Rubha Hunish

OS Grid Reference: NG410739

Highlights

The sills here show textbook examples of columnar jointing, chilled margins against sedimentary country rocks and transgressive relationships to the sediments. The thicker sills have a wide range of rock types, ranging from very olivine-enriched dolerites to pegmatitic dolerites rich in zeolites and poor in olivine. The marked variation in mineral proportions may be explained by the sinking of olivine during early crystallization of the sill magma and the subsequent redistribution of the mineral during flow of the magma.

Introduction

The Trotternish Sill Complex is one of the most remarkable features of the geology and scenery of northern Skye; excellent sill exposures lie within theRubha Hunish site (Fig. 2.10). The complex consists of a great sheet of basic–ultrabasic rock, typically split into a number of leaves which transgress through folded Jurassic strata while retaining a constant level below the base of the Tertiary lavas. The total thickness of the sill does not depart substantially from 230 m. The sheets provide fine examples of crystal differentiation and many ‘textbook' illustrations of the relationships between sills and their host sediments, as well as columnar jointing.

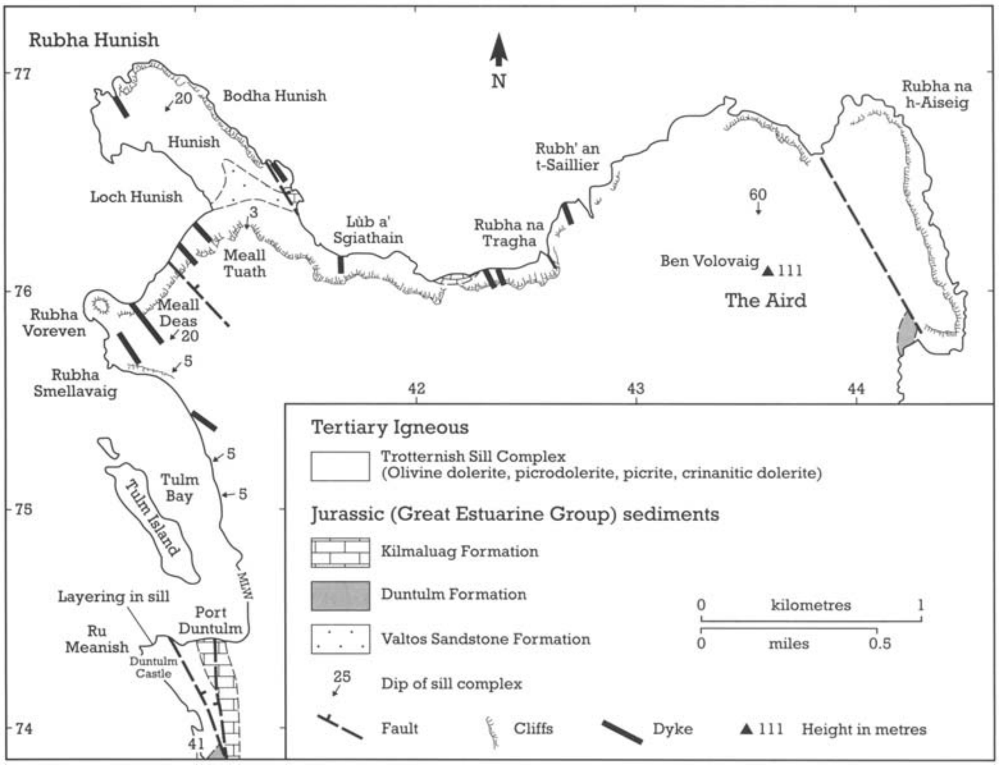

Figure 2.10: Geological map of the Rubha Hunish site (adapted from the British Geological Survey 'One-Inch' map, Northern Skye Sheet 80 and parts of 81, 90 and 91)

Walker (1932) and Anderson and Dunham (1966) have produced detailed descriptions of the Trotternish Sill Complex and Simkin (1967) has considered the role of flow differentiation during its emplacement. Bell and Harris (1986) give a useful synthesis of the Trotternish intrusions, and the geochemistry, mineralogy, petrology and structure of the sill complex have been examined in detail by Gibson (1988, 1990) and Gibson and Jones (1990).

