
Alkaline minor intrusive rocks

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Introduction

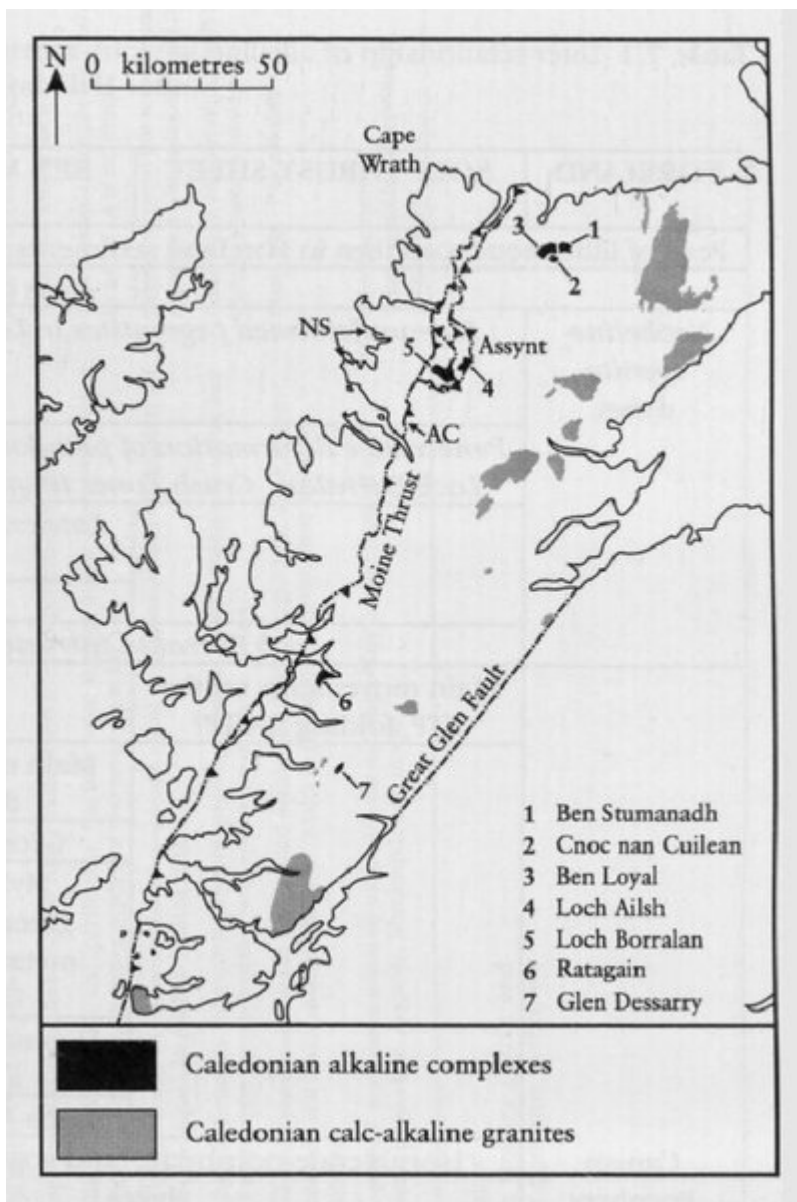
The extensive suite of dykes and sills of alkaline and related rocks in the Assynt district are petrologically unusual in a British context, and are important representatives of the Caledonian alkaline magmatism. They extend over a considerable distance, from north of the Assynt district at Loch More [NC 330 350], to south of the Assynt Culmination in the structure known as the Achall Culmination, near Ullapool [NH 144 953], (Figure 7.1). Although they are less well-known than the alkaline plutons, a glance at the Geological Survey special sheet of the Assynt district shows at once that they constitute a major part of the magmatism in Assynt. Although many of the rock types are not strictly alkaline their association in time and space with the alkaline magmatism is clear. They have very important structural and geochronological implications for understanding the evolution of the Moine thrust zone, into which many members were emplaced. The value of the minor intrusive rocks considered as a suite is greater than that of individual sites in isolation, and their relationship to the major alkaline plutons and to the individual thrust sheets, or nappes, is of critical importance. The profound implications of the alkaline rocks for the magmatic and tectonic evolution of the NW Highlands are discussed in the introduction to this chapter, and the age relationships are summarized in (Table 7.1). The distribution of some of the minor intrusive rock types is shown on (Figure 7.2). The reader is reminded that we are dealing with a region of very considerable crustal shortening, perhaps in excess of 100 km normal to the thrust belt if the Moine Thrust itself is included (Elliott and Johnson, 1980), and that the region involved in the alkaline magmatism must have extended from the unmoved Foreland (where nepheline-syenite dykes are found on the Atlantic coast) to a point many tens of kilometres to what is now the ESE.

