Bedrock Geology UK North: Cenozoic

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> **This topic provides descriptions of the rock types appearing on the British Geological Survey 1:625 000 scale map of the UK North and gives a brief explanation of their origins.**
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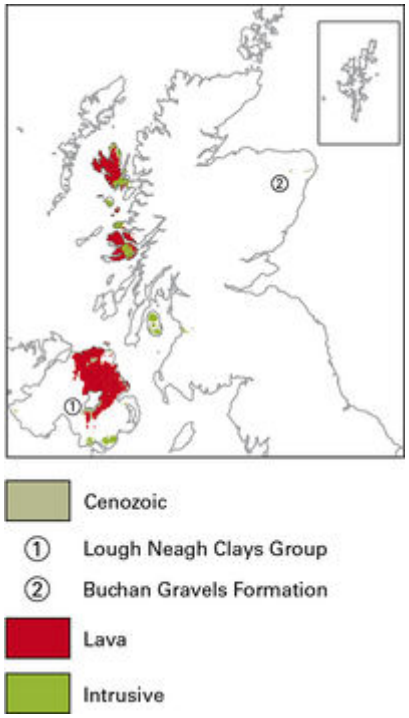
65 million years ago to the present day

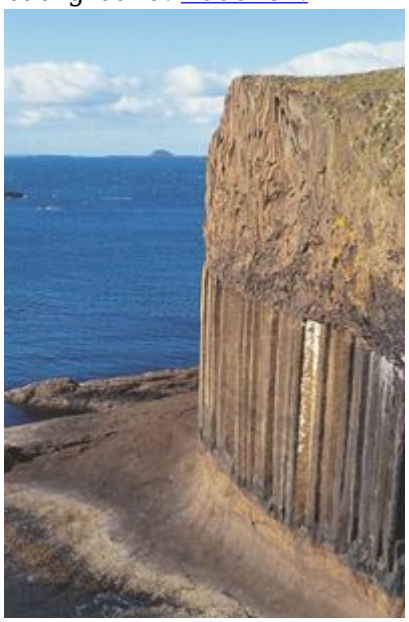


P785813.


MacCulloch's Tree: the cast of a large coniferous tree-trunk caught up in Palaeogene lava at

Ardmeanach, Mull. P580468.

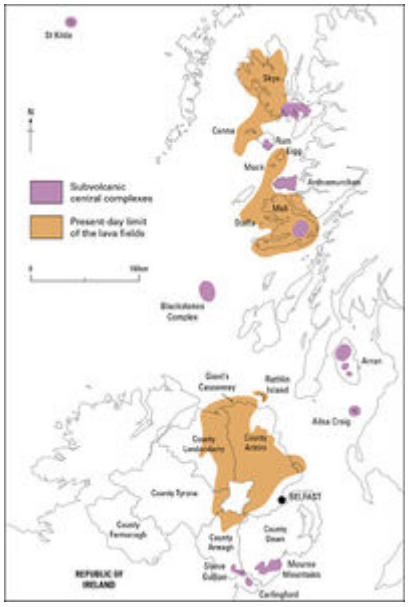
Columnar jointing in Palaeogene mafic lava forms the Giant's Causeway. The top of the Grand Causeway in the foreground, with the cliffs of Roveran Valley Head and Spaniard Rock in the background. P006482.



Columnar jointing in a thick Palaeogene basalt lava flow, Staffa (and Fingal's Cave). P580464.

At the end of the Cretaceous Period uplift in southern Britain was associated with the first stirrings of the Alpine Orogeny—the deformation episode driven by collision between the European and African plates, which had separated with the break-up of Pangaea. The main Alpine structural effects were imposed during the Palaeogene Period, but had little impact beyond southern England and Wales. Farther north, a very different Palaeogene history unfolded. Here, regional uplift and erosion late in the Cretaceous preceded the major episode of magmatism that produced intrusive subvolcanic complexes and the extensive and largely subaerial Palaeogene lava fields (G) that are seen across the Hebridean region of western Scotland and Northern Ireland (**Figure P785804**). Magmatism spanned an interval from about 62 Ma to about 55 Ma, and marked the first, failed attempts at continental break-up in an extensional episode of crustal thinning that culminated in the successful opening and spreading, farther west, of the Atlantic Ocean. Coarse, clastic sedimentary rocks are intercalated with the earliest of the lavas and suggest that the latter were erupted onto a land surface with considerable local relief. The climate was warm temperate to subtropical and plant

remains from the sedimentary beds associated with the lavas confirm that they were erupted across surface environments that ranged from upland forests down to low-lying swamps and lakes. In one spectacular example from Mull, the cast of a large conifer—known as MacCulloch's Tree—is encased in columnar basalt lava (**Plate P580468**).



Present-day distribution of lava fields and subvolcanic complexes of the Hebridean Province. P785804.

The initial, fissure eruptions produced mostly mafic lava but the later lava eruption from central volcanoes was accompanied by pyroclastic activity, which contributed to the sedimentary sequences accumulating in offshore basins. There, in the North Sea and Faroes–Shetland basins, more-or-less continuous Palaeogene and Neogene sequences of sandstone and mudstone reach thicknesses of 3000 and 4000 m, respectively. Post-volcanic Palaeogene sequences are preserved onshore only in Northern Ireland and may never have been extensive.

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  Jointing in the upper part of the lava flow is chaotic but is spectacularly regular in the lower part, which rests on a bed of volcaniclastic rock. P000770.

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The hills of northern Arran, composed of Palaeogene granite from the Arran Central Complex. P580487.

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Well-developed mineral layering in a Palaeogene gabbro from the Cuillin sector of the Skye Central Complex, Maell na Cuilce, Skye. P580475.

