Voxter Voe and Valayre Quarry

[HU 360 692]–[HU 362 706]

D. Flinn

Introduction

The Voxter Voe and Valayre Quarry GCR site contains several exposures of the Valayre Gneiss, including the Valayre Burn, where this unit was first described (Flinn, 1954). The Valayre Gneiss is an unusual lithological unit, in that it consists of microcline-megacryst augen in a variety of matrices. At the Valayre Quarry the matrix is a semipelite or micaceous psammite, but in other areas the matrix is pelitic and in places the gneiss resembles a deformed granite.

The Valayre Gneiss outcrop extends over a strike length of about 75 km. It occurs down the east coast of Yell (Figure 9.2) and across the Delting peninsula in the north of Mainland Shetland, where it marks the eastern limit of the Yell Sound Group, which is considered to represent the Moine Supergroup in Shetland. Accessible exposures of psammites of the Yell Sound Group occur in the GCR site in the cliffs to the north and south of Voxter Voe (Figure 9.14). The Valayre Gneiss generally marks the western limit of the Boundary Zone, which divides the dominantly Moine-like psammitic sequence to the west, from a more-mixed metasedimentary and metavolcanic succession to the east that is assigned to the Dalradian Supergroup.

Description

The GCR site encompasses the inlet of Voxter Voe and the adjacent shore and low cliffs of Sullom Voe to the north and south. It includes the lowermost part of the Burn of Valayre and the adjacent Valayre Quarry, which was formerly worked for roadstone and rock fill.

The key feature of this site is the Valayre Gneiss, which is exposed in the Valayre Burn, as well as at a number of other locations (Figure 9.14). The gneiss forms a zone containing abundant white microcline-megacryst augen, which varies in width up to 3 m in this area, but elsewhere can attain several hundred metres in thickness. The matrix lithologies are those of the local rocks, commonly with a mylonite-like schistosity. Thus, the unit varies from a schist, to a psammitic granofels, a leucosome-rich gneiss, a granoblastic gneiss, and even an anatectic gneiss in different parts of Shetland. The boundaries of the Valayre Gneiss are defined by the presence or absence of microcline megacrysts, and only rarely do they coincide with a change in matrix lithology. In this area the matrix rock-type is a schistose micaceous psammite or semipelite.

The microcline megacrysts vary from smoothly rounded to near-rectangular (up to 2:1), and are up to 5 cm long in their greatest dimension. Where the rock is lineated, the augen are best displayed on rock faces containing the lineation, and they commonly have tails composed of matrix-sized grains. The resulting augen having fat lenticular shapes that, together with the schistosity, impart a mylonitic appearance to the rock. The megacrysts are generally several centimetres apart; a typical example is seen where the gneiss crosses the Burn of Valayre (Figure 9.15) [HU 3676 6945] and on North Ward [HU 369 715]. However, in the Valayre Quarry [HU 3684 6959] the augen are atypical in that they are small and commonly several tens of centimetres apart.

In thin section some of the smaller augen are seen to be composed of two or more grains, or even aggregates of smaller microcline grains. Plagioclase augen up to several millimetres in diameter also occur, and these can also be composed of single or multiple grains. Some of the large microcline augen have rims about one matrix-sized-grain thick, made up of plagioclase and microcline, giving the rock a rapakivi-like texture. Such rims are absent from the plagioclase megacrysts. Some of the microcline-megacrysts contain inclusions of biotite apparently similar to the matrix biotites, but somewhat larger and with a different orientation.

The augen are all closely wrapped by the schistosity, defined mainly by micas in the matrix, which consists of quartz, plagioclase and micas with some interstitial microcline. Its grain size normally lies between 0.2 mm and 0.3 mm, typically less than that of the adjacent granofels and gneisses. Microcline is nearly always absent from the adjacent rocks.

The contact of the Valayre Gneiss with the Yell Sound Group can be seen in the Burn of Valayre, and these underlying rocks are exposed in the coastal cliffs of this GCR site. The dominant lithology exposed along the coastal sections is psatnmitic granofels. Where there is weak development of leucosomes, the psammites are termed 'semigneisses'. Similar rocks, again in the Yell Sound Group, are described in more detail in the Gutcher GCR site report (this chapter). At the south end of the Voxter Voe and Valayre Quarry GCR site the psammites have been thermally metamorphosed by the hypersthene-biotite diorite of the Brae Pluton, giving rise to cordierite and sillimanite in the more mica-rich psammites close to the contact and fibrolite farther away.

