Dixeyite : a new natural hydrous aluminiumsilicate

Autor(en): **Marmo, Vladi**

Objekttyp: **Article**

Zeitschrift: **Schweizerische mineralogische und petrographische Mitteilungen = Bulletin suisse de minéralogie et pétrographie**

Band (Jahr): **39 (1959)**

Heft 1-2

PDF erstellt am: **13.05.2024**

Persistenter Link: https://doi.org/10.5169/seals-30390

Dixeyite — a new natural hydrous aluminiumsilicate

By *Vladi Marmo* (Otaniemi, Finland)[1])

Abstract

A new hydrous isotropic mineral in an amphibolite from Sierra Leone is described. It is named dixeyite, in honour of Dr. Dixey — the first geologist of Sierra Leone.

Introduction

During the mapping in 1954 of the schist belt of the Kangari Hills, Central Sierra Leone, small boulders of a peculiar amphibolite were collected. That happened about 1 mile to the North of a small native village called Belihun, the location of which is approximately 8° 22′ 30″ N and 11° 36′ 15″ W. This amphibolite (of which a small outcrop was also found in 1956) consisted of abundant hornblende in a matrix composed of some isotropic, colourless mineral with remarkably low refractive index, and of minor amounts of quartz. The isotropic mineral was taken to be a zeolite. Later it was classed as analcime, and the rock itself was named "analcime amphibolite". As such it was described by the author in the Annual Reports of the Geological Survey Department of Sierra Leone (1955 and 1956), the petrologist of which department the present writer was at that time.

In 1957, after his return to Finland, the author reexamined the "analcime", and then found, that the powder diagram of this material was not that of analcime. Neither did it correspond to that of any other known mineral. Examination revealed, furthermore, that the refractive index of this mineral is too high for analcime. The chemical analysis of the separated material confirmed the results of the X-ray study, and indicated the probability of the mineral in question, which is an aluminiumsilicate, conspicuously hydrous, being new one.

---

[1]) Outokompu Co., Finland.

Fig. 1. Amphibolite containing isotropic unknown mineral N of Belihun, Sierra Leone. Thin section 40 ×. N //. 1 = dixeyite; 2 = hornblende; 3 = quartz; 4 = magnetite.