Description

Many of the petrographic and structural features of the Trotternish sill complex, including columnar jointing and transgressive relationships to the sediments, are demonstrated in the shore and cliff sections of this site. Inland, exposure is often indifferent. The site contains most of the facies found in these sills, including olivine dolerite, crinanitic dolerite, picro-dolerite, picrite, pegmatitic dolerite and finer-grained dolerite and basalt in the chilled margins against Jurassic strata.

A leaf of the sill at Duntulm Castle (NG 410 743) forms the headland beneath the castle. The rock is an olivine-rich, orange-brown weathering dolerite. It contains about 20 dark-coloured doleritic bands, each a metre or so in thickness, situated approximately midway up the steep cliff face. A similar feature is seen at Rubha Smellavaig and at Rubha Voreven (NG 406 758) to the north, and in the Meall Deas–Meall Tuath cliffs (NG 410 761). At the former locality, the banding is on a similar scale; individual dark bands averaging 0.3 m in thickness. Drever (in Brown, 1969) noted that the banding was conformable with wedging out of the sill leaf at Rubha Voreven. Gibson and Jones (1990) provide descriptions and illustrations of the layering from a number of localities and give the first detailed account of the petrography amd mineralogy of the layered rocks. The layers have well-defined mafic bases and grade upwards within centimetres (or rarely, metres) to felsic tops which are also more resistant to weathering. The layering reflects variation in the modal proportions of olivine, augite and plagioclase; at the base of layers at Rubha nam Brathairean (NG 444 758) olivine (14%) and plagioclase are poikilitically enclosed by large augite crystals (29%) and up to 6% magnetite is present. Upwards, the proportion of plagioclase increases (59%), there is a decrease in olivine (7%) and augite (22%) and the habit of the pyroxene changes from large poikilitic (ophitic) crystals to small granules. No pronounced compositional variation ("cryptic layering') has been detected. Gibson and Jones consider that the layering developed *in situ*, influenced by strong thermal gradients across the contacts of the sills. It resembles layering found in other thick doleritic or fine-grained gabbroic intrusions, for example, the Camas Mor dyke on Muck (Camas Mor site). A thin dyke cutting the Duntulm sill exhibits banding on a centimetre scale parallel to its edges. The layering appears to be caused, in part, by alternations of bands rich in frond-like plagioclase and darker bands rich in augite; the exposure is reminiscent of the 'Mystery Dyke' exposed on the foreshore at Bornaskitaig (NG 372 715) which has been described by Drever (in Brown, 1969).

Immediately to the east of Rubha Voreven, the thickness of the sill complex increases substantially to over a hundred metres and is comprised of dolerite, picro-dolerite and picrite. Several distinct zones can be recognized in this exposure, banding being prominent in the lower third of the section, for which Anderson and Dunham (1966) give a comprehensive description. The basal contact of the sill is not seen here but is thought to occur just below the lowest exposures. Olivine dolerite at the base is at first succeeded upwards, through rapid gradation, by more olivine-rich dolerite (picro-dolerite) which forms the layered/banded portion. This is replaced at higher levels by olivine dolerite, the upper contact of which is missing. Simkin (1965, 1967) has described the modal mineral variation in the Trotternish sills, including the fine example at Meall Tuath (Anderson and Dunham, 1966, fig. 15; Fig. 2.11). Simkin attributed the distribution of olivine in the intrusions to the process of 'flowage differentiation' and on this hypothesis, some of the banding may therefore be a fluxion feature.

