Palaeogene extrusive products on the Isle of Skye

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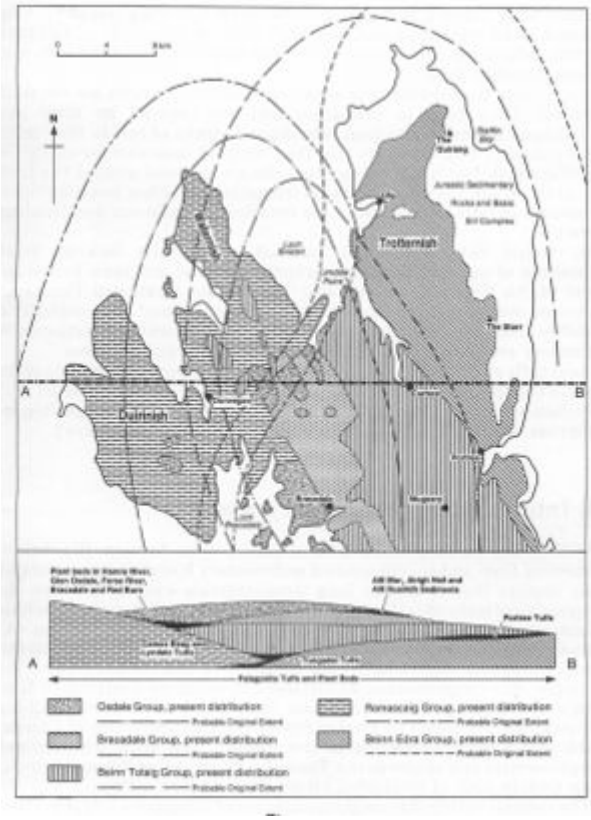

Figure 3 Geological sketch-map of the north Skye lava field (modified from Anderson and Dunham 1965)
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Contents

Chapter 3 Tertiary extrusive products

(A) Basal tuffs

Volcanic activity commenced on Skye at around 59Ma with the eruption of basaltic ashes (Figure 3). This material was deposited in shallow lakes which existed on a peneplained Jurassic surface. The violent nature of these eruptions is suggested by the presence of numerous bombs within the tuffs. Associated with these volcanic products are shallow-water lake sediments, including shales and sandstones, which contain plant fragments of Lower Tertiary age. In places the volcanic material grades into the lake sediments, suggesting that reworking processes were significant.

The tuffs contain sideromelane (a super-cooled basaltic glass), which has subsequently been altered by hydration processes associated with hot spring activity to a clay-like material called palagonite. Also present are crystals of olivine, pyroxene and plagioclase, fragments of black, slaggy material, and bombs of basaltic material, typically less than 20cm in diameter. Within the tuffs, especially towards the bottom of the sequence, plant fragments are preserved. These include grasses and conifers, suggesting a Mediterranian type of climate in the region.

Associated with the tuffs are: (a) minor vesiculated basic lavas containing pipe amygdales; (b) pillowed basalts; and, (c) horizons of accretionary lapilli, typical of tuff rings. The emission points of these volcanic products must have been relatively local, although they have not, as yet, been identified.

Exposure of the tuffs and associated sediments is generally restricted to north Skye. For example, in the Portree area, several sections containing a range of strata may be examined. In particular, the 30m-thick sequence at Craig Ulatota, on the east coast, north of Portree, illustrates the variability of the tuffs, ranging from very fine-grained material, through to coarser (lapilli-size) material containing bombs and lava pillows (or lava 'globes'). The sequence exposed in the gully on the south side of the Lon Druiseach illustrates how these rocks may be subdivided into individual beds, each representing a separate phase of volcanic activity. Other exposures include: the gully west of Beal (Bile) Chapel, SE of Torvaig; in the gorge of the River Chracaig (SW of Torvaig, below a small waterfall); and, at Camas Ban, on the south side of Loch Portree, where the rubbly base of the first lava flow above the tuffs may be examined in detail.

Away from the Portree area, especially inland, the tuffs are not well-exposed. They tend to inweather and are covered by scree and landslipped material, although landslipped blocks of tuff in the Staffin and Flodigarry areas indicate that they occur at least that far north. On the Waternish Peninsula palagonite tuffs are exposed around the Loch Bay area, where they are cut by an irregular sill. Other less significant exposures of tuffs in north Skye are detailed by Anderson and Dunham (1966).

In central Skye equivalent material is generally lacking. Small exposures of coarse-grained pyroclastic material are seen below the lavas of An Carnach, on the east side of the Strathaird Peninsula, although their exact field relationships are not clear. This material is possibly some kind of pyroclastic horizon which has been subjected to secondary reworking processes in a sedimentary environment.

