

*The ledmorite dike of Achmelvich, near Lochinver,
Sutherland.*

By P. A. SABINE, Ph.D., A.R.C.S., F.G.S.¹

Geological Survey and Museum, London.²

[Read November 1, 1951.]

IN the Geological Survey memoir³ a dike is recorded cutting the Lewisian gneiss near Achmelvich, north-west of Lochinver, Sutherland. At the time the mapping was carried out no thin section was prepared of the rock, and the dike was presumed to be a continuation of the Canisp porphyry dike which is exposed in the river Inver near Lochinver and farther south-east.

During an investigation of the post-Cambrian sills and dikes of Assynt and the adjoining districts of north-west Scotland, the writer examined the Achmelvich dike in some detail and recognized its affinities with the nepheline-syenites. It is the purpose of the present note to describe the field occurrence and petrography of the dike.

Field relationships.

The dike strikes west-north-west across the promontory at the mouth of Loch Roe (fig. 1) and cuts Lewisian gneiss, the foliation planes of which strike north-east and dip at steep angles to the south-east. The course of the nearly vertical intrusion is rather irregular. The best exposures are at its western end where it is about 3 feet thick. The edges are chilled against the gneiss and a banded structure is present near to the margin. Inclusions of gneiss in the marginal zone of the dike appear to have been derived from the contiguous gneiss. They have sharp edges and show no sign of reaction with the igneous rock. Spheroidal weathering of the dike occurs but is not prominent. Inland the dike decreases in width and is eventually lost beneath peaty ground.

¹ The work forms part of a thesis approved for the degree of Ph.D. in the University of London.

² Communicated with the permission of the Director.

³ B. N. Peach et al. The geological structure of the north-west Highlands of Scotland. Mem. Geol. Surv. Great Britain, 1907.

At its eastern end on the shore of Loch Roe the dike is about $2\frac{1}{2}$ feet thick. It is nearly vertical, chilled at the contacts, and shows slight marginal banding. Inland its width decreases to less than a foot and the dike cannot be traced across the peaty ground of Fairait Mhòr.

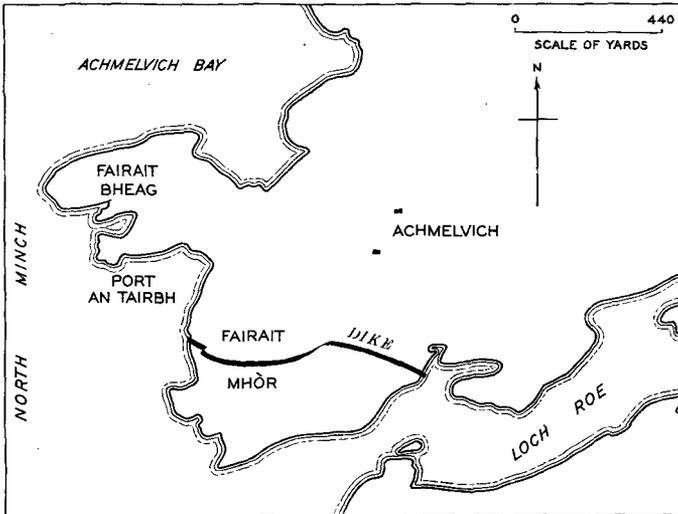


FIG. 1. Map of the area around Achmelvich, Sutherland. The position of the ledmorite dike is shown in black.

Petrography.

The freshest rock (Geological Survey slice no. S. 38132) is very fine grained and of mottled reddish- and greenish-brown appearance in hand-specimen. Under the microscope it is seen to be composed of a hypidiomorphic aggregate of alkali-felspar tablets in which there are distributed abundant needles of aegirine and numerous small dodecahedra of melanite. The felspar contains abundant needles of natrolite.

The aegirine needles, which are mainly fresh, reach 0.2 mm. in length. Melanite euhedra, up to 0.1 mm. across, are of deep brown colour and are sometimes rimmed by paler yellow garnet. Rarely the centres of the garnet crystals have altered to a colourless microcrystalline mineral of very low birefringence. The paler yellow garnet forming the rims of the original crystals is unaffected by this alteration, which has also been observed by the writer to be commonly developed in the similar ledmorites of Rhu More, Coigach.

Due to the presence of alteration products, determination of the felsic

constituents of the rock is difficult. Orthoclase, the identity of which was confirmed in the rock powder by its refractive indices $\alpha < 1.519$, $\beta 1.525$, occurs as tablets up to 1 mm. across. Natrolite is abundant in the felspar, forming diverging bundles of needles. Its identity was checked by X-ray powder methods after crushing the rock and separating the light fraction in bromoform. The resulting film showed only natrolite and felspar. Acid plagioclase was suspected in the thin section, but, due to the fine grain-size and many inclusions, could not be proved. In the rock powder small crystals of a biaxial doubtfully positive mineral, perhaps heulandite, were found having $\alpha 1.483$, $\gamma 1.490$, but the mineral could not be distinguished in the thin section.

