
Ardnamurchan

Introduction

The Ardnamurchan Peninsula is the site of a Tertiary igneous complex which was emplaced into Moine schists, Mesozoic sediments, and early Cenozoic volcanic rocks. It is much less rugged and mountainous than the other British Tertiary Volcanic Province central complexes, yet in many ways, it more strikingly — and often much more simply — demonstrates the salient geological features common to many of the centres.

The complex igneous geology of Ardnamurchan became recognized through the investigations of several geologists during the nineteenth century (for example, Judd, 1874, 1886; Geikie, 1888, 1897); however, it was not comprehensively mapped and examined until the official survey was undertaken by Richey and Thomas (1930). Despite appearing over half a century ago, the Ardnamurchan Memoir probably remains the most complete and widely used work on the area, although some of the interpretations and general conclusions reached in it have been questioned by subsequent investigators. The recent facsimile (1987) reprint of this Memoir is to be welcomed.

The Ardnamurchan Centre is renowned for its development of sets of cone-sheets and numerous arcuate, dominantly gabbroic intrusions which were, almost without exception, interpreted by the authors of the Memoir as ring-dykes. From the disposition of the ring-dykes and cone-sheets, Richey and Thomas (1930) recognized that these arcuate intrusions defined three separate centres of igneous activity (referred to henceforth as Centres 1, 2 and 3 respectively) and that the focus of the activity, as indicated by these centres, had shifted progressively with time (Table 4.1). Although there are many other features of interest in the igneous rocks of Ardnamurchan, it is these features in particular for which the area is renowned and upon which its claim to be of both national and international geological importance rests. The geology of the area has been the subject of several reviews and field guides (Richey, 1933; Richey, 1961; Stewart, 1965; Deer, 1969; Gribble *et al.*, 1976; Emeleus, 1982, 1983). It should, however, be mentioned that the status of the three independent but overlapping centres has been questioned (for example, Durrance, 1967; Green and Wright, 1969, 1974; Gribble *et al.*, 1976), as has the interpretation of many of the gabbroic and other intrusions as ring-dykes (for example, Wells, 1954a; Bradshaw, 1961; Skelhorn and Elwell, 1966). The Tertiary igneous geology of Ardnamurchan is represented by six SSSIs (Figure 4.1).

Relicts of the earliest activity, which was dominantly volcanic and probably covered much of the peninsula, are now found in the Ben Hiant area (Table 4.1). Remnants of mildly alkaline plateau lavas, overlying a basal ashy mudstone, are cut by a series of vents and pitchstone lavas of intermediate composition which post-date the basalts. The relationships of these rocks, together with numerous later dolerite intrusions, including a set of cone-sheets, are all excellently displayed in the Ben Hiant site; coarse volcanic breccias, possibly representing vent infills, are particularly well developed at Maclean's Nose.

The painstaking field and laboratory investigations of Richey and Thomas (1930) demonstrated the presence of a complex series of suites of cone-sheets and ring-dykes. Representative sections across such intrusions, assigned in the Memoir to Centre 2, are present in the Beinn na Seilg–Beinn nan Ord and Ardnamurchan Point to Sanna sites, while the most complete major ring structures are exposed in Centre 3 representing the final focus of activity. Studies made on these intrusions since the appearance of the Memoir have revealed features which, in some instances, do not conform to the expected pattern of the classic ring-dyke. Variations in these patterns have been noted in the two outermost intrusions of Centre 2 (Richey, 1940; Wells, 1954a, 1954b; Skelhorn and Elwell, 1966, 1971; Wells and McRae, 1969; Butchins, 1973). In addition to field studies, the mineralogy and geochemistry of the two principal centres (Centres 2 and 3) have received considerable attention (Bradshaw, 1961; Smith, 1957; Walsh, 1971, 1975; Gribble, 1974; Walsh and Henderson, 1977). Other features such as the dolerites, xenolithic inclusions and associated granophyric bodies with their distinctive net-veined relationships in dolerites have been described by Gribble (1974), MacGregor (1931), Wells (1951), Brown (1954), Paithankar (1968) and Vogel (1982).

The mutual relationships between all three centres of activity, and the successive truncation of the margins of intrusions and internal megascopic structures by later intrusions, are demonstrated in the Glas Bheinn–Glebe Hill site, where remnants of the former volcanic cover of the peninsula are also present as a screen between two ring-dykes. Intense thermal metamorphism of country rocks adjoining the major intrusions has been noted at several localities. A classic example of hornfelsed, aluminous, iron-rich, sediments (bole?) occurs in the site at Glebe Hill (Richey and Thomas, 1930), while a complex suite of calc-silicate hornfelses containing the mineral kilchoanite, first identified on Ardnamurchan (Agrell, 1965), crops out a short distance to the east.

