Post-Caledonian minor intrusions, Grampian Highlands

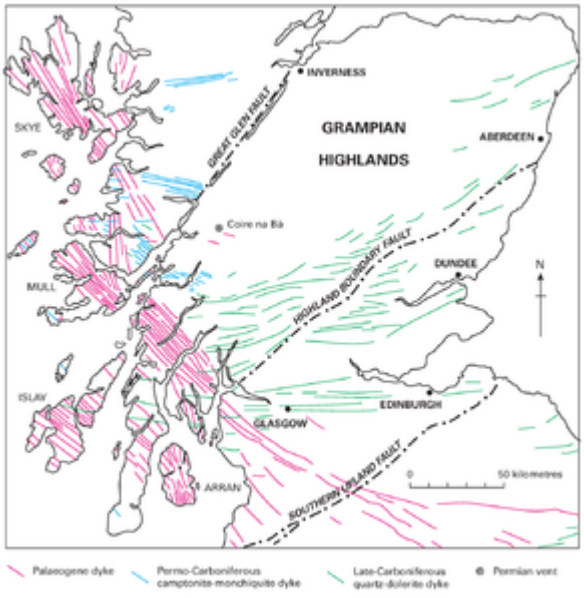
From Earthwise
Jump to navigation Jump to search

Stephenson, D, and Gould, D. 1995. British regional geology: the Grampian Highlands. Fourth edition. Reprint 2007. Keyworth, Nottingham: British Geological Survey.
□

Contents

Late Carboniferous Quartz-Dolerite Dyke Suite

Numerous east-trending quartz-dolerites occur in several parts of the Grampian Highlands (P915446). These are locally seen to cut the NNE- to NE-trending Late Caledonian dykes (Chapter 8) and are themselves cut by Permo-Carboniferous and Palaeogene dykes. They are most numerous in Argyll, good examples being seen at Carrick, Lochgoilhead and Restil (Cowal), and are quite common in Perthshire, with a few dykes also extending into Deeside and Buchan. Many of the dykes can be traced for considerable distances and can be readily located by aeromagnetic surveys due to their high magnetic susceptibilities. The Lochgoilhead dyke, for example, probably continues eastwards as far as Perth, a distance of over 100 km, while another, possibly discontinuous, dyke extends 65 km from Boddam, near Peterhead, to near Rhynie (Buchan, 1932; Gould, 1997). The quartz-dolerite dykes are usually thick; Read (1923) recorded a thickness of 13 m at Auchinbradie, near Insch, and they are commonly over 10 m.



Distribution of post-Caledonian minor intrusions in the Grampian Highlands and

adjacent regions. P915446.

The dykes in the Grampian Highlands represent the northern part of the more widespread quartz-dolerite suite of the Scottish Midland Valley (Cameron and Stephenson, 1985) and of northern England (Dunham and Strasser-King, 1982). The trend of the main dyke swarm swings from ESE at Loch Awe in the South-west Highlands, through east–west to north-east in Aberdeenshire. The trend of the intrusions may have been influenced by the Highland Boundary Fault but Russell and Smythe (1983) interpret the arcuate trend of the swarm as the site of a nascent ocean rift formed at the beginning of the separation of Greenland from north-west Europe. The dykes form part of a much wider magmatic province extending into Scandinavia (Macdonald et al., 1981)

In the Midland Valley and northern England, there are good stratigraphical controls on the intrusion age. K-Ar ages of 302 to 297 Ma have been obtained on Midland Valley quartz-dolerite dykes and sills (Fitch et al., 1970; de Souza, 1979) and by analogy, the dykes within the Grampian Highlands were probably intruded during a narrow time interval—perhaps about 5 Ma—in latest Carboniferous to earliest Permian times (about 300 Ma).

Petrographically, the dykes are fairly uniform, comprising laths of basic plagioclase, ophitic augite, opaque phases and a glassy or micropegmatitic mesostasis, with or without pseudomorphed olivine, hypersthene or pigeonite. Amphibole and biotite may fringe augite and the opaque phases. Chemically, they divide into dominant tholeiites, with subordinate olivine tholeiites and tholeiitic andesites, through variations in normative quartz, differentiation index and Mg/Mg + Fe ratio (Macdonald et al., 1981). The dykes are relatively rich in Ti and Fe, and are closely comparable to certain basalts erupted in Iceland and Hawaii at the present time. Chemical variations along dykes are slight but some thicker dykes show more significant variations across their width.