The petrography, chemistry and distribution of the dykes and sills was described by Sabine (1953) who also recognized the importance of the suite as structural markers. He recognized six main petrographical types of minor intrusive rock, together with some localized varieties. The sites are grouped below according to the six rock types using the varietal and local rock names adopted by Sabine (1953), with the more usual modern equivalents given where appropriate. The different types are as follows.

1. 'gorudite' (peralkaline rhyolite, comendite)
2. The Canisp Porphyry (porphyritic quartz-microsyenite)
3. 'hornblende porphyrite' (hornblende microdiorite, spessartite)
4. vogesite (hornblende-rich lamprophyre)
5. 'nordmarkite' (quartz-microsyenite)
6. ledmorite' (melanite nepheline-microsyenite)

A common introduction is provided here for each of the rock types, rather than for each individual site. The sites described are widely distributed (Figure 7.2), (Figure 7.13) and were chosen to provide examples with particularly significant structural relationships or which are relatively accessible examples of the different rock types making up the minor intrusive suite. There is one example of a probable diatreme (called a 'volcanic vent' by the early Geological Survey mappers) in Assynt. This is associated with a vogesite sill and is included in that section.

References



(Figure 7.1) Map of NW Scotland showing localities of alkaline intrusions, aligned roughly parallel to the Moine Thrust. Many alkaline dykes and sills occur in the Assynt district and also near Ullapool in the Achall Culmination (AC). GCR sites exemplifying nepheline-syenite dykes in the Foreland are indicated by NS. Caledonian calc-alkaline granites NW of the Great Glen are also shown. The Ratagain intrusion is largely calc-alkaline in character but has minor syenitic members (after Halliday et al., 1987, fig. 1).

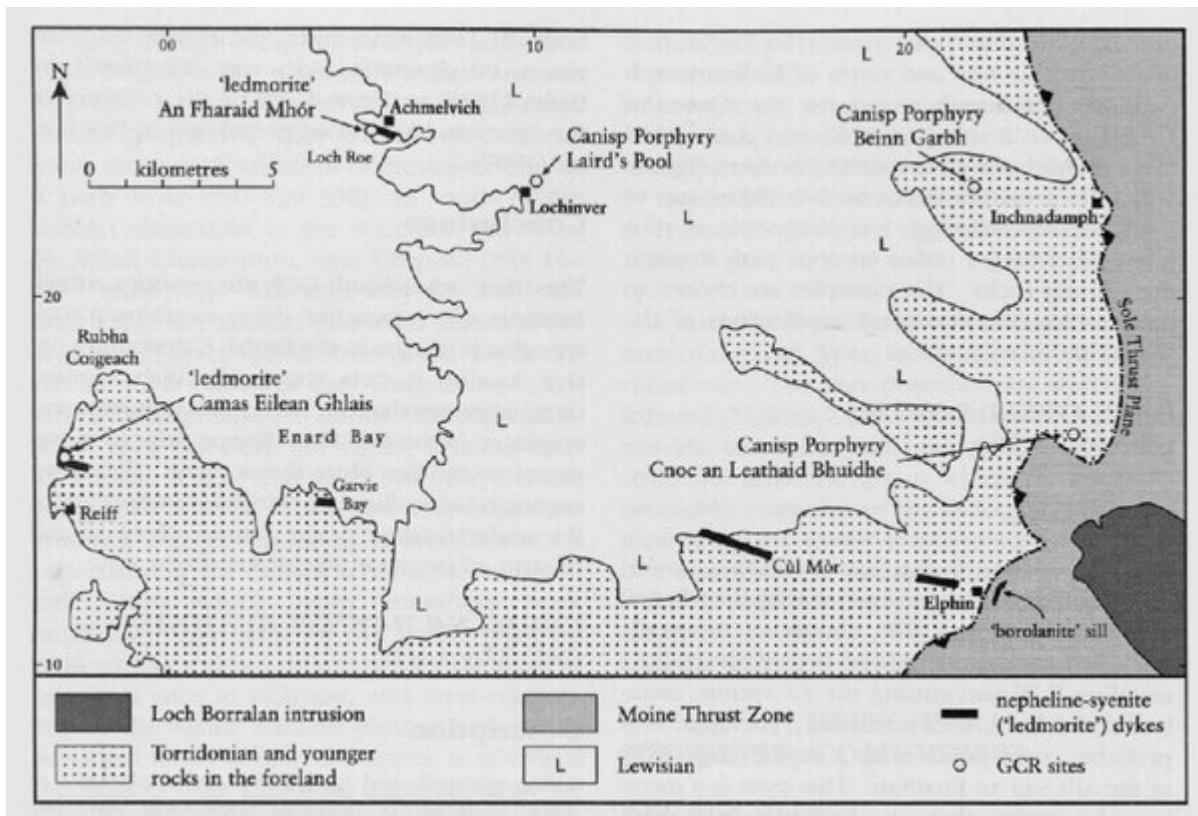
Table 7.1 Inter-relationship of alkaline igneous activity and major tectonic events in the Moine thrust zone (after Halliday *et al.*, 1987).