Acid tuffs and breccias are also found along the northern margin of the Cuillin Complex, in the Fionn Choire, where they are intercalated with silicified trachytes (Thompson 1967) and overlain and underlain by members of the plateau lava sequence (see Section (3D), below).

(B) Interbasaltic sedimentary rocks

Within the main plateau lava sequence (see Section (3D), below) numerous fine- and coarse-grained sedimentary horizons are preserved. This implies that relatively long time-intervals existed between the outpouring of individual lavas, allowing rivers to deposit material within numerous depressions, and vegetation to develop (see Section (3A), above). A tremendous variety of sedimentary rock-types belong to this group, including: shales, siltstones, sandstones, and conglomerates. For example: the conglomerate, sandstone and siltstone horizons in Glen Brittle and at Dunan Earr an Sguirr (between Loch Brittle and Loch Eynort), first described by Harker (1904); the conglomerates of Creagan Dubh and Creag Strollamus in the Eastern Red Hills district; and, conglomerates and shales in the Tungadal River, NE of Roineval, and in Glen Osdale, ESE of Healabhal Mhor.

The cobbles within the conglomerates are of various rock-types. Those of north Skye (for example, Tungadal River) contain fragments of lava, together with blocks of Jurassic sedimentary rocks, whilst those of central Skye (for example, Glen Brittle and Creagan Dubh) consist of a more 'exotic' assemblage. Within the Glen Brittle horizons, in addition to blocks of lava and Jurassic sedimentary material, there are large, rounded cobbles of granite, which Meighan et al. (1981) suggest could have been derived from the slightly older Rhum Igneous Complex, which lies to the south. Thus, it is clear that igneous activity was not synchronous throughout the province and that erosion processes were extremely effective during Lower Tertiary times.

In Glen Osdale, ESE of Healabhal Mhor on the Duirinish Peninsula, shaly plant beds yield important Lower Tertiary leaf impressions which correlate with the famous Ardtun Beds of SW Mull (Bailey et al. 1924).

Intercalated with some of the tuff horizons at the base of the north Skye lava sequence (see Section (3A), above) are thin seams of lignite. Examples include: at Camas Ban, on the south side of Loch Portree; and, in the Loch Bay area. These deposits have long since been exhausted as a source of fuel.

(C) Interbasaltic laterites

Between several of the plateau lavas (see Section (3D), below) clay-rich laterite horizons (boles) form the leached, upper portions of individual flows. These laterites are distinctly red and vary in thickness from a few millimetres up to several tens of centimetres.

Good examples may be examined at: Creag Mhor, west of Beal Point on the north side of Loch Portree; north of the castle on Loch Dunveganside; in a road-cut opposite Lochan nan Dunan, north of Staffin Bay; and, at the sharp bend in the road at the southern end of The Quirang.

It is often considered that a tropical climate is necessary for the development of laterites. However, as noted by Anderson and Dunham (1966), leaching processes are just as effective if sufficient heat from the lava pile is dissipated by circulating, hot groundwaters (see Section (12F) of Chapter 12).

(D) Plateau lavas

Anderson and Dunham (1966) estimate that, prior to Late Tertiary and Pleistocene erosion, the total thickness of lavas in north Skye exceeded 1200m. Most of the flows probably originated via fissure eruptions over a considerable period of time. Although numerous Late Tertiary faults cut the lavas, there is no evidence of large-scale displacements.

Several distinct lava compositions have been recognised, including: alkali olivine basalt, tholeiitic basalt, hawaiite, mugearite, benmoreite, and trachyte. The more basic flows show the development of a massive, columnar-jointed, central portion which stands proud of the softer, rubbly bases and ashy tops, giving rise to the distinctive trap topography of the lava field. In his survey of central Skye, Harker (1904) concluded that these massive central units were in fact members of a 'Great Group of Basic Sills'. Subsequent work on Mull (Bailey et al. 1924), and on Skye (Anderson and Dunham 1966), has shown clearly that this is not correct. Nevertheless, large sills are found within the Jurassic strata below the lava pile (see Section (9H) of Chapter 9) and this may have influenced Harker's conclusion.

