

Lower Old Red Sandstone volcanism, Caledonian magmatism, Grampian Highlands

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Lower Old Red Sandstone volcanism

Volcanic rocks in the Lower Old Red Sandstone occur principally in Lorn and Lochaber, with minor occurrences in the north-east Grampians, the Highland Border and Kintyre.

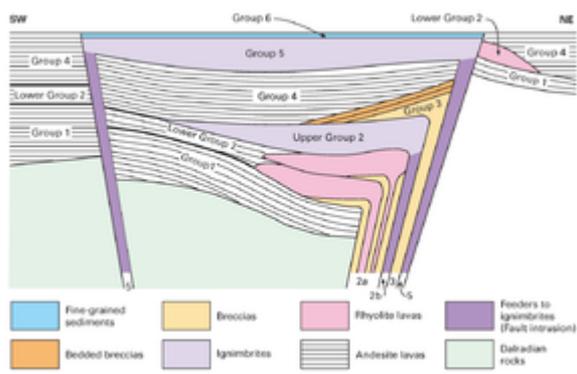
Lorn and Lochaber

Lower Old Red Sandstone volcanic rocks originally covered the whole area but are now preserved only in the Lorn Plateau and in downfaulted blocks within the Glencoe and Ben Nevis complexes (Bailey, 1960; Kynaston and Hill, 1908).

The **Lorn Plateau lavas** (108) have a present extent of 300 km² and a maximum preserved thickness of 800 m. Sedimentary rocks at the base of the succession on Kerrera contain Upper Lochkovian (Lower Devonian) fossils, implying, according to Morton (1979), a correlation with the Arbuthnott Group of the Midland Valley. The lavas are basalts and basaltic andesites, forming flows 5 to 30 m thick, with rare rhyolite flows up to 2 m thick. They were probably erupted from fissures fed by dykes and occasional small circular vents. Groome and Hall (1974) considered that appinites, rather than microdiorites, were the probable feeders to the lavas. Two intercalated flows of rhyolitic ignimbrite are thought to have originated from the Glencoe centre and were fed from the Fault Intrusion (Roberts, 1974).

The lavas are of potassic calc-alkaline type and show chemical similarities with the nearby lamprophyre intrusions; certain flows are anomalously rich in Mg, Ni and Cr. The lavas as a whole are richer in Sr, Ba, K, P and light rare-earth elements (LREE) than the equivalent age lavas of the Midland Valley and Southern Uplands, and the magmas are thought to be largely mantle-derived, with some contamination by crustal material, possibly of mafic granulite composition (Groome and Hall, 1974; Thirlwall, 1981; 1982). Clayburn et al. (1983) obtained a Rb/Sr isochron age of 400 ± 5 Ma (Early Devonian) for the Lorne Plateau lavas, very similar to the 401 ± 6 and 396 ± 12 Ma obtained from the probably genetically related Etive granites. The initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratio (0.7045–0.7050) of the lavas is also similar to that of the Etive granites (0.7055–0.7058). However,

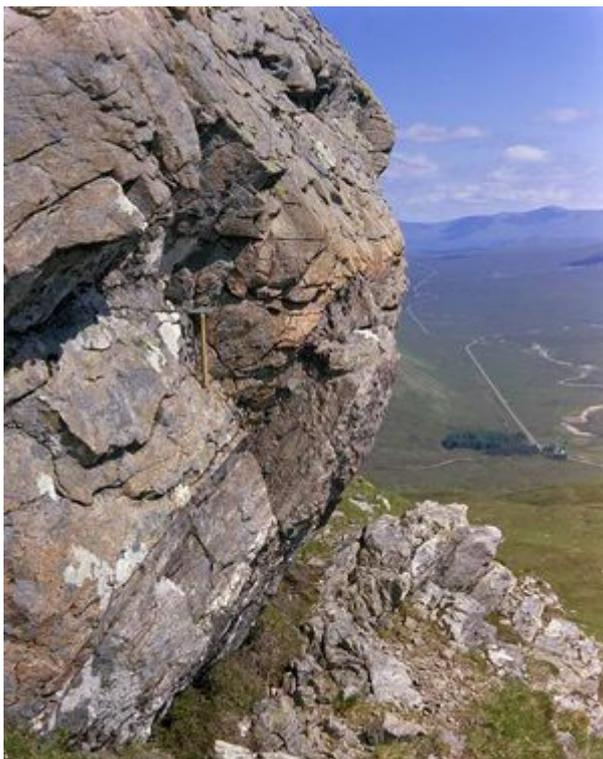
Thirlwall (1988) has suggested, on the basis of argon isotope work, that the Lorn Plateau lavas may be as old as 421 to 413 Ma, and that the Rb/Sr systematics of the lavas have been reset by the plutonic intrusions.



Volcanic evolution of the Glencoe cauldron (after Roberts, 1974).