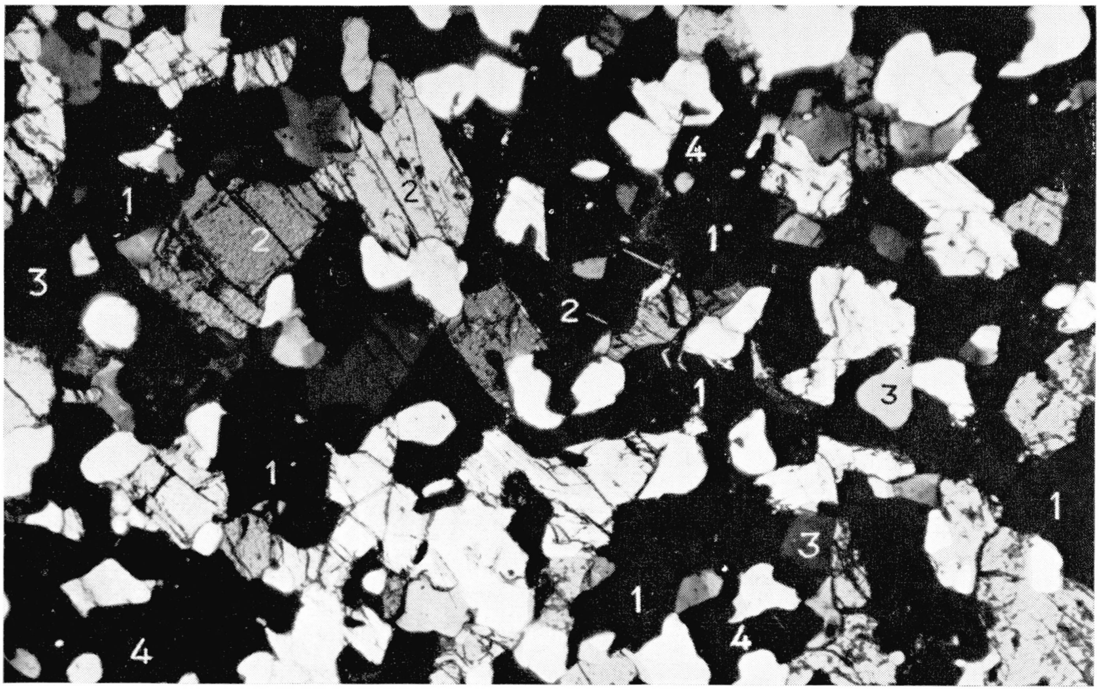

Fig. 2. Amphibolite containing isotropic unknown mineral N of Belihun, Sierra Leone. Thin section 40 ×. N+. 1 = dixeyite; 2 = hornblende; 3 = quartz; 4 = magnetite.

Amphibolite containing unknown mineral

Owing to the overburden masking the geology, it was not possible to ascertain the exact geological setting of the amphibolite containing the new mineral. This rock-type was found on the path along the Yandeye Stream, on its northern side, and also in a small outcrop, approx. 50 m N of the path. It is supposed, that this amphibolite occupies a very narrow zone along the western margin of the well-outcropped body of an ultrabasic rock, and at its contact with the embracing granodiorite. The occurrence of this peculiar amphibolite is at the southern end of a large schist belt including the Sula Mountains and the Kangari Hills (see for instance, MARMO, 1958), where the schist belt mainly consists of amphibolites. To the North of Belihun, the amphibolite contains a minor patch of an ultrabasic rock consisting of pyroxene and tremolite, and containing pleonaste and magnetite. At the border of this body, the amphibolite with the odd mineral occurs.

The amphibolite containing the isotropic mineral is a medium- and even-grained rock with a distinct but not strong orientation. In the hand specimens it does not differ in any way from the ordinary medium-grained amphibolites of the area. The texture of this rock is shown in figures 1 and 2. The main constituent is common green hornblende embedded in a mixture of the isotropic mineral and of minor amounts of quartz. There is no evidence to support the view that the zeolite-like mineral could have originated by some kind of alteration of any pre-existing mineral; on the contrary one gets the impression, that it is in fact an original constituent of the rock, and of more or less the same age as the hornblende. Quartz, however, seems to be somewhat younger than the isotropic unknown mineral.

Chemistry

The chemical analysis of this peculiar amphibolite is shown in table 1. The composition of the rock is, according to this analysis, rather strange. If the high water content is neglected, then the material corresponds to the following mineral association:

28.3 % Quartz
14.35% Pyroxene
26.2 % Plagioclase (An_{90})
1.7 % Orthoclase
4.7 % Corundum

1.9 %	Apatite
3.65%	Ilmenite
12.1 %	Magnetite
92.90	

Obviously, this mineral composition was not attained because of the presence of much water (4.74% combined). The actual mineral composition consists of quartz, hornblende, magnetite and the highly hydrous Al-mineral.

Table 1. *Chemical composition of amphibolite containing the isotropic mineral. Sierra Leone.* Analyst: AULIS HEIKKINEN

		Normative composition		Niggli values	
SiO_2	51.10%	Apatite	1.90%	al =	25.0
TiO_2	1.91	Ilmenite	3.65	fm =	58.0
Al_2O_3	13.94	Orthoclase	1.67	c =	15.0
Fe_2O_3	8.31	Albite	4.40	alk =	2.0
FeO	7.02	Anorthite	21.82		100.0
MnO	0.21	Corundum	4.74		
MgO	4.53	Magnetite	12.06	si =	150
CaO	4.75	Enstatite	11.30	k =	0.265
Na_2O	0.52	Ferrosilite	2.84	mg =	0.36
K_2O	0.27	$MnO \cdot SiO_2$	0.21	qz =	+ 42
P_2O_5	0.26	Quartz	28.31	ti =	0.044
CO_2	0.00	H_2O+	4.74	p =	0.004
H_2O+	4.74	H_2O-	2.39	h =	0.48
H_2O-	2.39	Total	100.03	o =	0.328
SO_3	0.00				
Cl	0.00				
Total	99.95				

Using bromoform-ethanol mixture, an attempt was made to separate the unknown mineral for chemical analysis. Because abundant and extremly fine needle-like inclusions of hornblende are present in the mineral, it was not possible to obtain sufficiently pure material. Nevertheless the material obtained by the separation was also analyzed (table 2).