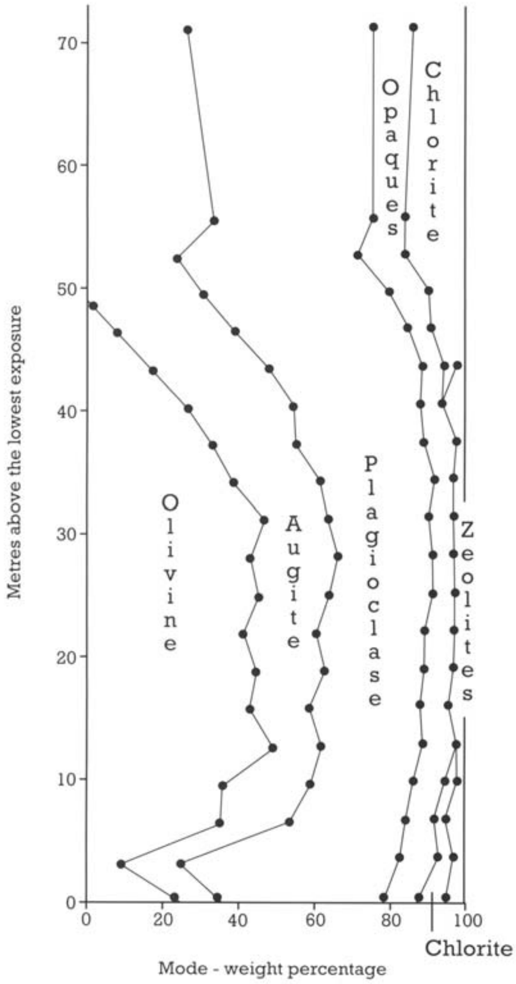

Figure 2.11: Modal variation in the Rubha Hunish sill (after Anderson and Dunham, 1966, fig. 15)

Much of the sill displays columnar, or prismatic jointing, fine examples occurring at Lub a' Sgiathain (NG 416 761). Here, spectacular fan jointing is observed which can be attributed to either intrusion into locally irregular bedding surfaces or unusual heat-loss conditions during cooling (Bell and Harris, 1986). At Rubha Hunish (NM 407 769), part of a sill leaf of crinanitic dolerite crops out beneath the olivine dolerite of Meall Tuath. In addition, patches of teschenitic dolerite occur within the sill at Ben Volovaig (NM 436 761) in association with veins and bands of pegmatitic dolerite. These carry rare olivine, a pale-brown idiomorphic clinopyroxene and large dendritic titanomagnetite. Zeolites are abundant, and large segregation veins, often sealing joint systems, are seen between Port Duntulm and Rubha Voreven.

Thin wedges of sediment separate the various sill leaves atRubha Hunish and small pockets of highly baked, often fused, sediments are recorded from many localities within the complex throughout the Trotternish Peninsula (for example, at Ru Meanish, NM 408 743). The sediments are recognized as belonging to the Great Estuarine Group (Lower Ostrea Beds and Ostracod Limestones) by Anderson and Dunham (1966), now termed respectively the Duntulm and Kilmaluag formations (Harris and Hudson, 1980).

Interpretation

Thick, mildly alkaline, olivine dolerite sills are a prominent feature of the successions beneath the plateau lavas of the British Tertiary Volcanic Province. In northern Skye, as elsewhere, they seldom intrude the lavas and are virtually restricted to the underlying Mesozoic (or older) sediments. However, immediately south of the site, at Creag Sneosdal (NG 415 689), the uppermost leaf of the complex intrudes the basal tuffs and sediments of the lava succession. The sill complex is remarkable in that it remains at a fairly constant level at or near the base of the lavas and therefore behaves in a broadly transgressive manner towards the open folds in the Jurassic strata. This suggests that lithostatic loading by the lava pile was an important factor controlling sill emplacement (Anderson and Dunham, 1966) implying a fairly constant thickness of lavas over northern Skye when the sills were intruded.

The relative ages of the sill complex and the Skye Main Lava Series lavas are fairly closely defined: the sills cut tuffs at the base of the lavas and may intrude the lowermost lavas at Camas Ban on the south of Portree Harbour (NG 493 428) and at Oisgill Bay (NG 135 495) on the western edge of the lavas. Both the sill complex and the lavas are cut by numerous dykes of the NW-trending swarm. The broad geochemical similarity between the sills and lavas of the Skye Main Lava Series was noted by Anderson and Dunham (1966). This was confirmed in detail by Gibson (1988) who concluded that the sills and lavas were related, but not exactly contemporaneous; the detailed elemental and isotopic data indicated that the Trotternish sill magmas reached higher crustal levels than the Skye Main Lava Series magmas before being significantly contaminated by wall rocks or fractionating. Thus, the sills and Skye Main Lava Series lavas belong to the same general phase of magmatism but emplacement of the sills was somewhat after at least the basal Skye Main Lava Series flows.

