Introduction to the geology of the Isle of Skye

Figure 1 Geological sketch-map of Skye

Table 1 Schematic stratigraphic column for Skye
Chapter 1 Introduction

(A) History of research

The Isle of Skye has been the subject of numerous geological studies over the last 200 years. It has acted as an excellent training ground for several generations of geologists, as well as providing a challenging outdoor laboratory for research workers, especially in the field of igneous petrology.

The earliest published studies include descriptions by Macculloch (1819), Von Oeynhausen and Von Dechen (1829) and Forbes (1845), which established that igneous rocks figured prominently in the structure of the island, although details of their distribution were not elucidated. During the second half of the Nineteenth Century, numerous detailed studies were undertaken in order to gain a better understanding of the nature and development of these igneous rocks. Principal amongst these studies were the publications of Geikie (1857, 1888b, 1897) and Judd (1874, 1878). Resulting from this work, the Lower Tertiary age of the igneous rocks was deduced, but a controversy arose as to the age relations of the two principal intrusive rock-types of gabbro and granite, as well as the style of eruption of the associated lavas, with both central and fissure mechanisms being suggested.

Following on from these studies research on Skye entered a new phase, dominated by the monumental work of Alfred Harker. Invited by Sir Archibald Geikie, the then director of the Geological Survey of Great Britain, Harker undertook a detailed investigation of the Lower Tertiary igneous rocks which crop out in the central mountainous part of the island. He spent seven field seasons, between 1895 and 1901, preparing detailed geological maps and collecting material for laboratory studies. In 1904 he published his findings in the classic volume "The Tertiary Igneous Rocks of Skye" (Harker 1904). As a result of his studies, Harker settled many of the arguments between Judd and Geikie (in favour of the latter): the principal ones being that the gabbros pre-date the granites and that the lavas were probably erupted from fissures.

By the end of the Nineteenth Century the detailed mapping of the Moine Thrust Zone, initiated by Peach and Horne of the Geological Survey in 1883, had reached Skye and, Clough (in Peach and Horne 1907 and Peach et al. 1910) went on to show that these Lower Palaeozoic tectonic features were preserved in a complex fashion in the SE part of the island, on the Sleat Peninsula.

Also as part of the Geological Survey's investigations, Woodward, Barrow and Wedd (in Peach et al. 1910) mapped the extensive development of Triassic and Jurassic strata which crop out on Skye. These rocks are of particular significance, as studies of them have contributed greatly to our knowledge of the sedimentation history of northern Britain during Mesozoic times.

The presence, therefore, of the Lower Tertiary igneous rocks, the Lower Palaeozoic thrust sheets, and the Mesozoic sedimentary rocks, has made Skye a classic area for field studies. More recent
research, undertaken subsequent to the investigations of the Geological Survey, is described in later chapters. A brief synopsis of the geology is presented in Section (1B), below.

**B) Geological synopsis**

On the basis of both geological and topographic features the island can be divided into three distinct parts (Figure 1) and (Table 2).

First, the Sleat Peninsula in the SE part of the island is composed of Lewisian Gneiss, Torridonian sedimentary rocks, Moine Schists and Cambro-Ordovician sedimentary rocks. The exact field relationships of these various rock-types are complicated due to extensive thrusting events which took place during Lower Palaeozoic times. This involved the transportation of large sheets of Lewisian Gneiss, Torridonian sedimentary rocks and Moine Schists over a foreland consisting of all of these rocks, plus Cambro-Ordovician strata. The present-day, mature topography is glacial in origin, with numerous rounded hills never rising above 300m O.D. in the southern half of the peninsula and only rising to above 700m O.D. in the NE.