Interbanded with the psammites to the north of Voxter Voe are a number of distinctive beds of quartzite that are colour laminated on a centimetre-scale, with rectilinear parallel pale-brown stripes. Similar striped quartzites occur to the north on the small island of Bigga and at Copister on the southern tip of Yell, but are not seen elsewhere in Shetland.

Garnet-studded hornblende schist bands occur widely in the psammites of the Yell Sound Group along the coastal section at the Voxter Voe and Valayre Quarry GCR site, with garnets locally up to 1 cm across. In a number of places, particularly at Brei Wick [HU 363 708], narrow bands of coarse-grained biotite schist occur which are similarly garnet-studded, while adjacent hornblende schist bands tend to have coarse-grained biotite schist selvages and/or scattered flakes of biotite. The exposures show all gradations, from hornblende schist bands with no biotite, to biotite schist bands with no hornblende, both with and without garnet. In thin section the biotite schist bands are seen to contain some recrystallized hornblende, and the field occurrence is consistent with potash meta-somatism having transformed the hornblende to biotite.

The coastal section to the north and south of Voxter Voe has suffered much intense cataclasis as it forms part of the shatter zone along the Walls Boundary Fault (Flinn, 1977). The quartzites are particularly heavily shattered, while the psammites to the south of Voxter Voe have been contorted around vertical axes for 500 m to the east of the contact with the diorite of the Brae Pluton.

The rocks to the east of the Valayre Gneiss are mostly mica-rich leucosome psamtpitic and semipelitic gneisses belonging to the Boundary Zone. These gneisses contain rare hornblende schist bands, but no garnetiferous examples are seen, either here or elsewhere in the Boundary Zone gneisses.

Interpretation

The Valayre Gneiss marks the eastern boundary of the Yell Sound Group, and can be traced along strike for some 75 km up across northern Mainland Shetland and along the east coast of Yell. The gneiss appears to form a near-continuous element of the geology, apart from interruptions by late faults, and is undoubtedly a significant feature in the geological history of Shetland. It coincides with a major, but not instantly obvious, lithological and tectonic break. Close study of these rocks has shown that the rocks of the Boundary Zone to the east of the Valayre Gneiss are notably different to those of the Yell Sound Group to the west (Flinn, 1994). However, the Valayre Gneiss does not mark the contact between the Moine and Dalradian in Shetland. About 1 km to the east of the Valayre Gneiss in the Voxter area is the Skella Dale Burn Gneiss, which is characterized by parallel-orientated ovoid microcline augen, about 1 cm long, in a quartzofeldspathic matrix. Like the Valayre Gneiss, it can be followed for more than 50 km along strike, and marks the eastern margin of the Boundary Zone and its contact with the Scatsta 'division', the lowest part of the Dalradian Supergroup in Shetland (Institute of Geological Sciences, 1981).

In some places the Valayre Gneiss has a mylonitic appearance in the field, but in thin section it is obvious that a mylonitic fabric has been modified by later pervasive recrystallization. The augen have the appearance of porphyroblasts, not porphyroclasts, and Flinn (1994) suggested that they grew in a zone of movement, coeval with the regional metamorphism of the area. This movement brought the Moine and Dalradian blocks together to form the East Mainland Succession. Similar megacryst augen elsewhere in the world have been interpreted as relict phenocrysts (Vernon, 1990),

