Latiumite (*sulphatic potassium-calcium-aluminium silicate*), *a new mineral from Albano, Latium, Italy.*

(With Plates X and XI.)

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THE ejected blocks found in the 'peperino' of the Alban Hills have long attracted the attention of mineralogists on account of their variety in content of well-crystallized minerals. It may be recalled that this Roman region provides the earliest and finest examples of the white octahedral haüyne, at first referred to a separate species (berzeline), and that this mineral with leucite, yellow garnet, wollastonite, green clinopyroxene, and melilite form characteristic assemblages in the tuffs from Albano, Frascati, and other places.[1]

In an examination of a group of specimens in the mineralogical collections at Cambridge, the occurrence was noted in two ejected blocks from Albano of a mineral bearing a superficial resemblance in section to anorthite or wollastonite, but which closer study reveals to be a new species which it is now proposed to name *latiumite* from the district of its origin (Latium). The two specimens (45482, 29799, Harker Slice Collection) are clearly the product of limestone reaction, containing as they do lime-rich minerals along with species characteristic of the Roman magmatic province, namely, haüyne and leucite. One of the assemblages contains in addition prominent crystals of kaliophilite[2] (pl. XI).

The first rock (45482, pl. X) is built of hedenbergitic pyroxene, grossular-andradite, melilite (humboldtilite), leucite, haüyne, and the new mineral in some abundance; and in the second (29799) the new mineral, more sparingly developed, is associated with clinopyroxene, garnet, leucite, haüyne, and kaliophilite (pl. XI, figs. 1 and 2). Melilite

[1] A systematic account of the 'enclaves de calcaires' of the Latium district is given in A. Lacroix, Enclaves des roches volcaniques. Ann. Acad. Mâcon, 1893, vol. 10, pp. 334–350.

[2] That this mineral is kaliophilite, not kalsilite, is demonstrated by both powder and single-crystal X-ray photographs. The anomalous properties which the mineral shows are at present under investigation by Dr. A. M. B. Douglas at Cambridge.

(humboldtilite, analysis, table III) is also present as scattered crystals. In the rock latiumite is intergrown with the chief minerals, but crystals can be isolated from cavities. These appear characteristically with an elongated tabular habit, but are modified by narrow faces along their longer edges and terminated by imperfectly developed forms. The crystals in 45482 appear white by a powdery incrustation, but in the second rock clearer glassy crystals can be obtained. The density of analysed material is 2·93, H. $5\frac{1}{2}$–6.

Weissenberg and oscillation photographs were taken, using copper radiation, of three crystals from the two specimens with the following results:

Monoclinic, a 12·12, b 5·13, c 10·80 Å., β 108°.

These values give a unit cell volume of 638 Å.^{3} and with the density determined as 2·93 the calculated molecular weight is 1125.

The powder photograph of latiumite is very rich in lines, but few of these are strong and they fade out rapidly below spacings of about 1 Å.

TABLE I. X-ray powder data for latiumite.

Int.	d in Å.	Int.	d in Å.	Int.	d in Å.	Int.	d in Å.
vw	7·2	w	2·72	vw	1·846	w	(1·340)
m	4·6	vw	2·63	vw	1·831	vw	1·319
m	4·5	vw	2·58	m	(1·812)	m	1·308
w	4·3	s	2·54	w	1·792	w	(1·289)
w	4·0	vw	2·49	vw	1·715	w	(1·274)
m	3·83	m	2·40	w	1·687	w	(1·257)
w	3·69	m	2·37	m	1·641	vw	1·241
w	3·63	m	2·33	m	1·604	vw	1·230
vw	3·53	m	2·31	m	1·563	w	(1·209)
w	3·46	w	2·25	m	1·522	vw	1·199
m	3·38	vw	(2·15)	vw	1·504	vw	1·186
m	3·28	w	(2·12)	vw	1·484	w	1·180
w	3·14	w	2·08	vw	1·473	vw	1·171
s_2	3·06	w	2·06	vw	1·463	vw	1·163
w	3·01	w	2·05	w	1·447	vw	1·151
s_3	2·96	m	1·997	w	1·435	vw	1·134
w	2·90	m	1·957	vw	1·433	vw	1·120
s_1	2·86	w	1·943	vw	1·417	vw	1·105
m	2·82	m	1·903	vw	1·408	vw	1·095
w	2·77	w	1·858	vw	1·395	vw	1·085

In table I the strongest line is marked s_1 and the two next strongest s_2 and s_3 respectively. (s = strong, m = medium, w = weak, vw = very weak; spacings corresponding to broad unresolved lines are enclosed in parentheses.)