Palaeogene volcanic rocks

In the Hebrides of western Scotland, extensive lava fields are centered on Skye and Mull, with the Antrim lava field farther to the south, in Northern Ireland; much more extensive lava outcrops occur offshore on the north-west continental margin. In thickness, the lava sequences range up to at least 1800 m thick on Mull and Skye (Mull and Skye Lava groups) and to at least 1000 m in Northern Ireland (Antrim Lava Group). The lower lavas are commonly interbedded with water-laid, tuffaceous sandstone that accumulated in shallow lakes or on alluvial plains; plant remains are commonly included. Higher in the thick and predominantly basaltic lava sequences, there are sporadic interbeds of various pyroclastic and volcaniclastic rocks.

Individual lava flows are commonly up to about 10 m thick, but some are much thicker, reaching over 120 m in Skye. The bases of the flows are generally vesicular; some flows are vesicular throughout, but the central parts of many flows are more massive and may show columnar jointing, spectacularly so in places such as Staffa, off Mull, and the Giant’s Causeway that is part of a World Heritage Site in County Antrim (**Plate P006482**). Some thick flows with columnar jointing in their centres also have an overlying, upper zone in which the columns are complex and highly irregular

(**Plate P000770 and P580464**). The topmost parts of the lava flows may also be vesicular and were commonly reddened by lateritic weathering during any hiatus in eruption. In Northern Ireland the Interbasaltic Formation, which separates the two main lava sequences, comprises 10 to 15 m of deeply weathered basalt that has been converted to a lateritic and locally bauxitic palaeosol.

Central, subvolcanic complexes and dyke swarms

The Palaeogene central complexes are the deeply eroded roots of major volcanoes. In general, they postdate the preserved lava fields, in some cases intruding them, but they overlapped in time with intrusion of the related dyke swarms. The central complexes mark a fundamental change in the character of the igneous activity from the widespread, multi-sourced eruption of the lava fields, to the more intense and localised magmatism of major volcanoes. There was also a marked change in the composition of the magmas. Whereas the lava (and dyke) eruptions were dominantly basaltic, the central complexes are compositionally diverse, containing a range of component rocks from ultramafic and gabbroic types to granite. Granite forms a large part of the surface outcrop in some areas (**Plate P580487**) but the more mafic lithologies are thought to form substantial, dense cores to the complexes at depth. Most of the complexes also contain enclaves of pyroclastic rock or lava, suggesting an early association with surface volcanism. Some of the gabbros show well-developed mineral layering (**Plate P580475**).

Several well-defined and broadly north-west-trending regional dyke swarms cut across the northern part of the British Isles, their intrusion reflecting a north-east–south-west extensional stress regime. The swarms intensify in the vicinity of the Palaeogene central complexes but intrude, and therefore generally postdate, the extensive lava fields although they too were undoubtedly fed by earlier dyke systems. Sills with a doleritic composition similar to that of the dykes are also common, but have a more restricted distribution.

A Palaeogene dolerite dyke left standing by the erosion of the Devonian sandstone into which it was intruded, Great Cumbrae, Firth of Clyde. P001078.

Many of the mafic dykes that make up the regional swarms are less than a metre across, although dykes up to 10 m across are fairly common (**Plate P001078**). A few even broader ones have been recorded but these may be composite intrusions. Nearly all of the dykes consist of basalt and/or dolerite. The Skye and Mull central complexes were the major sources of dyke swarms that extend from the Outer Hebrides and St Kilda (itself formed by a Palaeogene central complex) south-east across southern Scotland and into northern England. Dykes in Northern Ireland focus on the Slieve Gullion Ring-complex and the Mourne Mountains plutonic centres, but the regional swarms extend from Rockall (another Palaeogene granite) in the north west, to Wales and the English Midlands in

the south-east.

Post-volcanic sedimentary rocks

Following the cessation of magmatic activity in the Antrim–Hebridean region, sedimentation continued in the offshore, North Sea and Faroes–Shetland basins, where substantial thicknesses of mainly fine-grained clastic strata accumulated. The continuing deposition of volcanic ash layers demonstrates that magmatism was still active farther afield. Much of northern Britain and Northern Ireland remained dry land subject to erosion, and very little sedimentary deposition occurred onshore. Only two sequences are preserved: one in the vicinity of Lough Neagh, Northern Ireland, and the other in the Buchan area of north-east Scotland.

The Lough Neagh Clays Group strata (G) accumulated during the late Palaeogene, about 25 million years ago, in a faulted basin that originally covered most of the Antrim lava plateau. The preserved remnants now appear mostly as fault-controlled outliers within the basalt lava outcrop. A basal succession comprises 275 m of reddish brown lateritic clay with thin interbeds of sand, clay and lignite. It is conformably succeeded by at least 280 m of grey and brown clay, lignitic clay with siderite nodules and lignite, seams of which range up to 100 m thick; thin sandy interbeds occur sporadically. The depositional environment was fluvial and lacustrine, with the lignite originating as swamp and raised peat accumulations. The plant types present show the climate to have been temperate and frost-free; coniferous forest probably covered adjacent uplands.

Across much of Scotland, the Palaeogene and Neogene periods were a time of erosion and deep weathering but, in north-east Scotland, sedimentary accumulations from that interval make up the Buchan Gravels Formation (N). The deposits are up to about 25 m thick with clasts, commonly of flint, quartzite and weathered granite, contained in a kaolinitic, silty-clay matrix; they have suffered pervasive, subaerial weathering under warm, humid conditions. A fluvial origin is possible for the younger quartzite-rich gravels. The older gravels contain mostly flint and granite clasts and, though now about 120 m above sea level, probably originated as a beach accumulation when sea level was much higher.

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