The rock has been analysed, with the results shown in table I, column I. The specific gravity is 2.58.

TABLE I. Chemical composition of the Achmelvich ledmorite and similar rocks.

	I.	A.	B.	C.		II.
SiO ₂ ...	50.82	47.8	45.06	48.19	or	... 36.14
Al ₂ O ₃ ...	18.84	20.1	20.95	18.52	ab	... 17.03
Fe ₂ O ₃ ...	4.18	6.7	6.23	4.51	an	... 8.90
FeO ...	1.80	0.8	2.84	1.68	ne	... 13.78
MgO ...	0.92	1.1	3.31	1.12	no	... 2.13
CaO ...	5.47	5.4	8.32	10.29	il	... 1.67
Na ₂ O ...	5.62	5.5	3.51	3.44	pr	... 0.24
K ₂ O ...	6.14	7.1	4.09	3.05	mt	... 4.41
H ₂ O + 105° C.	4.42	2.4	{ 3.98†	3.00	hm	... 1.12
H ₂ O - 105° C.	0.28	(ign.)		{ 0.30‡	0.45	wo
TiO ₂ ...	0.88	0.7	1.25	1.75	di	... 4.97
MnO ...	0.38	0.5	—	trace	II. 6. (2) 3.3 ^r	
BaO ...	—	0.8	—	—	Salemase	
P ₂ O ₅ ...	0.07	—	0.66	trace		
CO ₂ ...	nil	—	—	—		
S ...	0.05	—	—	—		
SO ₃ ...	0.27	0.4	—	—		
Cl ...	0.01*	—	—	—		
	<u>100.15</u>	<u>99.3</u>	<u>100.50</u>	<u>101.00</u>		
Less O for S, Cl	0.03					
	<u>100.12</u>					

I. Ledmorite, Achmelvich. Analyst, W. H. Herdsman (new analysis). S. 38132.

A. Ledmorite ('borolanite'), Camas Eilean Ghlais, Rhu More, Coigach. Analyst, J. H. Player (Horne and Teall, 1892). S. 4390.

B. Ledmorite, Ledmore river. Analyst, A. Gemmell, Trans. Edinburgh Geol. Soc., 1910, vol. 9, p. 417.

C. Typical spotted borolanite, Am Meallan, Ross-shire. Analyst, W. Campbell Smith, Geol. Mag., 1909, dec. 5, vol. 6, p. 154.

II. Norm of analysis I.

* Determined by Mr. K. L. H. Murray in the Chemical Laboratory of the Geological Survey. † +110° C. ‡ -110° C.

Nomenclature.

The name borolanite¹ was proposed by Horne and Teall² in 1892 for the group of rocks exposed in the Loch Borrolan mass, Sutherland, 'especially characterised by the association of orthoclase and melanite'. They commented that 'The typical rock is a crystalline granular aggregate of orthoclase and melanite. Biotite, pyroxene, alteration products after nepheline and sodalite, sphene, and apatite occur as subordinate and variable constituents.' One of the most striking features of the rock was stated to be the pseudo-porphyrific aspect due to the white or more rarely pink patches, possibly representing original leucite.

'The affinities of borolanite are unmistakable,' wrote Horne and Teall. 'It is a member of the foyaite (elæolite-syenite) family. The occurrence of melanite as an important accessory in certain rocks belonging to the nepheline-leucite group has long been recognized. In our rock we have melanite raised to the rank of an essential constituent.'

In an appendix to their paper they also described as borolanite the rock from the dikes of Rhu More, and noted that this was the only rock in which they had found typical aegirine. The Loch Borrolan mass and the dikes of Achmelvich and Rhu More are shown in fig. 2.

Professor S. J. Shand³ restricted the use of the name 'borolanite' by designating melanite-syenite and melanite-syenoid rocks which contain less than 10 % by volume of melanite, whilst 'rocks containing ægirite-augite in addition to (and replacing) melanite, and which lack the spotted or porphyritic character', he termed 'ledmorite'. This group he considered might be regarded as a sub-group of borolanite. He referred to the Coigach rock as an 'unspotted borolanite', although he estimated it to contain 9.2 % by volume of melanite. He noted that certain 'points of difference must not be forgotten when that name (borolanite) is applied to it', and that the rock stands to the typical borolanites in much the same relation that ledmorite occupies.