A small, fairly clear crystal gave some measurements in the zone of

its elongation when studied by means of the optical goniometer. Another larger crystal from a different specimen showed a tabular habit parallel to a prominent cleavage. In both crystals a few rounded terminal faces

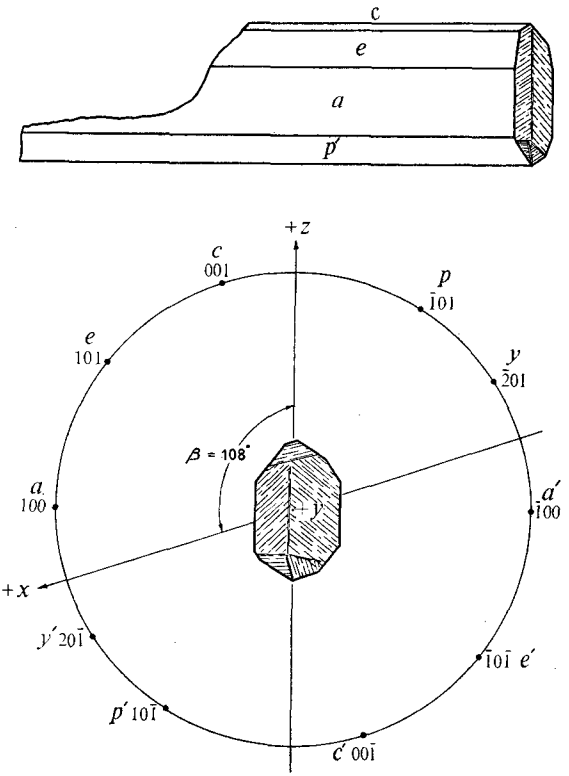


FIG. 1. Latiumite crystal elongated along *b*-axis (actual size 1½ mm.). Stereographic projection on (010). Striated areas represent rounded terminal faces.

could be seen, but these did not give measurements worth recording. In fig. 1 the faces have been indexed on the X-ray unit cell. The angles fit well and the indices are simple:

a (100)	*e* (101)	*c* (001)	*p* ($\bar{1}$01)	*y* ($\bar{2}$01)	*a'* ($\bar{1}$00)
	38°	34°	50°	25°	33°

Optical examination confirms the monoclinic symmetry, the elongation corresponding to the *b*-axis, which is also the *γ*-axis of the indicatrix. The optic axial plane is thus perpendicular to (010). The tabular

face taken as (100) is a plane of perfect cleavage and is also the twin plane, twinning being simple or multiple. In sections parallel to (010) the extinction is inclined, but sections cut perpendicular to α and β show straight extinction measured to the cleavage or long edge. Material isolated from 45482 gave the following values of the refractive indices α 1·600, β 1·606, γ 1·614, $\gamma-\alpha$ 0·014. One characteristic feature of the mineral in both rocks is the mottled extinction, reminiscent of that seen in coloured clinopyroxenes. The areas giving rise to the mottling are often quite irregular in shape, and in the plane of symmetry extinction angles range 16–28° ($\alpha:c$). Dispersion is marked $r > v$. Examples of this mottled extinction are seen in the photomicrographs (pl. X, figs. 2 and 4).

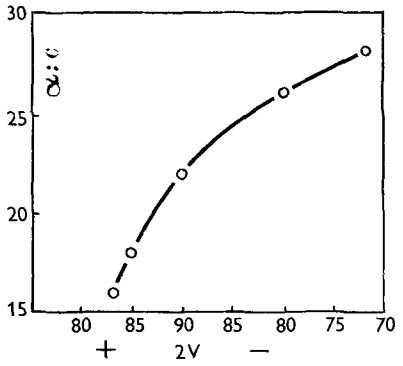


FIG. 2. Optic axial angle and extinction angle relationship in latiumite.

The mineral shows a variable optic axial angle, sections with a lower extinction angle being optically positive, those with higher extinction angles optically negative. Material in 29799 shows more consistently optically negative crystals, and on such grains refractive indices α 1·603, β 1·609, γ 1·615 were obtained. Zoning in some crystals is sometimes more regular in that it follows the outlines of the crystal sections. A series of measurements on the universal stage gave the following results (see fig. 2):

$\alpha:c$	...	16	18	22	26	28°
2V	...	83(+)	85(+)	90	80(−)	72°(−)

These extinction angles are measured in the obtuse angle β. The optical properties noted above clearly point to the new mineral as a solid solution series, but their correlation with chemical composition must await the discovery of further material for analysis.

