

# Alkaline Intrusions of Assynt and Ben Loyal, Younger Caledonian igneous rocks, Northern Highlands of Scotland

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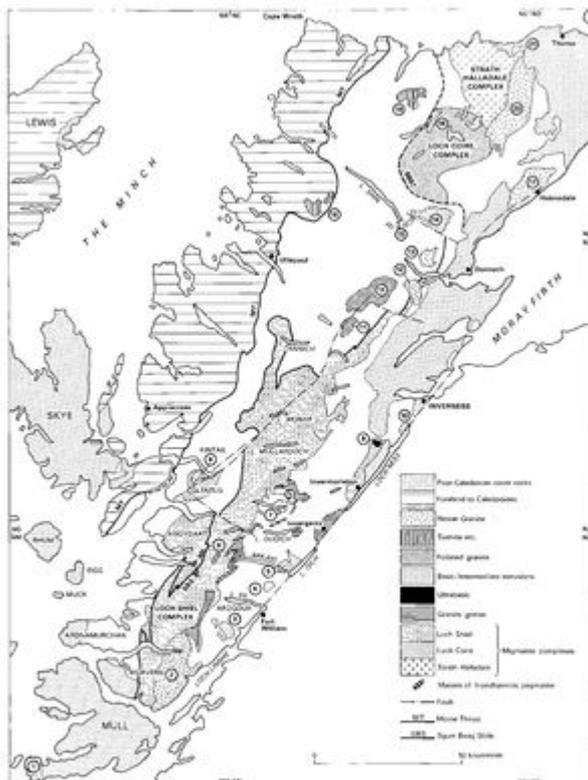
Johnstone, G S and Mykura, W. 1989. British regional geology: Northern Highlands of Scotland. Fourth edition. Keyworth, Nottingham: British Geological Survey.

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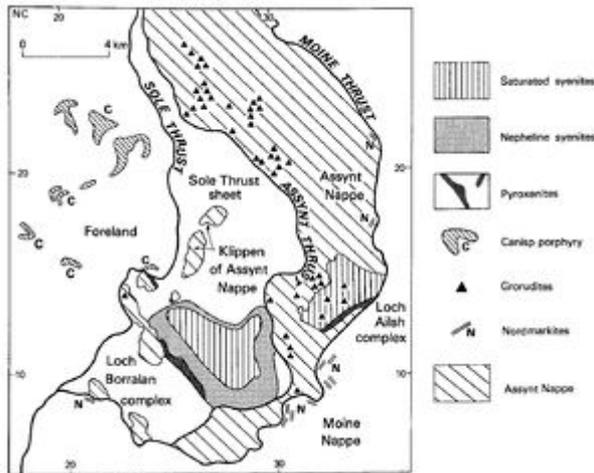
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## Introduction



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Major intrusions, granite gneiss and migmatites within the Caledonides of the Northern Highlands. P915476.



Geological sketch map of the alkaline complexes and minor intrusions of Assynt. P915481.



Ben Loyal, Sutherland: a pluton of quartz-syenite cuts Moine rocks. P000631.

In Assynt, alkaline igneous rocks occur within and close to the Moine Thrust Zone and the intrusions cut rocks of the foreland, the autochthonous nappes and the Moine Nappe (P915476, 24). Around Loch Loyal they are emplaced within the Moine Nappe, well to the east of the Moine Thrust. Elliot and Johnson (1970) have argued for large displacements along the Moine Thrust Zone and, as certain of the intrusions of the Assynt Alkaline Suite are found both in individual nappes within the thrust zone and in the Foreland, it could be concluded that the suite was originally emplaced over a large area which is now much reduced. Parsons (1979) argues for a relatively local source and so envisages a limited thrust displacement. Possibly this anomaly can be resolved by suggesting that the rocks were emplaced at a time when most of the movements on the various thrust sheets had been accomplished.

The Assynt Alkaline Suite was first described by the Geological Survey (Peach and others, 1907; Read and others, 1926). The suite comprises two major intrusions centred respectively on Loch Borralan and Loch Ailsh, and a complex of dykes and sills.

## Loch Borralan Complex<sup>[1]</sup>

The complex was first described in Geological Survey memoirs (Peach and others, 1907; Read and others, 1926), and its unusual petrology and position in the Thrust Belt has since made it the subject of several papers. It was considered by Shand (1909; 1910) to be a laccolith, differentiated in situ after assimilation of limestone, with the production of various saturated and undersaturated syenitic rocks whose varieties have been given local names, famous in petrological studies. It is now considered by Woolley (1970; 1973) to comprise an earlier rock suite of mafic to ultramafic syenites (ledmorite, assyntite, borolanite, nepheline syenite, cromaltite and other varieties) intruded as a sheeted complex. The roof and floor of the early intrusion were Durness Group limestones. A later plug-like body has intruded the early suite and it comprises a group of oversaturated and saturated syenites differentiated gravitationally in situ, with perthosites at lower levels and quartz syenites at upper levels. Various members of the earlier body show intrusive contacts, but all are thought to be derived from a common parent, differentiated gravitationally prior to emplacement.