From the analyses of tables 1 and 2 an attempt was made to calculate the possible chemical composition of the zeolite-like isotropic mineral. The separation by bromoform-ethanol yielded 30% by weight of material very enriched in the unknown mineral. Thus, the analysis of table 2 represents the composition of 30% of the total rock. If 30% of the mole values of this analysis are taken and subtracted from the total mole values of analysis 1, it should be possible to estimate the compo-

Table 2. *Chemical composition of the concentrate predominantly containing the unknown isotropic mineral, Sierra Leone.* Analyst: AULIS HEIKKINEN

SiO_2	51.72
TiO_2	0.55
Al_2O_3	21.15
Fe_2O_3	2.68
FeO	2.76
MnO	0.15
MgO	2.17
CaO	2.56
Na_2O	0.34
K_2O	0.32
P_2O_5	0.45
CO_2	0.00
H_2O+	10.26
H_2O-	5.03
Total	100.14

sition of hornblende of the rock, which is also the main impurity of the material represented by the analysis of table 2. This calculation yields a composition for the hornblende of $Na_2O_3 \cdot 2CaO \cdot 4(Mg, Fe)O \cdot 2(Al_2O_3, TiO_2) \cdot 6\ SiO_2 + 3 \times (2\ CaO \cdot 3.5\ (Mg, Fe)O \cdot 2Al_2O_3 \cdot 6\ SiO_2 = Na_2O \cdot 8CaO \cdot 14.5(Mg, Fe)O \cdot 8(Al_2O_3, TiO_2) \cdot 24SiO_2$.

If this composition (and magnetite) be subtracted from the analysis of table 2, there remain

$$\left.\begin{array}{rl} 730\ \text{mol.} & SiO_2 \\ 166\ \text{mol.} & Al_2O_3 \\ 3.5\ \text{mol.} & K_2O \\ 2\ \text{mol.} & CaO \\ 570\ \text{mol.} & H_2O \end{array}\right\} = \text{approximately } Al_2O_3 \cdot (4\text{—}5)SiO_2 \cdot (3\text{—}4)H_2O.$$

From this calculation it may be deduced, that the zeolite-like isotropic mineral has, in the main, the composition of a highly hydrous aluminiumsilicate, possibly containing a little potassium and calcium. Because the material analyzed contained some inclusions of quartz, the true composition of the isotropic mineral may well be $Al_2O_3 \cdot 4SiO_2 \cdot (3\text{—}4)H_2O$. By prolonged separation of the odd mineral, a portion amounting to a few mg of reasonable pure material was obtained. Because of the scarcity of material, only CaO, Al_2O_3 and SiO_2 were determined. The result: 0.05% CaO, traces of total iron, 23.65% Al_2O_3, and 63.14% SiO_2 well confirms the above-made calculation, as well as the suggested formula of the odd mineral ($Al_2O_3:SiO_2 = 1:4.5$).

It is interesting to compare this composition with that of analcime, which is $Na_2O \cdot Al_2O_3 \cdot 4SiO_2 \cdot aq$. Thus, the new mineral resembles analcime without Na_2O. Though nothing seems to replace the sodium, the optical properties and isotropy of the new mineral nevertheless indicate that the latter is very similar to analcime.

The new mineral could hardly be classed definitely as a zeolite since it contains neither alkalies or lime.

URBAIN (1936), however, considers that the water of hydrated Al-silicates, is mainly "zeolitic" as is also obviously the case in the mineral considered in this paper. The composition of this mineral is that of hydrous pyrophyllite ($Al_2O_3 \cdot 4SiO_2 + aq$) or of paramontmorillonite ($Al_2O_3 \cdot 4SiO_2 \cdot 6H_2O$). The former composition was mentioned by SEDLETZKY (1940) as a hypothetical metastable member between pyrophyllite gel and pyrophyllite, but it definitely has not a cubic structure.