The definition given by Horne and Teall appears to the writer, as it did to Professor Shand, to require some limitation. It is therefore suggested that the name 'borolanite' be applied to rocks consisting essen-

¹ Borolanite was named after Loch Borolan, as it was then spelt. Following customary Geological Survey practice place-names are here given as on the one-inch map, and the loch is therefore now spelt Borrolan.

² J. Horne and J. J. H. Teall. On borolanite—an igneous rock intrusive in the Cambrian limestone of Assynt, Sutherlandshire, and the Torridon sandstone of Ross-shire. *Trans. Roy. Soc. Edinburgh*, 1892, vol. 37, pp. 163-178.

³ S. J. Shand. On borolanite and its associates in Assynt. (*Second communication*.) *Trans. Edinburgh Geol. Soc.*, 1910, vol. 9, pp. 376-416.

tially of orthoclase and melanite together with biotite, pyroxene, nepheline or sodalite or alteration products of these minerals, sphene and apatite, and characterized especially by the presence of white spots or patches fully or incipiently developed. Broadly, this is the definition given by Shand. For other rocks which have close affinities with the borolanite type, but which lack the 'spotted' character, it is proposed

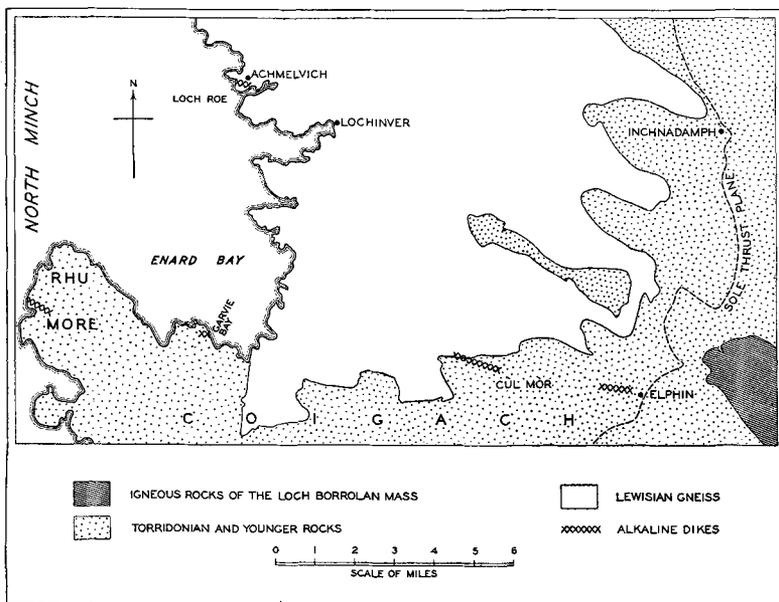


FIG. 2. Geological sketch-map of the district west and south of Inchnadamph, showing the post-Cambrian alkali-rich dikes.

that the name 'ledmorite' be used. Melanite and a felspathoid or its alteration products are still essential constituents and either aegirine or aegirine-augite may also be present.

This nomenclature rather widens the use of 'ledmorite', but has the advantage of keeping 'borolanite' for the spotted rocks without requiring another name for unspotted types—the natural history of which may be fundamentally different—which did not hitherto fall into the field covered by Shand's 'ledmorite'.

Professor A. Johannsen¹ records that in 1931 Shand (in litteris) withdrew the name ledmorite, but Johannsen recommended its retention for

¹ A. Johannsen. A descriptive petrography of the igneous rocks. Chicago, 1938, vol. 4, p. 117.

the melanite-malignites, and the writer is therefore to a considerable extent following Johannsen. In his 1939 paper Shand¹ did not state clearly whether he proposed to withdraw or continue the use of the name. Since it fills a definite gap in petrographical nomenclature, the writer is of the opinion that it should be retained.

With the proposed usage, the rock of Achmelvich is to be classed as a ledmorite. The rock of Rhu More should also be referred to as ledmorite, and not borolanite, a name which has hitherto given a false impression of the lithology to those who understand by 'borolanite' a nepheline-melanite-syenite with large white spots which may have been leucite.

Age of the dike.

The dike is unfoliated and cuts the Lewisian gneiss but there is no other direct evidence of age. Closely similar, and in some cases almost indistinguishable rocks of post-Cambrian age outcrop farther south at Rhu More, Garvie Bay, Cùl Mòr, and Elphin (fig. 2), and there is little doubt that the Achmelvich dike belongs to the post-Cambrian pre-thrust-movement period of igneous activity of Assynt.

Acknowledgements.—The cost of the chemical analysis was defrayed from a Royal Society grant which is gratefully acknowledged. The writer's thanks are due to Mr. A. J. Boyd of Inverkirkaig for collecting the specimen used for analysis.

¹ S. J. Shand, Loch Borolan laccolith, northwest Scotland. Journ. Geol. Chicago, 1939, vol. 47, pp. 408-420.
