NEOMESSELITE AND BETA-ROSELITE: TWO NEW MEMBERS OF THE FAIRFIELDITE GROUP*

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ABSTRACT

Neomesselite, $(Ca, Fe, Mn)_3(PO_4)_2 \cdot 2H_2O$, is the disordered, iron-rich analogue of fairfieldite, $Ca_2(Mn, Fe)(PO_4)_2 \cdot 2H_2O$. Found as a hydrothermal mineral in pegmatite at Palermo, North Groton, New Hampshire. Triclinic, as greenish white to white fibrous and fine-granular aggregates. Optically biaxial positive, with $nX = 1.653$, $nY = 1.659$, $nZ = 1.676$, $2V = 25°$, specific gravity 3.16 for material with Ca:Fe:Mn:Mg = 12.3:8.6:1.6:1; also $nX = 1.644$, $nY = 1.649$, $nZ = 1.663$, 2V small, for material with Ca:Fe:Mn:Mg = 26.8:8.4:5.4:1.

Beta-roselite, $Ca_2Co(AsO_4)_2 \cdot 2H_2O$, is a triclinic polymorph of roselite isostructural with fairfieldite. Found as dark rose-red granular aggregates at Schneeberg, Saxony. Biaxial negative, with $nX = 1.723$ (pink), $nY = 1.737$ (pale pink), $nZ = 1.756$ (nearly colorless), $2V = 80°–90°$, $r < v$. Specific gravity 3.71, hardness $3\frac{1}{2}$–4, perfect cleavage {010}.

NEOMESSELITE, $(Ca, Fe, Mn)_3(PO_4)_2 \cdot 2H_2O$

The name messelite was applied by Muthmann in 1889 to a mineral with the composition $Ca_2Fe(PO_4)_2 \cdot 2\frac{1}{2}H_2O$ found at Messel in Hesse, Germany. Messelite was re-examined in 1940 by Wolfe. He concludes from *x*-ray, optical and chemical study that the mineral actually is anapaite, $Ca_2Fe(PO_4)_2 \cdot 4H_2O$, partly altered to collinsite and discredits it as a species. The circumstance has now come about that an unaltered mineral has been found whose chemical composition is essentially that attributed to the original messelite. This mineral, for which the name neomesselite is proposed, has the composition $(Ca, Fe, Mn)_3(PO_4)_2 \cdot 2H_2O$ and is isostructural with fairfieldite. Anapaite (messelite) is a crystallographically distinct higher hydrate that is isostructural with parahopeite. The position of neomesselite and of an allied new mineral, beta-roselite, described beyond, among minerals of the formula-type $A_2B(XO_4)_2 \cdot 2H_2O$ is given in Table 1.

Neomesselite occurs as a late hydrothermal mineral in the Palermo pegmatite at North Groton, New Hampshire, in two ways: (1) as granular, cleavable masses with a pale greenish white to greenish gray color associated principally with granular siderite, plagioclase and quartz. Other associated minerals, present sparingly, include goyazite, whitlockite, herderite, platy crystals and lamellar masses of amblygonite, radial-fibrous aggregates of brown eosphorite, brazilianite, and grains of sphalerite. (2) As platy-fibrous, almost pure white masses either deposited upon and molded around euhedral crystals of ludlamite in veinlets cutting

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triphylite, or embedded in veinlets or patches of granular material composed largely of siderite, quartz and plagioclase with minor amounts of platy amblygonite, ludlamite, whitlockite and sphalerite. This type of neomesselite has been mentioned under the name fairfieldite by Wolfe (1949) in his paper on ludlamite from Palermo. While two modes of occurrence of the neomesselite can be distinguished, both are of essentially the same period of formation and are products of the re-working of triphylite crystals formed during the magmatic stage of crystallization by late-stage hydrothermal solutions.

Neomesselite has a single, nearly perfect cleavage on {001}. The color varies from almost pure white to pale greenish white and greenish gray. Luster vitreous. Hardness 3½; specific gravity of the granular material 3.16. Distinct, measurable crystals have not been found. In open cavities the mineral sometimes forms globular or sheaf-like arrangements of lamellae with a rudely radial arrangement. When broken these show curved and irregular cleavage surfaces. The surface of the globules is indistinctly crystalline. Under magnification, the crystals composing the aggregates are seen to be terminated either by a single plane inclined to the elongation or by a pair of steeply inclined planes whose common edge is inclined at an angle to the elongation. The appearance of these aggregates is very similar to that of the fairfieldite found in the New England pegmatites. The symmetry of neomesselite is indicated to be triclinic by the optical properties and by the close resemblance of its powder pattern to those of collinsite and fairfieldite.

TABLE 1. MINERALS OF THE $A_2B(XO_4)_2 \cdot 2H_2O$ FORMULA-TYPE

Fairfieldite Group (Triclinic)		Roselite Group (Monoclinic)	
Fairfieldite	$Ca_2(Mn, Fe)(PO_4)_2 \cdot 2H_2O$	Roselite	$Ca_2(Co, Mg)(AsO_4)_2 \cdot 2H_2O$
Neomesselite	$(Ca, Fe, Mn, Mg)_3(PO_4)_2 \cdot 2H_2O$	Brandtite	$Ca_2Mn(AsO_4)_2 \cdot 2H_2O$
Collinsite	$Ca_2(Mg, Fe)(PO_4)_2 \cdot 2H_2O$		
Beta-roselite	$Ca_2(Co, Mg)(AsO_4)_2 \cdot 2H_2O$		

Optically, neomesselite is biaxial positive. Flakes resting on the cleavage show the acute bisectrix X emerging just outside of the field of view. 2V varies from about 20° to 35°. Cleavage flakes show an extinction angle of 16° to 23° as measured from Z′ either to the elongation of occasional lath-like flakes, or to an indistinct lineation in the grains that in some instances are parallely arranged needle-like inclusions, and in others appear to be either a second cleavage or extremely narrow polysynthetic twin lamellae. Turned on edge, the cleavage flakes show inclined extinction up to about 22°. The indices of refraction, given in Table 2, and the other optical constants vary somewhat with the ratio of the cations present.

