of deformation subsequent to the main phase is cataclastic faulting and locally prominent kink folding. Rare lamprophyre dykes are entirely post tectonic and post metamorphic.

2.3 Interpretation

The original sedimentary protoliths to the now-metamorphosed Scalloway succession were sandstones, mudstones and subordinate limestones of probable shallow marine facies. No definitive examples of sedimentary structure are preserved but the micaceous partings, regularly spaced at intervals of a few millimetres through some psammite units, and the regular division of the rocks into bed-like units, commonly of slightly different composition, are probably original sedimentary features. Mineralogically the psammites and pelites now consist of varying proportions of biotite, muscovite, quartz and plagioclase; garnet, kyanite and staurolite are accessories. These minerals and others mentioned above all developed during prograde metamorphism.

Three stages have been recognized in the formation of the Colla Firth Permeation Belt. May (1970) recognized an earlier stage in which kyanite and staurolite were formed, but since the kyanite and staurolite occur only within the permeation belt they, like the garnet and sillimanite elsewhere, might have formed during the gneiss development. The first undisputed stage recognized in the metamorphism of the area as a whole is the regional metamorphism with coincident tectonizing deformation. In the second stage some of the rocks within the area of the permeation belt were partially or completely transformed into gneiss (Figure 7.5). The presence of partially transformed rocks ('semigneisses') and even unaltered rocks among the gneisses proves that their formation followed regional metamorphism. The third stage involved the emplacement of granitic and pegmatitic sheets into the folded gneisses of the permeation belt and the adjacent rocks on either side.

The three stages are closely connected by having similar fabrics; foliations, schistosities and lineations are all parallel where they exist, although some of the granitic sheets are structureless. There have been slight differences in the detailed interpretation of this evidence. In the opinion of May (1970), the textural evidence preserved within this GCR site confirms that the granitic sheets were intruded as the gneissose fabric formed; the constituent minerals in the granite have been granulated and recrystallized to produce a fabric continuous with that in both the gneissose and non-gneissose country rocks. May therefore considered that the regional metamorphism, the gneiss development and the emplacement of the granitic sheets were all 'syn-tectonic and broadly synchronous'. In contrast, Flinn (1954, 1967) considered that the gneisses formed in a distinct event immediately after the regional metamorphism, while the thermal and stress structure was still in place. The two events could however have overlapped and the granitic sheets were probably emplaced very soon afterwards. The radiometric (Rb-Sr) date of 530 ± 25 Ma, obtained by Flinn and Pringle (1976) for the granitic sheets should therefore indicate a minimum age for the main deformation and peak metamorphism of the Shetland Dalradian. However, it is neither precise nor accurate by modern standards and needs to be repeated using modern techniques.