(Table 4.1) The geological succession in the Ardnamurchan Central Complex (based on Richey and Thomas, 1930, Chapter 7)

(youngest)

Late NNW-trending dolerite dykes

Centre 3

Quartz monzonite

Tonalite

Fluxion biotite gabbro of Glendrain

Fluxion biotite gabbro of Sithean Mòr

Quartz-biotite gabbro

Quartz dolerite, granophyre-veined

Inner Euclite

Biotite euclite

Quartz gabbro, southern side of Meall an Tarmachain

Quartz gabbro of Meall an Tarmachain summit

Outer Euclite

Great Euclite

Cone-sheets of Centre 3 (sparse)

Porphyritic gabbro of Meall nan Con screen

Gabbro, south-east of Rudha Groulin

Gabbro of Plochaig

Fluxion gabbro of Faskadale

Quartz gabbro of Faskadale

(Migration of focus of activity to Achnaha area)

Centre 2

Felsite, south of Aodann

Fluxion gabbro of Portuairk

Younger quartz gabbro of Beinn Bhuidhe

Quartz gabbro of Beinn na Seilg

Quartz gabbro of Loch Caorach

Euclite of Beinn nan Ord

Inner cone-sheets of Centre 2

Quartz dolerite of Sgurr nam Meann

Quartz gabbro of Aodann

Older quartz gabbro of Beinn Bhuidhe

Granophyre of Grigadale

Quartz gabbro of Garbh-dhail

Old Gabbro of Lochan an Aodainn

Hypersthene gabbro of Ardnamurchan Point

Glas Eilean vent

Outer cone-sheets of Centre 2

(Migration of focus of activity to Aodann area [NM 453 664])

Centre 1 and the Ben Hiant vent*

Cone-sheets of Centre 1 (penecontemporaneous with the quartz dolerite intrusion of Ben Hiant)

Ben Hiant quartz dolerite

Composite intrusion of Beinn an Leathaid

Augite diorite of Camphouse

Quartz dolerite of Camphouse

Porphyritic dolerite of Ben Hiant

Granophyre west of Faskadale

Quartz gabbro west of Faskadale

Old Gabbro of Meall nan Con

Porphyritic dolerite of Glas Bheinn

Agglomerates of Northern Vents

Tuffs, agglomerates and lavas of Ben Hiant vents

Trachyte plug

(Igneous activity localized at Ben Hiant and also centred on a focus c. 1.3 km west of Meall nan Con)

Palaeocene basalt lavas and thin sediments

Jurassic and Triassic sandstones, shales, limestones, conglomerates

Moine metasediments

(oldest)

*The relative ages of many of the units assigned to Centre 1 and Ben Hiant are uncertain. (From Emeleus, in Sutherland, 1982, table 29.5).