Microchemical tests show that latiumite is rich in calcium and aluminium. It is soluble in weak acids leaving a silica pseudomorph, and it reacts for SO_3 and CO_2. In 45482 the mineral gave a reaction for chlorine with $AgNO_3$ and HNO_3, but in grains tested from 29799 this constituent proved absent. Single grains tested with potassium ferro- and ferricyanides gave a positive reaction for ferric and ferrous iron.

The mineral fuses before the blast of the blowpipe and the resulting glass partly devitrifies at a low red-heat to a fine-grained product, uniaxial negative, yielding a powder photograph closely similar to that of a gehlenitic melilite. Centrifuged in heavy liquids latiumite can be

TABLE II. Chemical analysis of latiumite. (Analyst, J. H. Scoon.)

			Mol. ratios.	Oxygens.		Atoms to O = 25.			
SiO_2	...	28·33	472	944	5·31	5·31	10·00	5·31	7·00
Al_2O_3	...	24·67	242	726	5·45	4·69, 0·76		1·69, 3·76	
Fe_2O_3	...	0·50	3	9	0·07	0·07		0·07	
FeO	...	0·55	8	8	0·09	0·09	1·13	0·09	4·13
MnO	...	0·02	—						
MgO	...	0·76	19	19	0·21	0·21		0·21	
CaO	...	29·41	525	525	5·91				
Na_2O	...	1·11	18	18	0·40	8·04		8·04	
K_2O	...	7·20	77	77	1·73				
H_2O+	...	0·27	—	2326					
H_2O-	...	nil	—	106					
				2220					
SO_3	...	5·42	68	—	0·76 (SO_4)	0·76	1·18	0·76	1·18
CO_2	...	1·60	36	÷ 88·8	0·40 (CO_3)	0·40		0·40	
Cl	...	0·14	2	—	0·02 (Cl_2)	0·02		0·02	
		99·98							
Less O = Cl		0·03			Mol. wt. 1121				
		99·95							

isolated from the heavier garnet, clinopyroxene, and melilite and from the lighter haüyne and leucite. Material so isolated has been analysed by Mr. J. H. Scoon. The results set down in table II are from two analyses, one a partial analysis (i.e. less SO_3, CO_2, Cl) of pure material, and the other a product containing a very small fraction of melilite which itself has been subject to analysis by Mr. J. H. Scoon (table III).

A tentative interpretation of the latiumite analysis is set down in table II in the light of the molecular weight of the unit cell determined from the X-ray data. Calculated on a basis of 25 oxygen atoms, which gives a molecular weight of 1121 (X-ray data 1125), the figures of column 5 of table II are obtained, and on this basis the volume in cubic Å. units per oxygen atom is approximately 22. The figures of column 5 may be allotted alternatively as in columns 6 and 7 corresponding to

a sheet structure or one of mixed groups (?[SiO_4][Si_2O_7]). In view of its complexity as a solid solution, chemical analysis of additional latiumite material is much to be desired, and the problem of its formula may be left till these further chemical data and an X-ray structural analysis have been completed.

TABLE III. Chemical analyses of humboldtilite.

		1.	2.	1a. Metals in 1 to O = 7.
SiO_2	...	40·57	41·07	1·857 } 2·000
Al_2O_3	...	10·46	10·47	0·560 { 0·143 } 2·000 ; { 0·417 }
Fe_2O_3	...	0·97	3·80	0·033
FeO	...	2·62	—	0·099 } 0·991
MnO	...	0·16	—	0·005
MgO	...	6·35	6·02	0·437
CaO	...	34·42	33·92	1·689
Na_2O	...	3·49	3·25	0·308 } 2·030
K_2O	...	0·64	1·04	0·033
H_2O+	...	0·33	—	$Ca_2Al_2SiO_7$(Ge) 13
H_2O-	...	0·15	—	$Ca_2MgSi_2O_7$(Ak) 55
TiO_2	...	< 0·01	—	$CaNaAlSi_2O_7$ 32
		100·16	99·57	Sp. gr. 3·00, ω 1·637, ϵ 1·632

1. Humboldtilite in ejected block with latiumite, grossular-andradite, clinopyroxene, leucite, and haüyne, in peperino, Albano, Latium. (Analyst, J. H. Scoon.)