Returning to the bulk composition of this rock (table 1) and remembering that it very probably occurs at the contact between pyroxene-spinel-magnetite-rich ultrabasic rock and granodiorite, it may be of interest to compare this bulk composition with that of the ultrabasic rock. Recalculation of the analysis of table 1 into minerals characteristic of this ultrabasic rock, one gets the following composition (neglecting the water content of the rock, and taking the excess of Al_2O_3, in accordance with the composition of the unknown, hydrous Al-mineral, as pyrophyllite).

diopside	18.36%
spinel	6.23%
magnetite	12.06%
ilmenite	3.65%
pyrophyllite	25.65%
albite	4.40%
orthoclase	1.67%
apatite	1.90%
quartz	18.78%
	92.70%

This calculation reveals, that the amphibolite of odd composition may well have derived as a marginal variety from the above-mentioned ultrabasic rock, by addition of much alumina, silica and water, which in turn could have derived from solutions circulating along the contact zone during and immediately after the emplacement of the ultrabasic material.

Dixeyite

The unknown mineral was separated from the well-crushed rock by means of a bromoform-ethanol mixture and the centrifuge. This procedure revealed that the specific gravity of the unknown mineral is approximately 2.51—2.52. The refractive index of the mineral is 1.5057.

Because of the intense intergrowth of the new mineral with extremely thin needles of amphibole it was not possible to separate sufficiently pure material for very exact examination. It was, however, possible to obtain a small amount of reasonably pure material for a diffraction picture. This gave the pattern of table 3.

In this table, a_0 values for all reflections are also indicated and show some variation; this suggests that the lattice may not be exactly cubic. Optically, however, the mineral is perfectly isotropic. The average value of column 1 for $a_0 = 7.55$ Å, of column 2, $a_0 = 7.7$ Å, and the mean of both, $a_0 = 7.6$ Å, should give the approximate size of the unit cell. The size of the unit cell will at least lie near that of such a cubic cell.

If the oxygen-atom content of the unit cell be calculated from what remains when the analysis (table 2) is subtracted from the analysis (table 1) and taking into consideration both the known approximate value of the specific gravity of the examined mineral and the value $a_0 = 7.6$ Å, the result obtained is 22.55 atoms of oxygen per unit cell. This suggests, that the size of a_0 should be doubled, which is also in agreement with the fact that the mineral is highly hydrous, and zeolite-like.

Table 3. *Reflections of dixeyite*

1				2			
d		hkl	a_0	d		hkl	a_0
3.32	s	(210)	7.404 Å	3.40	s	(210)	7.582 Å
3.09	s	(211)	7.570 Å	3.19	s	(211)	7.813 Å
2.69	v.w	(220)	7.613 Å	2.74	d	(220)	7.56 Å
2.33	d	(310)	7.369 Å	2.58	d	(300, 221)	7.74 Å
2.27	s	(311)	7.536 Å	2.46	d	(310)	7.774 Å
2.15	w	(222)	7.390 Å	1.85	w	(410, 322)	7.622 Å
2.01	w	(321)	7.517 Å				
1.83	w	(410, 322)	7.539 Å				
1.79	w	(411, 330)	7.589 Å				
1.72	w	(331)	7.479 Å				
1.68	w	(421)	7.694 Å				

s = strong; d = distinct; w = weak; v.w = very weak

1. according to the X-ray diffraction chart,
2. according to the photograph of the powder diagram.

Thus it is assumed that the examined mineral has 180 oxygen atoms in the unit cell, providing this cell deviates but little from a cubic cell with a_0 = 15.2 Å.

The chemical composition, optical examination and the X-ray study suggest, that the mineral described in this paper, is a new mineral with a structure resembling that of zeolites.

It will be named *dixeyite,* in honour of Dr. F. Dixey, Director of the British Overseas Geological Surveys, because he was the first geologist appointed by the government of Sierra Leone, and it was he who first described the geology of this country more extensively.

References

Geological Deptm. of Sierra Leone. Annual Report 1955 and 1956.

Marmo, V. (1958): Serpentinites of Central Sierra Leone. Bull. Comm. géol. Finlande 180, pp. 1—30.

Sedletzky, J. D. (1940): On the principles of classification of argillaceous minerals. — Compt. Rend. (Doklady) Acad. Sci. USSR, vol. 26, pp. 240—243.

Urbain, P. (1936): Classification des silicates d'alumine hydratés (lato sensu), du point de vue du pétrographe, et du géologue. — Compt. Rend. soc. géol. France, 1936, fasc. 8—9, pp. 147—149.

Received: 17th of October 1958.