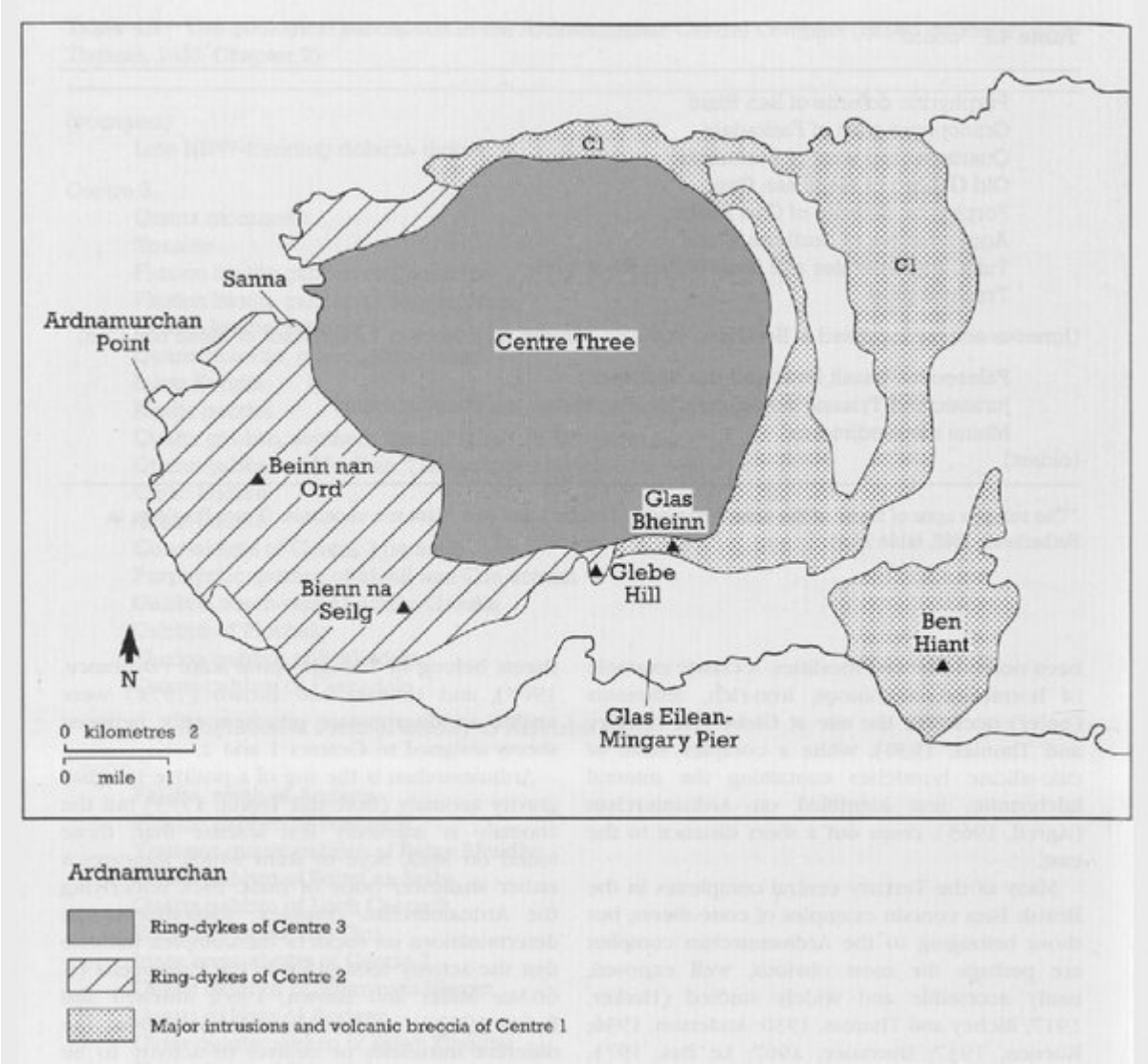
Many of the Tertiary central complexes in the British Isles contain examples of cone-sheets, but those belonging to the Ardnamurchan complex are perhaps the most obvious, well exposed, easily accessible and widely studied (Harker, 1917; Richey and Thomas, 1930; Anderson, 1936; Kuenen, 1937; Durrance, 1967; Le Bas, 1971; Holland and Brown, 1972; Phillips, 1974). The most extensive suites are those developed about Centre 2, and the Glas Eilean–Mingary Pier site has been selected as a standard reference section where the form, petrology, contact-metamorphic effects and, to some extent, the emplacement mechanism of these intrusions can be studied. In Richey and Thomas's classification, the cone-sheets in this site comprise part of the outer set of Centre 2; members of the inner set may be seen in the Beinn na Seilg–Beinn nan Ord site and the rather poorly developed suite attributed to Centre 3 may be studied on the south-east of the Centre 3 site (Table 4.1). The Glas Bheinn–Glebe Hill site contains cone-sheets attributed to Centre 1, but it has been suggested that all the cone-sheets belong to a single spiral suite (Durrance, 1967), and Holland and Brown (1972) were unable to discriminate geochemically between sheets assigned to Centres 1 and 2.

Ardnamurchan is the site of a positive Bouguer gravity anomaly (Bott and Tuson, 1973) but the anomaly is markedly less intense than those found on Mull, Skye or Rum which indicates a rather shallower body of mafic rock underlying the Ardnamurchan complex. Radiometric age determinations on rocks of the complex indicate that the activity took place in the Palaeocene (c. 60 Ma; Miller and Brown, 1965; Mitchell and Reen, 1973) but the data do not allow the different intrusions or centres of activity to be separated, since the duration of igneous activity at Ardnamurchan was probably of the order of one million years, comparable with the margin of error of the Ardnamurchan age determinations (cf. (Table 1.1); Mussett *et al.*, 1988).