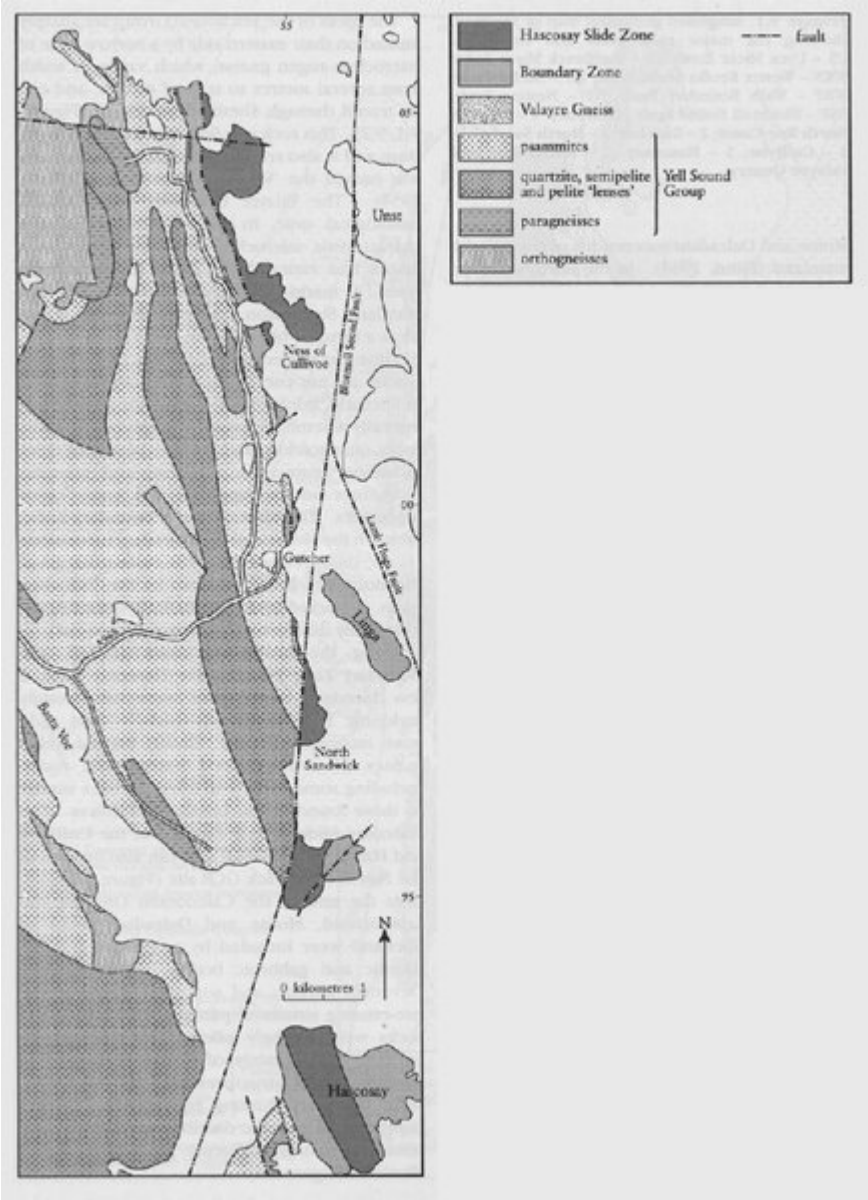
but this explanation does not seem appropriate for the Valayre Gneiss, whose genesis has yet to be fully explained.

The hornblende schist and biotite schist bands at this site that represent early mafic intrusive sheets and bodies in the Yell Sound Group have been analysed for major- and trace-elements. Their geochemistry shows that potassium contents increase with increasing biotite content, whilst calcium content decreases. Biotite schists of this type occur only in the proximity of the Brae Pluton, a twopyroxene-mica-diorite (Gill, 1965), and of the Graven Complex, a cluster of predominantly appinitic granodiorite intrusions that lies north of the GCR site (Flinn, 1985). Biotite from one biotite schist band has been dated by the K-Ar method at 391 ± 12 Ma (J.A. Miller, pers. comm.). A similar age of 392 ± 6 Ma was obtained from late-stage biotite from an altered twopyroxene-mica-diorite of the Brae Pluton (Miller and Flinn, 1966). However, biotite from an unaltered twopyroxene-mica diorite gave an age of 437 Ma (Gill, 1965). Biotites from the Graven Complex all give ages of about 407 Ma (Miller and Flinn, 1966). These dates have been recalculated using currently accepted decay constants. It is concluded that the hornblende schists were metasomatized soon after the emplacement of the Graven Complex, by late-stage fluids associated with the intrusions.