FORELAND	SOLE THRUST SHEET	BEN MORE NAPPE	MOINE NAPPE	AGE (Ma)
Peak of illite metamorphism in Foreland sediments				c. 408 ¹
Ross of Mull Granite cuts Moine thrust plane				414 ± 4 ²
<i>Nepbeline-syenite dykes</i>	<i>Late undeformed pegmatites in Loch Borralan</i>		<i>Cnoc-nan-Cùilean intrusion</i>	426 ± 9 ⁵
	<i>Penetrative deformation of pseudoleucite rocks at Loch Borralan. Crush Zones in quartz-syenites</i>		<i>Final movements on the MTP</i>	
		<i>Late crushing in Loch Ailsh</i>		
		<i>'Nordmarkite' sills near the MTP</i>		
	<i>Loch Borralan intrusion</i>			430 ± 4 ³
Canisp Porphyry	Main movements on the STP, folding BMTP?			
		Main movements on the BMTP	Moine mylonites and 'D1' Main movements on MTP	
		'Grorudite' dykes		
		Mylonites and greenschist-facies metamorphism in Loch Ailsh		
		Sgonnan Mór folds and fabric		
		Loch Ailsh intrusion		439 ± 4 ⁵
	'Hornblende-porphyrite' and vogesite sills and dykes		'D3' of Glen Dessarry Moine. Deformation of syenite	
			Glen Dessarry intrusion	456 ± 5 ⁴

Events in italic were essentially synchronous. MTP: Moine thrust plane. BMTP: Ben More thrust plane. STP: Sole thrust plane. The radiometric ages are from the following sources: 1. Johnson *et al.*, 1985. 2. Halliday *et al.*, 1979a. 3. Van Breemen *et al.*, 1979a. 4. Van Breemen *et al.*, 1979b. 5. Halliday *et al.*, 1987.



(Figure 7.2) Map of the Assynt district showing the major thrusts, the two major alkaline intrusions, and the distribution of two of the six types of minor intrusive rocks. BA is the critical locality, at Bad na h-Achlaise, where nepheline-syenites and pyroxenites of the Loch Borralan intrusion are intruded into one of the klippen (the Cam Loch Klippe) of the Ben More Nappe. GCR sites in the thrust zone related to minor intrusive rocks are shown by circled numbers. 'Grorudite': 1, Glen Oykel South; 2, Creag na h-Innse Ruaidhe. 'Hornblende porphyrite': 3, Cnoc an Droighinn; 4, Luban Croma. 'Vogesite': 5, Allt nan Uamh; 6, Glen Oykel North (diatreme). 'Nordmarkite': 7, Allt na Cailliche. (After Sabine, 1953 and Johnson and Parsons, 1979, fig. 3.)



(Figure 7.13) Map of western Assynt showing distribution of nepheline-syenite ('ledmorite') dykes in the Foreland and their relationship to the Loch Borralan nepheline-syenites in the Moine thrust zone. GCR sites exemplifying the 'ledmorite' dykes and the Canisp Porphyry are also shown. The full extent of the Canisp Porphyry around Beinn Garbh is shown on Figure 7.15.