The lavas of north Skye dip at a shallow angle to the west and have average individual thicknesses of 10m. On the basis of their field relationships, they may be divided into five groups (Anderson and Dunham 1966). These are:

	m
5. Osdale Group	+500
Alternating basalt and mugearite flows	
4. Bracadale Group	120
Alternating mugearite and trachyte flows	
3. Beinn Totaig Group	600
Alternating basalt and mugearite flows. A porphyritic basalt at the top of the group	
2. Ramascaig Group	750
Alternating porphyritic and non-porphyritic basalts, with a mugearite flow at the top of the group	
1. Beinn Edra Group	300
Non-porphyritic basalts with a few porphyritic flows and a mugearite at the top of the group	

The distribution of these groups is shown in (Figure 3). Groups 1 and 2 both lie directly upon Jurassic strata, but are nowhere in contact. They are thought to have been erupted at approximately the same time. Groups 3, 4 and 5 lie above the first two groups and were erupted sequentially. Between the groups sedimentary horizons are occasionally found (see Section (3B), above). Detailed mapping shows that each of the groups thins markedly towards the margins of their present outcrop, suggesting that the original lava field did not extend any great distance further than that preserved at present.

The Beinn Edra Group occupies the area north of a line between Portree and Carbost, on the Trotternish Peninsula. The group is typified by the sequence exposed on The Storr. Anderson and Dunham (1966) list details of 24 flows which have been recognised in this section, although it is estimated that a further 120m of lava is concealed below scree and landslipped material. Most are olivine basalts, showing the development of laterites on their upper surfaces.

Lavas of the Ramascaig Group are preserved on the west side of north Skye, on the Waternish and Duirinish Peninsulas, and are dominated by alternating porphyritic and non-porphyritic basalts. Anderson and Dunham (1966) describe sections from Ben Connan and Healabhal Bheag in Duirinish, and Ben Geary in Waternish.

The Beinn Totaig Group differs from the previous two due to the presence of a significant number of mugearite flows, in addition to olivine basalts. Lavas of this group crop out in a broad belt of ground

running NW-SE between Lyndale Point in the north, and Glen Drynoch in the south. The type-locality mugearite occurs within this area, to the west of the settlement of Mugeary on Druim na Criche, and is found in the form of a composite flow containing porphyritic and non-porphyritic portions. Other good examples of similar composite lavas are exposed to the NE of Loch Harport, on Roineval.

Lavas of the Bracadale Group lie to the west of the Beinn Totaig Group and represent a westward shift in the volcanic activity. Mugearites and trachytes dominate this group, suggesting that the magmas involved resided within the crust for a sufficient period of time to allow extensive fractionation to take place. Four trachytes have been recorded from this group and all are found in the Ben Scudaig area, north of Bracadale. A particularly accessible trachyte flow from this group is exposed on the roadside 3km NE of Bracadale, at Ros a' Mheallain, where it is readily identified by its pale grey colour and platy fracture.

Finally, in the Osdale Group, there is a return to more basic compositions. These lavas are preserved along the east side of Loch Bracadale and are dominated by basalts and mugearites. The top of the sequence is not seen.

In a study of lavas from north Skye, Thompson et al.(1972, 1980a) paid particular attention to whole-rock compositions and mineralogies and concluded that two distinct groups are present:

1. A transitional series (in terms of their position with respect to the Critical Plane of Silica Undersaturation of the Basalt Tetrahedron of Yoder and Tilley 1962), which they term the Skye Main Lava Series (SMLS). This consists of olivine basalts, hawaiites, mugearites, benmoreites and trachytes. Within this group two divergent trends are identified:
    1. basalt hawaiite mugearite–benmoreite—which evolved under lower crustal (high) pressures
    2. basalt low-Fe intermediates trachyte—which evolved under upper crustal (low) pressures
2. Tholeiitic basalts, which Thompson et al. (1972, 1980a) refer to as members of the Preshal Mhor type, and which are found within the upper part of the Osdale Group. Presumably, these basalts constituted a significant proportion of the lava sequence which has been removed by erosion. In terms of their whole-rock compositions, there are many similarities between Preshal Mhor basalts (Ca-rich, K-, Ti- and P-poor, light rare-earth-element (LREE) depleted) and mid-ocean ridge basalts (Wilkinson 1982). The type-locality Preshal Mhor basalt, south of the River Talisker in Gleann Oraid, is over 100m thick, and may represent a fossil lava lake.

Thompson et al. (1972, 1980a) conclude that the lack of any distinctive geochemical trends within the lava sequence, with time, suggests that subvolcanic chambers, in the classical sense, did not exist below north Skye during Lower Tertiary times. They suggest that numerous small crustal reservoirs were more significant, and that good lateral connections were not present, thus allowing the almost synchronous eruption of dissimilar magmas.

