

# Bedrock Geology UK North: Archaean and Palaeoproterozoic

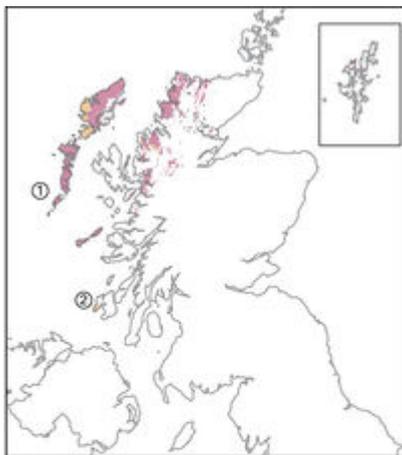
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**This topic provides descriptions of the rock types appearing on the British Geological Survey 1:625 000 scale map of the UK North and gives a brief explanation of their origins.**

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## More than 1600 million years ago



- Archaean
- ① Lewisian Gneiss Complex
- Palaeoproterozoic
- ② Rhinns Complex

P785805.



The characteristic scenery produced by Archaean gneiss of the Lewisian Complex seen here at Castlebay, Barra, Outer Hebrides. [P008322](#).

**The crystalline, metamorphic rocks** of the Hebridean terrane originated as part of a continental assemblage of Archaean cratons and Palaeoproterozoic deformation belts that had been brought together by about 1.7 billion years ago (i.e. 1700 million years ago or 1.7 Ga). The dispersed fragments of this assemblage can now be recognised along the length of a vast tectonic zone

(Caledonian Orogen) that stretches from Scandinavia, through Scotland to Greenland and North America. In Britain, the Hebridean terrane consists principally of the various high-grade metamorphic rocks that make up the Lewisian Gneiss Complex (A1-3 & Z1)†. This forms the north-west extremity of Scotland, cropping out in a coastal strip on the mainland, from Cape Wrath to the Sound of Sleat, and extending westward across the Outer Isles (**Plate P008322**). Its eastern margin is the Moine Thrust Belt, on which rocks of the Northern Highlands terrane have been carried westward over the Lewisian gneisses. East of the Moine Thrust, inliers are formed from Lewisian-like (or Lewisianoid) gneisses caught up in the folding and thrusting of the overlying, younger Proterozoic strata. Geophysical evidence suggests that Lewisian-like rocks underlie the younger Proterozoic sequences at least as far south as the Great Glen Fault. To the south of that structure, a distinctive Palaeoproterozoic gneiss assemblage is seen in the Rhinns Complex of western Islay.



Lewisian Complex gneiss, Watersay, Barra, Outer Hebrides: an Archaean foliation deformed by Palaeoproterozoic shear zones. P616087.

## Lewisian Gneiss Complex

**Most of the rocks** that make up the Lewisian Gneiss Complex (A1-3 & Z1) were originally igneous and formed more than 2.8 billion (Ga) years ago; they were then repeatedly modified under conditions of high temperature and pressure, deep within the Earth's crust. The intensity of these periods of reworking has produced crystalline, high-grade metamorphic rocks and has obscured many details of their original character and relationships (**Plate P616087**). In broad terms, the complex originated in two, multi-phase episodes of intense deformation and metamorphism (tectonothermal events). One episode is mainly Archaean and comprises the Scourian and Inverian events, the other is Palaeoproterozoic and comprises the Laxfordian events. The two episodes were separated by the intrusion of a regional dyke swarm (the Scourie dykes) mainly at about 2.4 Ga. However, the generalisation conceals much local variation, which allows different interpretations and fuels a continuing scientific debate. This is perhaps unsurprising since the Lewisian Gneiss Complex contains a record of sedimentary, igneous and metamorphic events that occurred over a period of 1400 million years — that length of time covers almost one third of the Earth's existence!

**The majority of the Lewisian gneisses** originated during the Archaean as broadly tonalitic,

intrusive plutons, but they had already been reworked by tectonothermal events prior to the intrusion of the mafic and ultramafic Scourie dyke suite in mid Palaeoproterozoic times. The Archaean rocks are typically coarse-grained, banded or streaky, grey felsic gneisses, which commonly enclose dark layers and lenses composed mostly of hornblende. In places, these mafic rocks are sufficiently abundant to form substantial belts of spectacularly banded gneisses (**Plate P008309**). A few large mafic enclaves may represent relict oceanic crust and are locally in association with more pelitic gneisses of sedimentary origin.