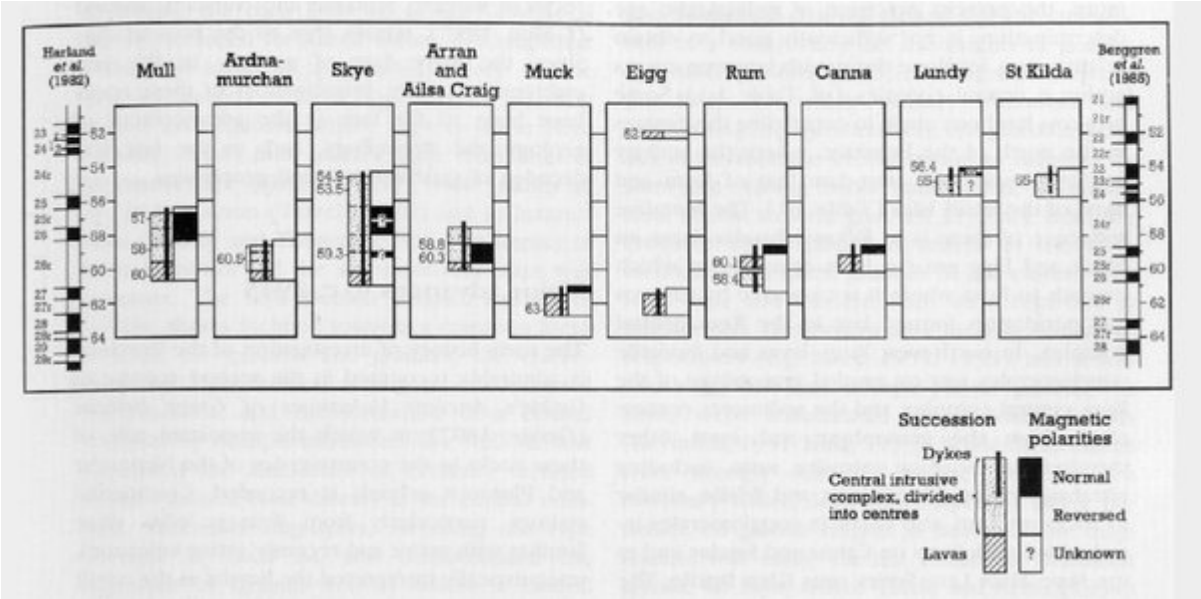
References

(youngest)	Late NNW-trending dolerite dykes
Centre 3	<ul style="list-style-type: none"> Quartz monzonite Tonalite Fluxion biotite gabbro of Glendrain Fluxion biotite gabbro of Sithian Mor Quartz-biotite gabbro Quartz dolerite, granophyre-veined Inner Eucrite Biotite eschrite Quartz gabbro, southern side of Meall an Tarmachain Quartz gabbro of Meall an Tarmachain summit Outer Eucrite Great Eucrite Cone-sheets of Centre 3 (sparse) Porphyritic gabbro of Meall nan Con screen Gabbro, south-east of Ròdha Groulin Gabbro of Plochaig Fluxion gabbro of Faskadale Quartz gabbro of Faskadale
	(Migration of focus of activity to Achnaha area)
Centre 2	<ul style="list-style-type: none"> Felstie, south of Aodann Fluxion gabbro of Portuairk Younger quartz gabbro of Beinn Bhuidhe Quartz gabbro of Beinn na Seilg Quartz gabbro of Loch Caorach Eucrite of Beinn nan Ord Inner cone-sheets of Centre 2 Quartz dolerite of Sgorr nam Meann Quartz gabbro of Aodann Older quartz gabbro of Beinn Bhuidhe Granophyre of Grigadale Quartz gabbro of Garbh-dhall Old Gabbro of Lochan an Aodainn Hypersilene gabbro of Ardnamurchan Point Glas Eilean vent Outer cone-sheets of Centre 2
	(Migration of focus of activity to Aodann area (NM 483 684))
Centre 1 and the Ben Hiant vent*	<ul style="list-style-type: none"> Cone-sheets of Centre 1 (penecontemporaneous with the quartz dolerite intrusion of Ben Hiant) Ben Hiant quartz dolerite Composite intrusion of Beinn an Leathaid Augite diorite of Camphouse Quartz dolerite of Camphouse
	<ul style="list-style-type: none"> Porphyritic dolerite of Ben Hiant Granophyre west of Faskadale Quartz gabbro west of Faskadale Old Gabbro of Meall nan Con Porphyritic dolerite of Glas Bheinn Agglomerates of Northern Vents Tuffs, agglomerates and lavas of Ben Hiant vents Trachyte plug
	(Igneous activity localized at Ben Hiant and also centred on a focus c. 1.3 km west of Meall nan Con)
	<ul style="list-style-type: none"> Palaeocene basalt lavas and thin sediments Jurassic and Triassic sandstones, shales, limestones, conglomerates Molise metasediments
(oldest)	
*The relative ages of many of the units assigned to Centre 1 and Ben Hiant are uncertain. (From Embley, in Sutherland, 1982, table 29.5).	

(Table 4.1) The geological succession in the Ardnamurchan Central Complex (based on Richey and Thomas, 1930, Chapter 7)



(Figure 4.1) Map of the Ardnamurchan Peninsula showing localities mentioned in the text.



(Table 1.1) British Tertiary Volcanic Province: summary of the geological successions, radiometric ages and magnetic polarities (after Mussett et al., 1988, figure 2)