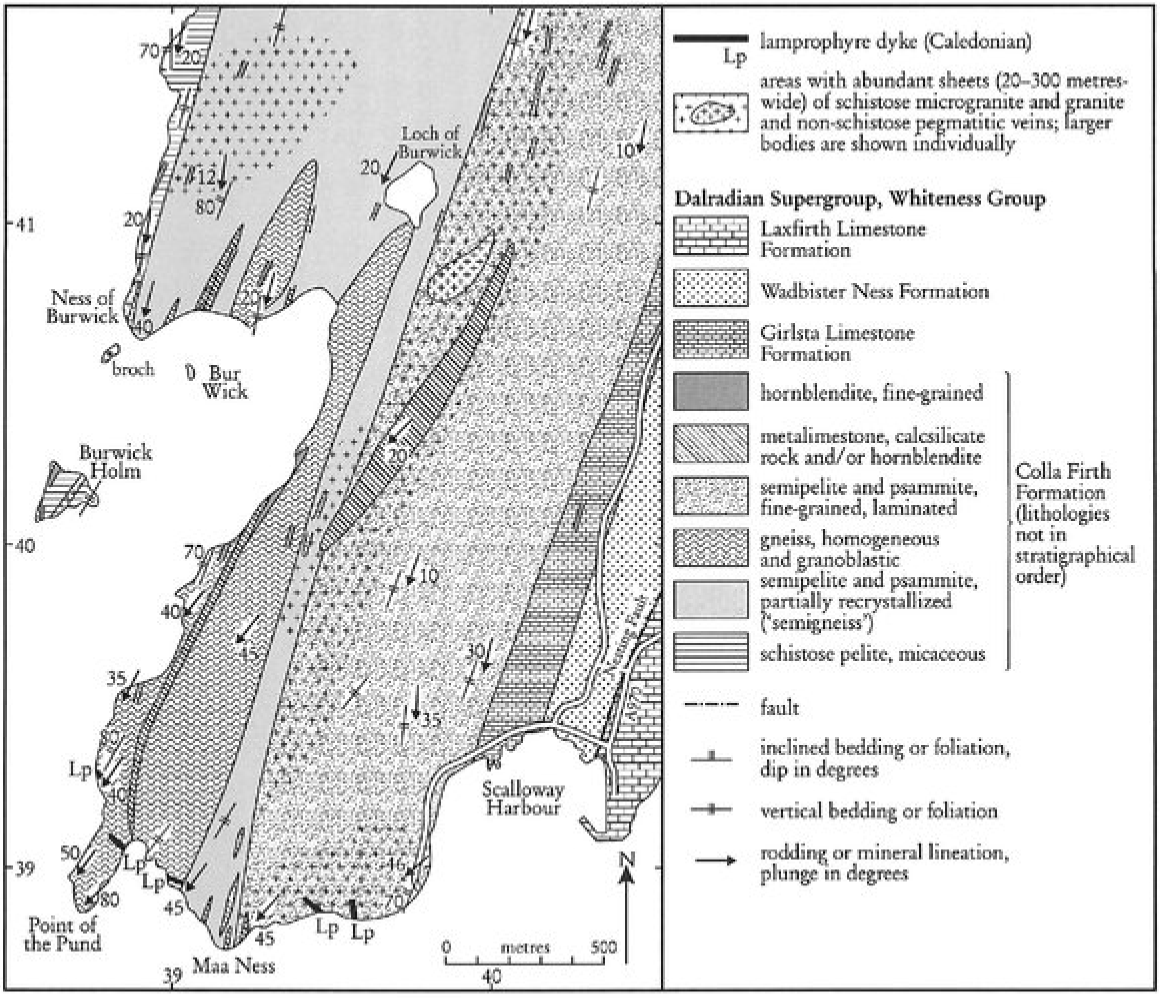
The possible causes and/or mechanisms of gneiss development have been discussed by Flinn (1954, 1967, 1995). The metamorphic minerals and grades involved are so low (below garnet grade in the Scalloway area) that there can be no question of the gneisses having formed by partial melting. He considered that the gneisses are most likely the result of recrystallization in which their grain size was doubled or trebled. This was brought about with little or no change of composition by the percolation (permeation) through the rocks of hot watery solutions from below, controlled by the pre-existing vertical layering and schistosity in the Whiteness Group. The water initiated the grain growth by grain-boundary migration and also supplied the heat for the diopside thermal aureole that occurs along the length of the belt. The granitic sheets are of S-type and probably formed by melting of the crust at depth. It is possible that they supplied some heat but it is notable that the aureole is continuous and is entirely confined to the gneisses, whereas the granitic sheets are irregularly distributed and extend beyond the aureole. May (1970), however, attributed the presence of diopside porphyroblasts in calcsilicate rocks to a late period of post-tectonic static metamorphism that is represented by the growth of various porphyroblasts elsewhere in Mainland Shetland (Flinn, 1967; see the *Hawks Ness* GCR site report).

2.4 Conclusions

The Scalloway GCR site provides a well-exposed and instructive section through part of the Colla Firth Permeation Belt, which is of national and possibly international significance. At the GCR site, this gneissose zone is developed within a sequence of semipelitic to psammitic metasedimentary rocks forming part of the Colla Firth Formation in the Whiteness Group of the Shetland Dalradian. The psammites and pelites have been recrystallized to a homogeneous granoblastic gneiss with a fabric parallel to that in the adjacent rocks outside the belt, which have been regionally metamorphosed and deformed but are not gneissose. Numerous granitic sheets and veins were intruded into both the gneiss belt and the adjacent non-gneissose rocks and these too have a schistose fabric.

Textural evidence preserved within the rocks of this GCR site confirms that the regional metamorphism and gneiss formation, although possibly originating from distinct events, were both broadly coincident with the principal deformation and that all of these events only shortly preceded or overlapped with the intrusion of granitic sheets. The age of the granitic sheets is therefore of great national importance as an indicator of the minimum age of deformation and peak metamorphism in the Shetland Dalradian. A radiometric, Rb-Sr date of 530 ± 25 Ma is imprecise, probably inaccurate and dating by a modern, more-precise method is clearly desirable. However, the date does suggest that the deformation might be radically different in timing to the deformation affecting the Dalradian sequence elsewhere (e.g. peaking at *c*. 470 Ma in the Grampian Highlands). It follows that an understanding of these tectonometamorphic relationships is crucial for the wider interpretation of the Dalradian succession both in Shetland and in the Scottish mainland.

[References](#)



(Figure 7.4) Map of the area around the Scalloway GCR site.

(Figure 7.5) Typical homogeneous granoblastic gneiss of the Colla Firth Permeation Belt, Whiteness Group, viewed normal to the lineation and parallel to the foliation. Point of the Pund, Scalloway [HU 3873 3889]. Hammer shaft is 33 cm long. (Photo: D. Flinn, BGS No. P 574422.)