Banded mafic and feldspathic Archaean gneiss, Lewisian Complex, South Uist, Outer Hebrides. [P008309](#).

**The oldest of the Archaean rocks** are the felsic gneisses of the Outer Hebrides, which yield protolith ages of 3.2 to 2.8 Ga. The oldest gneisses on the mainland have protolith ages of about 3.0 Ga but differences in the detail of the age range from different parts of the complex suggest a complicated early history prior to the amalgamation of the component parts. High-grade metamorphism occurred at about 2.7 Ga, with an additional metamorphic episode at about 2.5 Ga recorded in the northern part of the mainland. This metamorphism, together with deformation and the formation of wide shear zones, preceded intrusion of the earliest Scourie dykes. These were intruded, predominantly as quartz-dolerites, in two swarms; the main one was emplaced at about 2.4 Ga with subsidiary intrusion at about 2.0 Ga.

**The Scourie dykes and their host gneisses** were reworked during subsequent Palaeoproterozoic tectonothermal events but first, following dyke intrusion, a sedimentary sequence of sandstone, quartzite, limestone and banded ironstone formed at about 2.0 Ga in the central part of the mainland area; associated sheets of amphibolite originated as oceanic or island-arc basalts. The whole assemblage is known as the Loch Maree Group (Z1) and represents sedimentation and volcanism in a marine environment close to a continental margin. It is intruded by granitic rocks, now gneissose, which were generated during volcanic arc magmatism and associated subduction of oceanic material at about 1.9 Ga. Subsequent tectonothermal events, between about 1.9 and 1.6 Ga, resulted in a network of shear zones, refolding and metamorphism. At about the same time (around 1.85 Ga) granite sheets were intruded into the northern part of the mainland Lewisian.

**In the Outer Hebrides area**, prior to any Palaeoproterozoic deformation, substantial bodies of mafic igneous rock were intruded and are associated with sequences of metasedimentary rocks. The largest of these assemblages is the South Harris Complex; the adjacent metasedimentary rocks of the Leverburgh Belt are compositionally similar to the Loch Maree Group of the mainland but are somewhat younger, with an age of about 1.9 Ga. Palaeoproterozoic tectonothermal activity probably peaked at about 1.8 Ga but continued until about 1.5 Ga, with many areas showing superimposed metamorphic effects. Late in the Palaeoproterozoic deformation phase, at about 1.7 Ga, a suite of granites and pegmatites was intruded, particularly into the gneisses of south-west Lewis and Harris.

Some of the granites were deformed by the final throes of Palaeoproterozoic tectonism. Later tectonism in the hanging wall of the Outer Isles Thrust has converted some of the Lewisian gneisses to cataclasite and mylonite (F).

## **Lewisian-like rocks elsewhere in northern Scotland**

**East of the Moine Thrust Belt**, and within the Moine Supergroup outcrop, several small inliers contain rock assemblages that are Lewisianoid in character, but typically have a higher proportion of mafic gneisses than is seen in the Lewisian Complex itself. The rocks of the inliers are of Archaean age, but at one locality (the Glenelg-Attadale inlier) there is evidence for a metamorphic event at about 1.05 Ga that is largely absent from the main Lewisian outcrop to the west. Most of the inliers contain abundant small pods of ultramafic rock, but the Glenelg inlier is unusual in that it also contains eclogite, a very high-grade metamorphic rock that was originally formed at a depth of 60 km in the Earth's crust. Eclogite is not present elsewhere in the Lewisian Complex. Farther north, in Shetland, felsic and mafic gneisses of Lewisianoid character form the north-west extremity of Mainland, and in places are tectonically interleaved with psammites of probable Moine association.

**The Rhinns Complex of western Islay** (and a small outcrop on Colonsay) consists of Palaeoproterozoic, felsic gneisses, the igneous protoliths of which were generated at about 1.8 Ga, probably in a subduction-related magmatic arc. Deformation and metamorphism then occurred prior to the intrusion of further felsic and mafic igneous rocks, generated in the same tectonic regime, at about 1.7 Ga. The Rhinns Complex may be the surface expression of a unique Islay-Colonsay terrane that extends south-west towards Northern Ireland (where Lewisian-like rocks form Inishtrahull island, off the north coast) but similar Palaeoproterozoic rocks could also underlie much of the Neoproterozoic succession south of the Great Glen.

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