Granite tors on Mither Tap, Bennachie, Aberdeenshire, with well-marked horizontal and subvertical joints (D 4523). P220488. P220488.



Glencoe Boundary Fault, Stob Mhic Mhartuin, Lochaber. The fault separates the main Glen Coe Fault Intrusion (top left), from bedded quartzites (bottom right). P002751.

Glencoe and Ben Nevis are two of the best-exposed examples of cauldron subsidence (Bailey, 1960). The volcanic sequence in **Glencoe** (109; [\(P915437\)](#); [\(P220488\)](#) and [\(P002751\)](#)) is preserved in a downfaulted block within the elliptical ring fracture. Roberts (1974) has postulated the following sequence of events and products in the Glencoe cauldron:

Initial stages of volcanic activity

Group 1—basalts and pyroxene-andesite lavas

First cycle of caldera formation

Lower Group 2—andesite and rhyolite lavas, interbedded with a thin ignimbrite layer near the top

Upper Group 2—rhyodacitic ignimbrite flow

Possible hiatus in volcanic activity

Group 3—breccias, grits and shales

Second cycle of caldera formation

Group 4—hornblende-andesite lavas

Group 5—rhyodacitic ignimbrite flow

Possible hiatus in volcanic activity

Group 6—grits and shales

Subsequent stages of volcanic activity

Group 7—andesite and rhyolite lavas, interbedded with a thin ignimbrite flow

The first stage of caldera formation was marked by a considerably larger movement along the north-east part of the ring-fracture than along the south-west part. However, during the second period of caldera formation the amount of movement along the ring fracture was roughly uniform. The Fault Intrusion follows the ring-fracture and shows flow structures; it was the feeder for the Upper Group 2 and Group 5 ignimbrites, which appear to have completely filled the caldera and flowed possibly as

far as the Lorn Plateau.



North face of Ben Nevis, Lochaber. The cliffs and summit area consist of a cylindrical mass of Lower Old Red Sandstone andesitic lavas and volcanoclastic rocks. P000747.

A 600 m-thick Lower Old Red Sandstone sequence unconformably overlying Dalradian rocks is preserved by subsidence within the central ring-structure of the **Ben Nevis Complex** (110; Bailey, 1960; [P000747](#)). It consists principally of hornblende- and biotite-andesites with intercalated agglomerates and sediments, and is believed to be part of a regional lava cover, otherwise completely removed by erosion from the Ben Nevis area.

North-east Grampians

The Tillybrachty Sandstone Formation of the largely sedimentary Old Red Sandstone outlier at **Rhynie** (111) contains a single flow of highly vesicular andesite lava (Trewin and Rice, 1992; Read, 1923, pp. 180–182), which has suffered potash metasomatism in the vicinity of the Rhynie hot spring system. The Rhynie Chert, lying within the Dryden Flags Formation, has been interpreted as a siliceous sinter, related to the same hot spring system.

A single outcrop of andesite in the **Cabrach outlier** (112) may be a lava and the stratigraphical equivalent of that in the Tillybrachty Sandstone Formation (Hinxman and Wilson, 1902, p. 66). Andesite exposed in the **Gollachy Burn** (113) near the Moray Firth coast has been variously interpreted as a lava flow of Lower or Middle Devonian age, or as a sill intruding the underlying Dalradian quartzites (Peacock et al., 1968, p.40).

Highland Border

A few outliers of Lower Old Red Sandstone rocks containing lavas overlie Dalradian and Highland Border Complex rocks unconformably in the **Forest of Alyth** area (114) and near **Monzie** (115). They occur as discontinuous faulted exposures, but have been correlated with the main Strathmore sequence of the Midland Valley by Armstrong and Paterson (1970). A distinctive dacitic ignimbrite, the 'Lintrathen Porphyry', occurring from the Forest of Alyth to the North Esk, belongs to the

Lochkovian Crawton Group, while the basaltic and andesitic lavas of the Forest of Alyth and Comrie are assigned to the immediately overlying Arbuthnott Group (also Lochkovian).

Kintyre

The New Orleans Conglomerate Formation (Friend and Macdonald, 1968) within the Lower Old Red Sandstone of Kintyre consists dominantly of coarse conglomerates of lava boulders, and has an estimated thickness of 890 m. Acid tuffs crop out at one locality. A nearby volcanic source is indicated. Precise correlation with the Lower Old Red Sandstone succession of the Stonehaven area is not possible, but the New Orleans Conglomerate Formation is believed to be equivalent to the Arbuthnott or Garvock groups (Lower Devonian).

Seven-fold division of the Caledonian Igneous Suite

[Pre-tectonic basic magmatism](#)

[Syntectonic granitic intrusions](#)

[Syn- to late-tectonic basic and ultramafic intrusions](#)

[Late-tectonic granitoid intrusions](#)

[Post-tectonic granitoid intrusions](#)

[Late- to post-tectonic minor intrusions](#)

Lower Old Red Sandstone volcanism

Full list of references

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