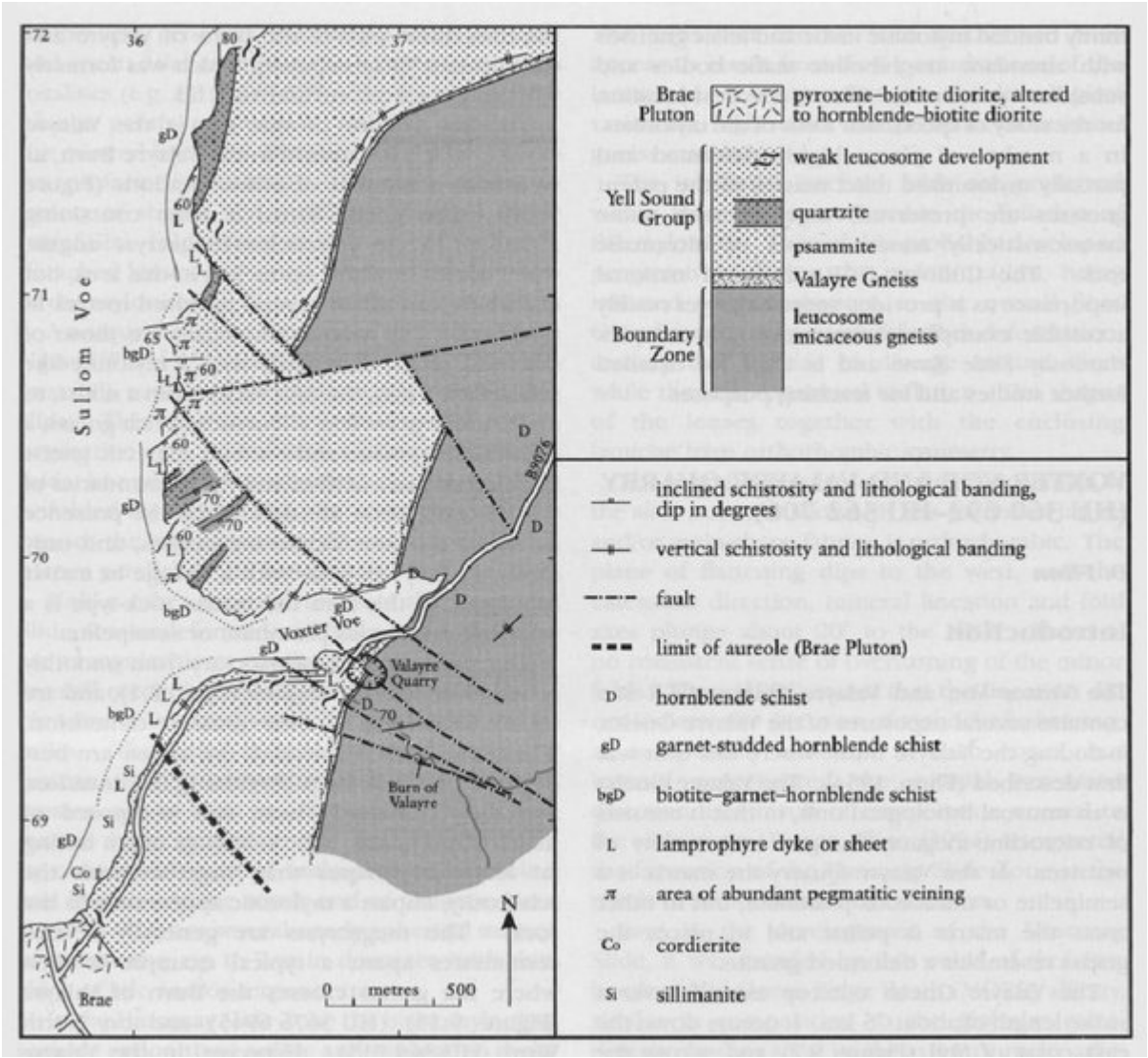
Conclusions

The Voxter Voe and Valayre Quarry GCR site contains the type locality of the Valayre Gneiss, first described by Flinn (1954). This microcline-megacryst augen gneiss lithology, which can be traced across Mainland Shetland and Yell, marks the eastern boundary of the Yell Sound Group, the Shetland equivalent of the Glenfinnan and Loch Eil groups of the Moine Supergroup on the Scottish mainland. Rocks of the Yell Sound Group are exposed in the coastal sections of this site. The Valayre Gneiss also marks the western margin of the Boundary Zone, a 1–2km-wide tectonically assembled band of mostly gneissose rocks that lies between the Moine and Dalradian group equivalents in Shetland. It remains unclear as to the origin and full geological significance of the Valayre Gneiss, but the site is undoubtedly of national importance and suitable for further study.

References



(Figure 9.2) Map of the north-east coast of Yell showing the main rock units and the locations of the Gutcher, North Sandwick, Hascosay and Cullivoe GCR sites. After 1:50 000 Sheet 130, Yell (British Geological Survey, 1994).



(Figure 9.14) Map of the Voxter Voe area on the east side of Sullom Voe, Mainland Shetland.

(Figure 9.15) Microcline-megacryst augen gneiss of the Valayre Gneiss in the Burn of Valayre, Voxter [HU 3676 6945]. 20 p coin for scale. (Photo: D. Flinn.)