2. Humboldtilite in ejected block with yellow garnet, clinopyroxene, leucite, and haüyne, in peperino, Latium. F. Millosevich, Studi su minerali del Lazio. La melilite degli inclusi nel peperino. Atti (Rend.) R. Accad. Lincei, Roma, Cl. Sci. fis. mat. nat., 1921, ser. 5, vol. 30, sem. 1, pp. 80–84. [M.A. 2–165.]

1a. Analysis 1 recalculated to 7 oxygen atoms.

EXPLANATION OF PLATES X AND XI.

Photomicrographs of slices from ejected blocks in peperino, Albano, Latium, Italy.

PLATE X.

FIG. 1. A large twinned crystal of latiumite showing (100) cleavages: enclosures are green hedenbergitic pyroxene (centre), yellow grossular-andradite, and humboldtilite. Ordinary light. ×22.

FIG. 2. The same section, between crossed nicols, has been rotated to show the patchy zoning in the upper half of the twin. The hedenbergitic pyroxene crystal (right centre) is at extinction. ×22.

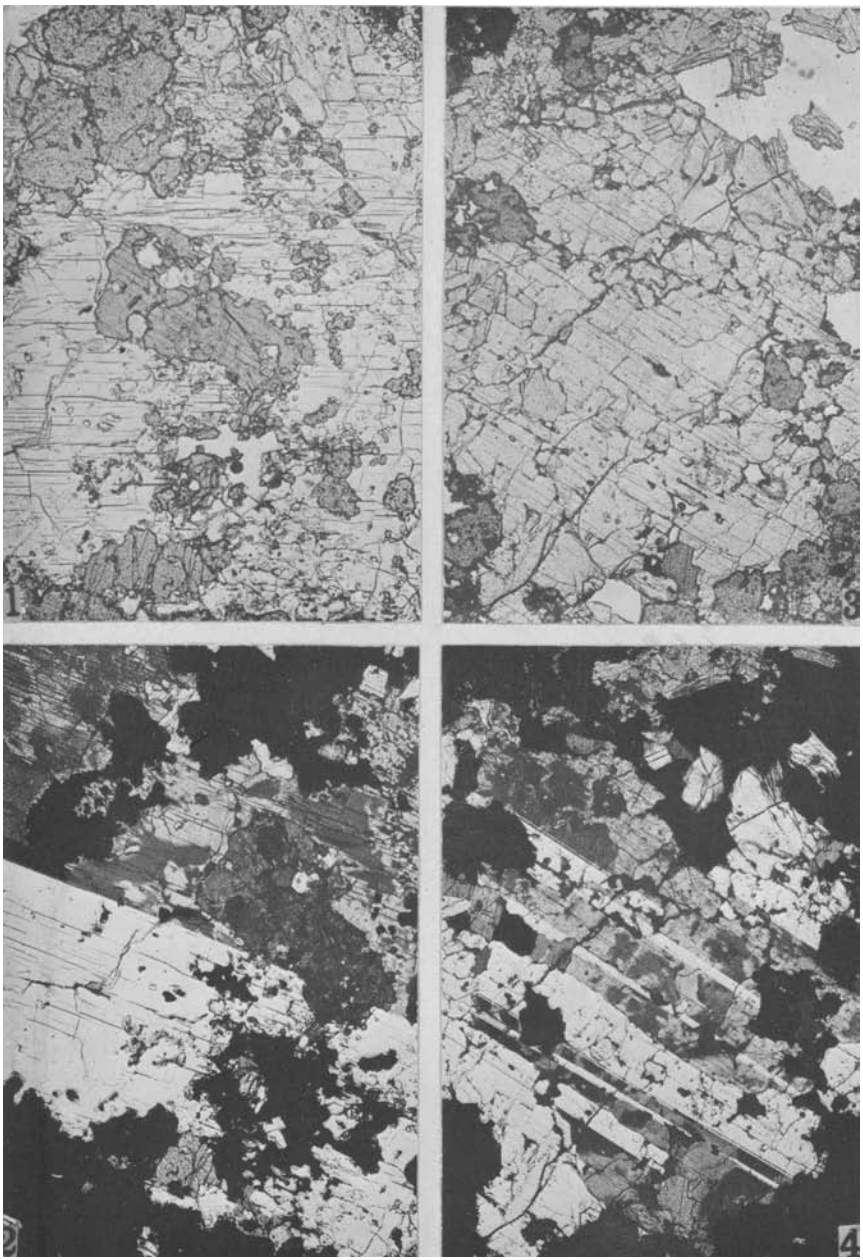
FIG. 3. Latiumite, a multiple twinned crystal, cut nearly perpendicular to the acute bisectrix (γ), enclosing grossular-andradite and bordered (left) by humboldtilite. Ordinary light. ×22.