Exposure of the complex is incomplete, and drilling for commercial purposes has shown several varieties of ultramafic rock not exposed at the surface; some of these are interpreted as metasomatic alteration products formed by contact with the enclosing limestone. According to Matthews and Woolley (1979) these ultramafic rocks have been squeezed from a possible subhorizontal position to form a steeply inclined sheet along the south-west margin of the complex.

The intrusion lies in the Thrust Belt between the Sole Thrust and the Assynt (or Ben More) Nappe, and the rocks of the earlier suite are commonly penetratively deformed by the movement along the Assynt (or Ben More) Thrust. It is inferred that the intrusion overlaps these movements, and a U-Pb age of the intrusion of c.430 Ma has been obtained by van Breemen and others (1979a). This sets the age for the main movement along that thrust. Undeformed nepheline syenite pegmatites of the later intrusion, however, cut the Assynt Thrust.

## Loch Ailsh Complex

The Loch Ailsh intrusion lies within the Assynt (Ben More) Nappe and beneath the Moine Thrust; it is less diverse than that of Loch Borralan. It was first described by Phemister (*in* Read, 1926) and, like the Loch Borralan Complex, was thought to be a stratified laccolith, gravity-differentiated to give an ultramafic base. Parsons (1965) has shown that the ultramafic rocks, like those of Loch Borralan, form steep screens between syenites and the altered Durness Limestone country rock. The main rock types are rather sodic, saturated or slightly under-saturated, leucocratic syenites which Parsons has divided into three units, forming a regular chemical series emplaced at slightly different times. These units he designed  $S_1$ ,  $S_2$  and  $S_3$ . The combined unit,  $S_1$ - $S_2$ , has a gently undulating upper surface overlain by  $S_3$ , which appears to be derived from a central plug-like body. A zone of xenoliths of pyroxene syenite at the junction between  $S_2$  and  $S_3$  is taken by Parsons to represent the remnants of a contact-altered limestone roof to  $S_1$ - $S_2$ , prior to the emplacement of  $S_3$ .

## The alkaline minor intrusions of Assynt

The rocks of the Foreland, Thrust Belt and Moine Nappe of Assynt are cut by a diverse, but petrographically linked suite of sills and dykes. Depending on their position, the rocks are either unaffected by the thrust movements or are variably altered. Sabine (1953) divided the suite into aegirine felsite (grorudite), Canisp porphyry (biotite-aegirine-albite-oligoclase porphyrite), hornblende porphyrite, nordmarkite, vogesite and ledmorite. The distribution of these rocks is shown in [P915481](#); it indicates that, whereas the Canisp porphyry intrusions are confined to the

Foreland and the gneisses to the Assynt Nappe, the nordmarkites occur in both the Assynt and Moine Nappes. It is believed that the minor intrusions were emplaced after most of the movement in the Moine Thrust Zone had been accomplished.

## The Loch Loyal alkaline intrusions

Three syenitic masses similar to the larger intrusions of Assynt lie around Loch Loyal, well within the Moine Nappe. They comprise the Ben Loyal, Cnoc na Cuilean\* and Beinn Stumanadh\* intrusions respectively (Read, 1931; King, 1942; Robertson and Parsons, 1974). <sup>[2]</sup> Current Ordnance Survey spelling (1986)

The Ben Loyal Intrusion ([P000631](#)) consists of two quartz syenites of similar chemistry but slightly different mineralogy and habit. The outer syenite is a laminated two-feldspar rock in which the lamination is ascribed by Robertson and Parsons to flowage of a crystal mush. The lamination is roughly concordant with the foliation of the surrounding schists. The form of the intrusion is that of a sheet or laccolith, fed from the south-east, which distends and deflects the schist envelope on the north-west. The inner mass of coarse, non-laminated syenite makes up about half of the Ben Loyal intrusion. It has a gradational contact with the outer syenite and differs from it in that feldspar of the inner mass is mainly perthite. Aegirine-augite is the common mafic mineral of both rocks, with hornblende confined to the outer syenite.

The Cnoc na Cuilean intrusion is stock-like (Robertson and Parson, 1974) and of slightly different composition to Ben Loyal. Basic syenites of variable composition occupy a marginal zone to non-laminated, quartz-poor syenite. The Beinn Stumanadh intrusion is made up of sheets of dark brownish syenite, partly transgressing and partly concordant with the foliation of the Moine, the upper sheet being at least 400 m thick. Sodic and ultrasodic rocks are found round the Cnoc na Cuilean intrusion as metasomatic replacements of the enclosing schists and are probably related to the syenitic magma from which the main intrusion derives.

Similar small alkaline metasomatic patches have been noted in a few other places in the Northern Highlands, notably in the Loch Hourn–Glen Cannich area (Tanner and Tobisch, 1972; Peacock, 1973). These patches comprise albitites with sodic pyroxenes and amphiboles. No parent syenitic bodies are known to account for the presence of these rocks, and it is uncertain whether they are all coeval. (See also the description of fenitisation near the Great Glen, p.110).

## [Selected bibliography](#)

## Footnotes

1. <sup>↑</sup> The Ordnance Survey has revised place-name spelling twice, and this has resulted in references in the literature to Loch Borrolan and Loch Borolan, and a well known rock from the complex is named Borolanite.
2. <sup>↑</sup> Current Ordnance Survey spelling (1986)

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