Permo-Carboniferous Camptonite–Monchiquite (Alkaline Lamprophyre) Dyke Suite

The alkaline lamprophyres of the Grampian Highlands are chemically similar to suites in Norway, USA, Alaska and New Zealand (Rock, 1983). They were mostly intruded as dykes, though there are a few vents and plugs. The dominant rock types are camptonite, monchiquite and alkali basalt. Petrographically, most of the dykes consist of titanium-rich augite, biotite and amphibole (kaersutite), generally occurring as phenocrysts, in a groundmass of the same minerals plus feldspars (camptonite) and often abundant feldspathoids (monchiquite). Chemically, the dykes range from mildly silica-undersaturated alkali basalts through basanites to very strongly undersaturated nephelinitic compositions. Collectively, they are the most silica-poor and alkali-rich of any igneous rocks in the British Isles, and resemble certain recently erupted lavas and intrusive rocks of the Honolulu area of Hawaii and the East African Rift. The dykes are coeval with the Permian Glas Eilean lavas and probably with a 60 m-thick alkali olivine-dolerite sill which intrudes the Coal Measures of the Machrihanish outlier. The parent magmas of these rocks are probably closely related, though the more undersaturated differentiates are known only from the dyke swarm. Baxter (1987) postulates that they were formed by 0.4 to 2 per cent partial melting of a garnet-lherzolite source underlying the spinel-bearing lithospheric mantle found as xenoliths in some monchiquites.

Some of the dykes retain fragments (xenoliths and xenocrysts) of the lower crust and mantle through which they have passed. The Colonsay, Machrihanish and Ardmucknish dykes have all yielded rich and highly significant mantle xenolith assemblages (Rock, 1983; Upton et al., 1983), as has the small volcanic agglomerate-nephelinite vent at Coire na Bà near Kinlochleven (Bailey, 1960). The xenoliths include a wide range of pyroxenites and peridotites (olivine-pyroxene-rich rocks), many of them rich in biotite, tangible evidence that a heterogeneous mantle underlies this part of Scotland.

Palaeogene dykes

In the South-west Highlands, an immense number of mostly basic Palaeogene dykes occur and trend uniformly NW–SE. There are several distinct major concentrations (P915446; Speight et al., 1982). That traced through Appin and Cowal represents the south-western extension of the regional linear swarm emanating from the Mull Central Complex; the regional linear swarm has locally resulted in 10 per cent crustal extension (about 60 to 70 dykes per kilometre traverse). The dyke swarms through Islay and Jura/Colonsay (F Walker, 1961), causing some 5 per cent crustal extension (23 dykes per km), have not been positively linked to any intrusive centre but aeromagnetic data suggest that they may emanate from the submarine Blackstones Centre west of Mull. Smaller swarms of dykes in northern Kintyre (McCallien, 1932) and Craignish (Allison, 1936) represent northern bifurcations of the Arran swarm and result in a maximum crustal extension of 5 per cent (about 12 dykes per km).

Petrologically, the dykes include both tholeiitic and alkali basalts and dolerites, mugearites, tholeiitic andesites, andesitic pitchstones and trachytes, with numerous composite and multiple examples. Little modern work has been carried out on the Palaeogene dykes in the Grampian Highlands but summaries of information for dykes of other areas are given by Thompson (1982a; b).

Two small Palaeogene bosses are noteworthy. An elongated boss on Maiden Island, Oban (Walker, 1939), shows an unusual occurrence of picrite marginal to olivine-dolerite. A second boss at Cnoc Rhaonastil, Islay (Walker and Patterson, 1959; Hole and Morrison, 1992) is one of a very rare group of Palaeogene alkali dolerite intrusions (similar rocks form the much better-known Shiant Isles Sill-complex of the Minch), which carry nests of feldspathoidal syenite differentiate.

All these dykes and bosses can be dated, by analogy with adjacent areas, to the period 60 to 52 Ma (Macintyre et al., 1975).

Full list of references

Namespaces

- Page
- Discussion

☐

Variants

Views

- Read
- Edit
- View history
- PDF Export

☐

More

Search

Search Go

Navigation

- Main page
- Recent changes
- Random page
- Help about MediaWiki

Tools

- What links here
- Related changes
- Special pages
- Permanent link
- Page information
- Cite this page
- Browse properties

- This page was last modified on 31 January 2018, at 15:44.

- Privacy policy
- About Earthwise
- Disclaimers
-

-