FIG. 4. The same field between crossed nicols showing the characteristic development of the mottled zone structure in the latiumite lamellae. ×22.

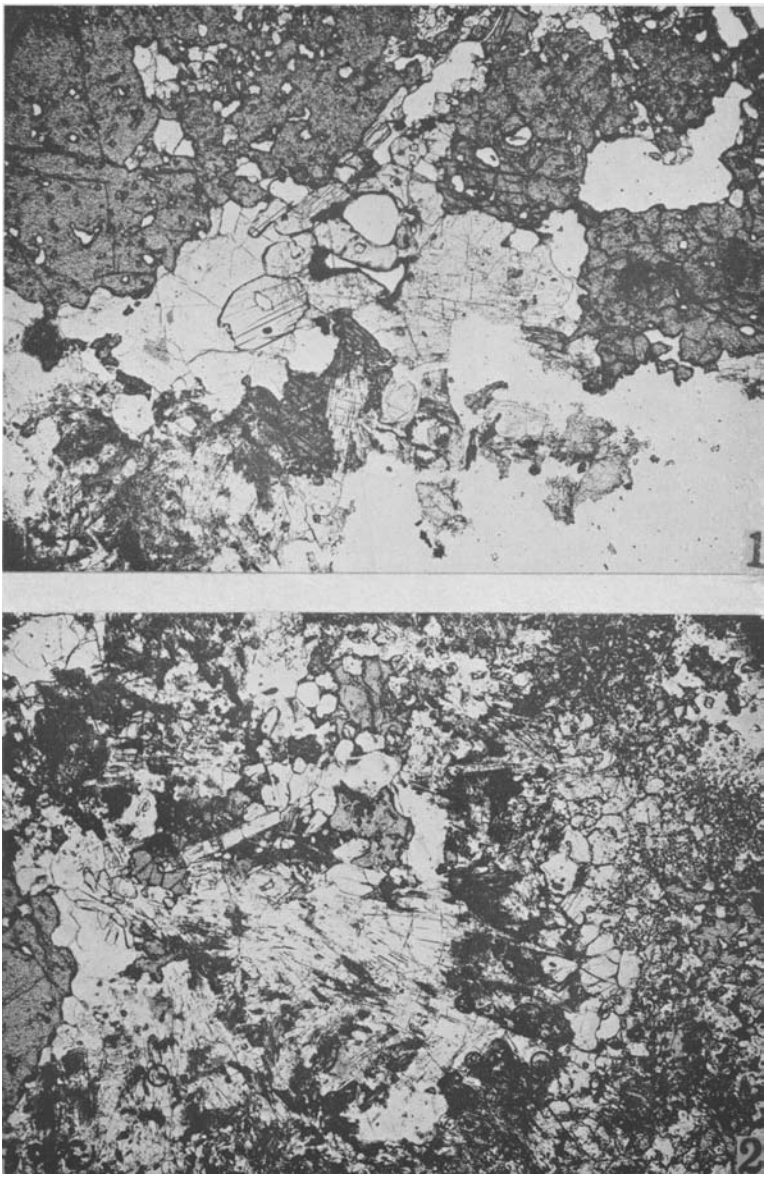
PLATE XI.

FIG. 1. Latiumite with kaliophilite in ejected block, Albano, Latium. Above grossular-andradite with some clinopyroxene. The clear grains with high relief and good cleavage are latiumite (left centre) set in haüyne. A vertical section of kaliophilite with cross fracture is seen enclosed in clinopyroxene (below the centre and other crystals are shown to the right of centre). Ordinary light. ×20.

FIG. 2. Another assemblage showing latiumite and kaliophilite. Right edge clinopyroxene and haüyne, followed on the left by clusters of humboldtilite; at the centre columnar crystals of kaliophilite with latiumite (higher relief) and darker grains of grossular-andradite. ×20.



C. E. TILLEY AND N. F. M. HENRY: LATIUMITE IN EJECTED BLOCK, LATIUM, ITALY



C. E. TILLEY AND N. F. M. HENRY: LATIUMITE AND KALIOPHILITE IN EJECTED BLOCK, LATIUM, ITALY