Second, north Skye, including the peninsulas of Trotternish, Waternish and Duirinish which consists of a plateau-type topography indented by large sea-lochs, such as Loch Dunvegan and Loch Snizort. Here, Jurassic sedimentary rocks crop out, mostly along the east coast, and are capped by large thicknesses of Lower Tertiary plateau lavas and pyroclastic rocks. Both the sedimentary rocks and the extrusive igneous rocks dip at a shallow angle to the west, giving rise to steep scarp slopes on the east side of this part of the island, whilst much gentler dip slopes occur in the west.

Basalts dominate the lavas, with numerous basic tuffs, containing bombs and fragments of lapilli-size, at the base of the pile. Further up the sequence sandstones and shales containing plant fragments are intercalated with the lavas.

Intruded into the Jurassic sedimentary rocks are sills of Lower Tertiary age, ranging from relatively homogeneous dolerites through to picrites showing mineral layering. Due to the contrast in hardness between the sills and the enclosing sedimentary rocks, there is the development of spectacular cliffs of columnar-jointed igneous material capping the softer Jurassic strata. The most famous example of this occurs on the east coast of north Skye, 2km south of Staffin, and is referred to as the Kilt Rock.

Another feature which involves these Jurassic and Lower Tertiary rock-types is extensive areas of landslipped material, which developed during Quaternary times. Spectacular scarp lines such as The Storr and The Quirang are examples.

Third, and giving rise to the most spectacular scenery, is the mountainous tract which forms the central portion of the island. Here, Lower Tertiary intrusive rocks, younger than the plateau lavas of north Skye, are dominant and strongly control the local topography. At the present level of erosion, the rock-types gabbro (s.l.) and granite (s.l.) are the most significant. The rugged horseshoe-shaped mass of the Cuillin Hills rises to about 1000m O.D. and is built of coarse-grained, basic rock-types, typified by gabbros. In strong contrast are the younger Red Hills, composed of intrusive acid rocks, lying to the north and east of the Cuillin Hills and exhibiting a more rounded, subdued outline. The Red Hills do not achieve the same altitude as the Cuillin gabbros and reach their maximum height in the summits of Glamaig (775m O.D.) and Marsco (736m O.D.). The spectacular topographic contrast between the gabbros of the Cuillin Hills and the acid intrusions of the Red Hills is most obvious in the vicinity of Glen Sligachan, which is flanked to the west by gabbro and to the east by granites and felsites.

Detailed mapping indicates that the coarse-grained basic rocks of the Cuillin Hills can be subdivided
into peridotites, allivalites, eucrites and gabbros (s.s.). Many of these units exhibit layering. In particular, the peridotites of An Garbh-choire and the gabbros of Druim Hain have been noted for their distinctive mineral banding. The margin of the Cuillin Complex appears to dip inwards at a steep angle, suggesting that the whole mass is funnel-shaped. Piercing these rocks are numerous pipe-like bodies of intrusive pyroclastic material, the largest occurrence of which is found on Meallan Dearg.

Another phenomenon associated with the layered basic rocks of the Cuillin Hills is the development of minor intrusions, referred to by Harker (1904) as inclined-sheets, but later renamed cone-sheets by Bailey et al. (1924). They are typically less than 1m thick and are composed either of basalt or dolerite. When mapped in detail they trace out the shapes of incomplete cones and have a common focal point below Meall Dearg, at the southern end of Glen Sligachan.

Post-dating the Cuillin Complex, there are three further centres of igneous activity, all of which are dominated, at the present level of erosion, by acid intrusions. These are, in order of development: (1) The Srath na Creitheach Centre; (2) The Western Red Hills Centre; and, (3) The Eastern Red Hills Centre. Spatially-associated with each of these centres are various pyroclastic rocks.

The Srath na Creitheach Centre is located at the southern end of Glen Sligachan and is composed of three distinct granitic intrusions, referred to as the Meall Dearg, Ruadh Stac and Blaven Granites. All are younger than the bedded pyroclastic rocks exposed at the northern end of Loch na Creitheach.

