A note on a nordmarkite and an associated rare-earth mineral from the Ben Loyal syenite complex, Sutherlandshire.

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Summary. A nordmarkite from the Ben Loyal syenite complex has been analysed, in which a powdery yellow mineral occurs in miarolitic cavities. The mineral may be a new hydrated species with a monazite structure and a chemical composition essentially that of monazite but with silicon partly replacing phosphorus and with magnesium, calcium, and iron partly replacing the rare earths.

A NORDMARKITE from the Lettermore quarry on the shores of Loch Loyal, typical of extensive areas of the Ben Loyal mass from this locality westwards to Sgor Chaonasaide, has been analysed (table I). It is chemically and mineralogically related to the pulaskites described by Read (1931, p. 177) and King (1943, p. 160) from the Cnoc na Cuilean intrusion. A modal analysis indicates the presence of about 12 % of quartz and 9 % of blue-green hornblende. The feldspar consists of albite and a slightly microperthitic orthoclase. Hornblende shows pleochroism α yellow-green, β green, γ blue-green, and the absorption scheme is $\gamma > \beta > \alpha$. A fair amount of sphene occurs, in which a qualitative spectrographic analysis shows minor Al, Fe, Mn, and Mg, and traces of Zr, Y, Ce, V, Pb, Sn, La, Nb, Na, Cr, Ba, Yb, and possibly Eu. The rock shows a holocrystalline texture in thin section, but in the field a faint foliation is often apparent.

Pegmatitic veins in nordmarkite. Heddle (1901) described the mineral association thorite, amazonite, babingtonite, magnetite, topaz, galena, sphene, and rubinglimmer from the cliffs of Sgor Chaonasaide and from an erratic boulder on Beinn Bhreac to the north. This mineral association probably occurs in pegmatitic veins cutting the main nordmarkite in the Sgor Chaonasaide cliffs. Other veins containing the association amazonite, magnetite, sphene, and allanite are present. The amazonite is perthitic in appearance and the green coloration is often patchy and

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irregular. A qualitative spectrographical analysis of the amazonite indicates traces of Fe, Ba, Na, Rb, Ca, Mg, Pb, and Mn.

TABLE I. Chemical compositions of nordmarkite and of the yellow rare-earth mineral.

	1.	2.
SiO_2	64·94	18·84
TiO_2	0·81	1·90 (TiO₂ + Al₂O₃)
Al_2O_3	16·25	
$(La,Nd)_2O_3$, CeO_2	—	32·00
Fe_2O_3	1·68	10·61*
FeO	1·00	n.d.
MnO	0·06	0·04
MgO	1·03	1·90
CaO	1·56	6·61
Na_2O	6·08	—
K_2O	5·88	—
H_2O+	0·38	6·51†
H_2O-	0·14	6·06
P_2O_5	0·26	15·87
ZrO_2	n.d.	—
	100·07	100·34

	1 N.	1 M.
Quartz	4·8	12·0
Orthoclase	33·8	29·4
Albite	51·4	47·4
Hypersthene	0·5	—
Diopside	5·9	—
Acmite	0·8	—
Hornblende	—	9·2
Magnetite	0·7	1·0
Ilmenite	1·3	—
Sphene	—	1·0
Apatite	0·5	tr.
Hematite	0·3	—
	100·0	100·0

1. Nordmarkite, Lettermore quarry, Loch Loyal. Anal. O. von Knorring.
2. Yellow mineral from nordmarkite, Lettermore quarry, Loch Loyal. Anal. O. von Knorring.

1 N. Norm of nordmarkite, anal. 1.
1 M. Mode of nordmarkite, anal. 1.

* Total iron as Fe_2O_3. † Loss on ignition.

Yellow mineral in nordmarkite. A striking feature of the nordmarkite from the Lettermore quarry is the abundance of miarolitic cavities often filled with a canary-yellow, kaolin-like mineral. The cavities are up to a few millimetres across and contain, apart from this yellow mineral, aggregates of an albitic plagioclase and apatite, a zeolite mineral, identified as harmotome, forming white pseudo-tetragonal crystals, together with the mineral constituents of the nordmarkite. The yellow mineral is powdery to fluffy in appearance with a specific gravity of about 2·90 and a mean refractive index of $1{\cdot}647 \pm 0{\cdot}003$. Both the unheated and the ignited material gave X-ray powder photographs similar to monazite, and no extra lines indicating the presence of admixed impurities were observed. A qualitative spectrographic analysis of a specimen of the yellow mineral shows the presence of the following:

Major elements: La, Fe, Ce, Si, P.
Minor elements: Al, Ca, Mg.
Trace elements: Ba, Sr, Ti, Pb, Mn, Zr, Be, V, Ga, Na.

A tentative chemical analysis, made on 90 mg. of picked material, is given in table I. As the mineral is often intergrown with finely crystalline apatite the figures for calcium and phosphorus may be too high. Due to the small amount of material available for analysis the water content is based on the loss on ignition and halogens like F and Cl have not been determined. The data so far obtained indicate that the present mineral may be a distinct new hydrated species with a monazite structure and a chemical composition essentially that of monazite but with silicon partly replacing phosphorus and with magnesium, calcium, and iron partly replacing the rare earths. The mode of occurrence and the mineral association suggest a low temperature hydrothermal origin for this rare-earth mineral. The possibility of heterogeneity exists and contamination by some kaolin minerals is not entirely excluded. Further work on this mineral is in progress. It is interesting to note that King (1943, p. 160) in his analysis of the pulaskite from Cnoc na Cuilean reports traces of rare earths, an observation which cannot be attributed to the rare-earth content of the accessory sphene and allanite alone. Not all the cavities contain the present rare-earth mineral. A greenish-yellow curdy mineral of the montmorillonite group has been frequently observed and stilbite has been identified from cavities of the nordmarkite from Sgor Chaonasaide.

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