Remnants of the Skye lava field are also preserved in central and southern Skye, in the vicinity of the intrusive centres. In particular, they crop out: (1) on the Strathaird Peninsula, and in Camasunary Bay; (2) in the Eastern Red Hills district, at Creagan Dubh, Creag Strollamus and Kilchrist; (3) in the southern and western Cuillin Hills; (4) on Glamaig and Beinn na Cro; and, (5) in the Fionn Choire, north of the Cuillin Hills.

1. On Strathaird approximately 18km^2 of lavas achieve a total thickness of 300m and lie directly upon Jurassic and Cretaceous strata. They are relatively flat-lying, although slight flexuring of the entire sequence, due to the nearby intrusive centres, is readily noted. The main exposures are found on the flat-capped hills of the peninsula, dominated by Ben Meabost, together with

the material on the west side of Camasunary Bay, south of Sgurr na Stri. All of these lavas have been subjected to hydrothermal alteration by the nearby Cuillin Complex (see Section (12F) of Chapter 12). Three zones of alteration have been identified (Almond 1964): (i) a narrow Inner Zone (100–400m wide) of pyroxene hornfels; (ii) a Middle Zone (approximately 1km wide), of actinolite-albite-epidote-chlorite-bearing rocks; and, (iii) an Outer Zone (at least 5km wide, the outer margin is not seen), where the lavas are slightly altered, but are still dominated by their primary mineralogies.

2. At Creagan Dubh basaltic lavas rest unconformably upon a basement of Lewisian Gneiss and exhibit greenschist-facies mineral assemblages. Ten lavas are preserved, with both members of the SMLS and tholeiitic types represented (B.R. Bell 1984a). The lavas at Creag Strollamus have not been studied in detail but can be traced across Caolas Scalpay, onto Scalpay. The Creagan Dubh and Creag Strollamus exposures do not show the development of the trap topography typical of the north Skye lavas, possibly as a result of hydrothermal and metamorphic alteration processes (see Section (12F) of Chapter 12). At Kilchrist basic lavas are intercalated with various pyroclastic rocks (B.R. Bell 1984a).
3. The fine-grained, basic rocks of the southern and western Cuillin Hills may be separated into two groups. The first group consists of basic lavas along the southern margin of the Cuillin Complex. These show features similar to the lavas of Strathaird, although the zones of alteration are much narrower. The second group consists of fine-grained, basic rocks within the various gabbros, eucrites and peridotites of the Cuillin Complex. Harker (1904) considered these as representing large blocks and slabs of basalt lava which had foundered into the Cuillin magma chamber. Subsequent studies (Bailey 1952; Hutchison 1966a) have concluded that these rocks are intrusive tholeiite sheets (see Section (9E) of Chapter 9).
4. On Glamaig, in the Western Red Hills, and on Beinn na Cro, in the Eastern Red Hills, extremely altered basaltic lavas have been elevated to their present positions by the incoming, later granites. A few kilometres north of Glamaig the base of the lava sequence is at sea-level, whilst on Glamaig, lavas have been raised to a height in excess of 700m O.D. Such differences in elevation can be taken as a measure of the uplift which took place during the intrusion of the granites.

In the Fionn Choire, north of the Cuillin Hills, lavas with a distinctive purplish-brown coloration and strongly-developed flow-banding crop out. Very little vegetation is present on the ground where these lavas occur, and their extent can be noted from as far away as Sligachan. They are intercalated with various acid tuffs and breccias, and the whole sequence is of the order of 600m thick. Originally, these lavas were interpreted as silicified rhyolites (Harker 1904), but Thompson (1967) showed them to be silicified trachytes, with many features in common with the trachytes of north Skye.

(E) Acid lavas

The only true acid (rhyolitic) lavas preserved on Skye are located in Srath Beag, in the Eastern Red Hills district (B.R. Bell 1985). The main outcrop is approximately 14m thick, shows a strong fluxion structure, and contains sparse phenocrysts of quartz and altered ferromagnesian minerals. Above the rhyolite is a thick ignimbrite sheet, whilst below are coarse agglomerates (see Section (8D) of Chapter 8). All three rock-types are preserved in a thin screen between the Inner and Outer Granites of the Eastern Red Hills Centre (see Chapter 7). The chemical composition of these rhyolites is very similar to that of the Outer Granite and it may be concluded that the rhyolites are extrusive equivalents of the subvolcanic granites of the district.

References

Appendix 1: Glossary of petrological names and terms

Appendix 2: Glossary of fossil names

Appendix 3: Glossary of place names and grid references

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