The younger Western Red Hills Centre lies further to the north and is dominated by ring-shaped acid intrusions. All are granites or felsites, other than: (1) the Marsco Summit Gabbro, which just predates the earliest granite of the centre; (2) marscoite, in the form of a thin, discontinuous ring-dyke, derived by the mixing of two discrete magmas, one of which was acid, the other an Fe-enriched basic fractionate called ferrodiorite; and, (3) a thin, discontinuous ring-dyke of the ferrodiorite. Rocks which have resulted from magma-mixing processes during the evolution of the Western Red Hills Centre, together with the basic parent (ferrodiorite) and the acid parent (a felsite) are collectively referred to as the Marscoite Suite. Intrusive agglomerates are found in the Belig and Meall a’ Mhaoil areas and are considered to have been formed by underground explosions during vent-forming episodes.

The Eastern Red Hills Centre is the last focal point of volcanic and subvolcanic activity preserved in central Skye and is located to the west of Broadford. Again, granites dominate, with the ring-dyke -shaped Glas Bheinn Mhor and Outer Granites, and a boss-shaped Inner Granite. Between the Outer and Inner Granites country-rocks are preserved, including: Lewisian Gneiss, Torridonian sedimentary rocks, Cambro-Ordovician dolostones (in places altered to marbles by the thermal effects of the granites), Mesozoic (Triassic and Jurassic) sedimentary rocks, and remnants of Lower Tertiary plateau lavas. Field relationships are complicated by the Lower Palaeozoic thrust sheets preserved within this part of Skye. As in the Western Red Hills Centre, early gabbro intrusions are recognised, namely the Beinn na Cro and Broadford Gabbros. South of the Inner Granite, at Kilchrist, is a large mass of pyroclastic rocks, surrounded by a mixed-magma ring-dyke formed of material referred to as the Kilchrist Hybrids. The pyroclastic rocks were considered by Harker to represent a vent infill, but more recently have been interpreted as a sequence of volcanic products deposited under subaerial and subaqueous conditions. Pyroclastic rocks are also found around the Inner Granite and a similar interpretation has been suggested for these. It is probable that the pyroclastic rocks and the mixed-magma Kilchrist Hybrids pre-date the main granitic intrusions of the Eastern Red Hills Centre.

Another feature of the Eastern Red Hills Centre is the development of an arcuate suite of composite
sills, running from Sitishnish in the south to Rubha na Sgianadin in the north. They consist of fine-grained basic margins and felsite centres. The basic components are usually less than 2m thick and chill against the country-rocks, whilst the acid centres are much thicker (in some cases up to 50m) and show no signs of chilling against the basic component, suggesting that both magmas were intruded over a short period of time. Composite dykes, of similar nature, are associated with these sills.

Cutting many of the rocks of the intrusive centres, as well as the surrounding country-rocks, are members of a NW-SE -trending Lower Tertiary dyke swarm. Most of the dykes are basic in composition, ranging from tholeiites, through transitional compositions, to distinctly alkaline types. They have their greatest development within the Cuillin Complex and are much less common in the relatively younger granites of the Srath na Creitheach, Western Red Hills and Eastern Red Hills Centres.

Other types of minor intrusion include: ultrabasic dykes and sills; trachyte dykes; augite-andesite dykes; pitchstone dykes; and, various brecciated acid intrusions.

During the Lower Tertiary igneous activity hydrothermal fluids circulated through the intrusive centres and surrounding country-rocks. This has caused much alteration of primary mineralogies, especially within the igneous rocks. Nearest the intrusive centres there is the development of secondary epidote and chlorite, whilst further out secondary zeolites are common.

Finally, glacial activity during Quaternary times has greatly modified and controlled the surface expression of many of the rock-types which crop out on Skye. In places, particularly on the lower ground, glacial deposits obscure the underlying solid geology.

References

Appendix 1: Glossary of petrological names and terms

Appendix 2: Glossary of fossil names

Appendix 3: Glossary of place names and grid references

At all times follow: The Scottish Access Code and Code of conduct for geological field work


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