The striking mineral variation, and hence rock types, within the sill complex can be largely explained in terms of modal variation in the amount of olivine (Fig.2.11). Olivine enrichment in this sill complex and in many others is often explained in terms of gravitational settling of dense, early-formed olivine phenocrysts (for example, Walker, 1930). However, detailed investigations of the northern Skye sills by Simkin (1965, 1967) showed that such a process is an inadequate explanation, since the thicker parts of the sills do not display correspondingly thicker olivine-rich lower layers and the margins tend to be phenocryst poor. Using observations from the experimental studies of Bhattacharji and Smith (1964), Simkin applied their concept of flowage differentiation to explain the modal mineral variations in the Skye sills.

Conclusions

The north Skye sills result from the injection of mildly alkaline olivine basalt magmas into the Mesozoic sediments underlying the plateau lavas. The general level of sill intrusion conforms to the base of the lava pile but transgresses the folded sediments; the load imposed by the lava pile is thus seen as having exercised pressure control on the level to which the sill magmas rose.

The thick Trotternish sills show considerable internal variation in the proportions of their minerals, which is attributed to the combined effects of settling early-formed, dense minerals (olivine, possibly spinel) under gravity and their redistribution and concentration during flow of the intruding magma. The chemical composition of the less olivine-enriched facies of the sills is broadly comparable with alkali olivine basalts in the Skye Main Lava Series (SMLS). The sills must be of an age comparable with the SMLS, or slightly younger, since they appear to intrude only the lowermost part of the lavas and both sills and lavas are cut by many members of the north-west dyke swarm.

Reference list

Anderson, F.W. and Dunham, K.C. (1966) *The Geology of Northern Skye*. Memoir of the Geological Survey of Great Britain, HMSO, Edinburgh.
Bell, B.R. and Harris, J.W. (1986) *An Excursion Guide to the Geology of the Isle of Skye*. Geological Society of Glasgow, 317 pp.
Bhattacharji, S. and Smith, C.H. (1964) Flowage differentiation. Science, **145**, 150–3.
Brown, G.M. (1969) *The Tertiary Igneous Geology of the Isle of Skye*. Geologists' Association Guide, 13, 37 pp.
Gibson, S.A. (1988) The geochemistry, mineralogy and petrology of the Trotternish Sill Complex, northern Skye, Scotland. Unpublished Ph.D. Thesis, Kingston Polytechnic.
Gibson, S.A. (1990) The geochemistry of the Trotternish sills, Isle of Skye: crustal contamination in the British Tertiary Volcanic Province. *Journal of the Geological Society of London*, **147**, 1071–81.
Gibson, S.A. and Jones, A.P. (1990) Igneous stratigraphy and internal structure of the Little

Minch Sill Complex, Trotternish Peninsula, northern Skye, Scotland. *Geological Magazine*, **128**, 51–66.

Harris, J.P. and Hudson, J.D. (1980) Lithostratigraphy of the Great Estuarine Group (Middle Jurassic), Inner Hebrides. *Scottish Journal of Geology*, **16**, 231–50.

Simkin, T.E. (1965) The picritic sills of north Skye, Scotland. Unpublished Ph.D. Thesis, University of Princeton.

Simkin, T.E. (1967) Flow differentiation in the picritic sills of north Skye. In *Ultramafic and Related rocks*. (ed. PJ. Wyllie), Wiley, New York, pp. 64–9.

Walker, F. (1930) The geology of the Shiant Isles (Hebrides). *Quarterly Journal of the Geological Society of London*, **86**, 355–98.

Walker, F. (1932) Differentiation in the sills of northern Trotternish (Skye). *Transactions of the Royal Society of Edinburgh*, **57**, 241–57.