Chemical analyses of the granular and fibrous types of neomessolite are cited in Table 2 in comparison with some reported analyses of fairfieldite. Analysis 1, of the greenish, granular material, conforms closely to the formula $(Ca, Fe, Mn, Mg)_3(PO_4)_2 \cdot 2.4H_2O$. The true water content probably is $2H_2O$. The several cations, present in the ratio Ca:Fe:Mn:Mg = 12.3:8.6:1.6:1. appear to be structurally equivalent, and in this the mineral departs from the general formula $A_2B(XO_4)_2 \cdot 2H_2O$, where A = Ca and B = Mg, Co, Fe″ or Mn″, found for the related minerals (Table 1). Analysis 2, of the white, fibrous material, affords a somewhat different ratio of the cations, with Ca:Fe:Mn:Mg = 26:8.4:5.4:1, and here also these appear to be structurally equivalent.

Neomessilite apparently forms a continuous isomorphous series with

TABLE 2. CHEMICAL ANALYSES AND OPTICAL DATA FOR NEOMESSLITE AND FAIRFIELDITE

	1	2	3	4	5	6
CaO	23.19	28.00	30.76	30.85	30.02	29.77
MgO	1.36	0.77				
FeO	20.92	11.54	7.00	4.75	3.42	1.00
MnO	3.94	7.35	12.40	14.82	17.40	19.68
Fe_2O_3	0.83	nil				
P_2O_5	36.90		39.62	39.55	[37.69]	37.79
H_2O	11.30		9.67	9.70	9.81	9.94
Insol.	1.39		0.55	0.50	1.66	1.07
Total	99.83		100.30	100.58	[100.00]	99.25
G	3.16			3.016	3.07	
nX	1.653	1.644		1.640	1.636	1.633
nY	1.659	1.649		1.650	1.644	1.641
nZ	1.676	1.663		1.660	1.654	1.562
2V	25°	small		86°	very large	—
Ext. angle	20°	23°		—	—	—

1. Neomesselite, Palermo, N. H. Greenish white, granular. L. C. Peck analysis, 1948.
2. Neomesselite. Palermo, N. H. White, platy-fibrous. H. J. Hallowell analysis, 1949.
3. Fairfieldite. Branchville, Conn. Penfield analysis in Brush and Dana, *Am. J. Sci.*, **17,** 359 (1879). Sum includes Na_2O 0.30.
4. Fairfieldite. Poland, Maine. Gonyer analysis in Berman and Gonyer, *Am. Mineral.*, **15,** 375 (1930). Sum includes Na_2O 0.41.
5. Fairfieldite. Branchville, Conn. Wells analysis in Brush and Dana, *Am. J. Sci.*, **39,** 212 (1890). It is not certain if the optical data, from Larsen, *U. S. Geol. Surv. Bull.* **679,** 74 (1921), refer to material of this particular composition.
6. Fairfieldite. Buckfield, Maine. Vassar analysis in Landes, *Am. Mineral.*, **10,** 386 (1925).

fairfieldite, as seen from the selected analyses cited in Table 2, and the name might then be restricted to that part of the series with fairfieldite with Fe>Mn. Before uniting these species in a series, however, it would be desirable to establish the structural relations of the two minerals. All of the reported analyses of fairfieldite conform to the formula $A_2B(XO_4)_2\cdot 2H_2O$ while neomesselite apparently is the disordered equivalent $(A, B)_3(XO_4)_2\cdot 2H_2O$. Fairfieldite itself needs further study, since a close comparison of *x*-ray powder photographs of this mineral from some of its reported localities show slight unexplained differences. The material from Newry, Maine, and Hagendorf, Bavaria, is virtually identical in pattern with that of the fibrous neomesselite from Palermo and is relatively close to that of collinsite, whereas the fairfieldite from Branchville, Connecticut, and Buckfield, Maine, have identical patterns which differ slightly from those of the other fairfieldites and from neomesselite. The *x*-ray powder spacing data for the fibrous neomesselite and the analyzed Buckfield fairfieldite are given in Table 3.

TABLE 3. *X*-RAY POWDER SPACING DATA FOR NEOMESSELITE, FAIRFIELDITE AND BETA-ROSELITE

Iron radiation, manganese filter, in Ångstroms

Neomesselite				Fairfieldite				Beta-Roselite			
I	*d*	*I*	*d*	*I*	*d*	*I*	*d*	*I*	*d*	*I*	*d*
5	9.00	3	2.48	2	7.06	5	2.30	2	6.40	4	1.719
3	7.01	3	2.45	9	6.40	3	2.24	1	5.66	3	1.701
10	6.34	2	2.41	6	5.08	2	2.21	3	5.12	1	1.606
5	5.07	3	2.35	5	4.53	4	2.17	1	4.68		
4	4.57	1	2.25	6	4.33	5	2.13	4	3.98		
4	4.51	3	2.23	1	3.96	6	2.10	6	3.59		
1	3.83	1	2.21	6	3.60	7	2.04	3	3.38		
4	3.74	4	2.13	3	3.48	1	1.986	4	3.22		
4	3.58	4	2.10	2	3.34	3	1.963	9	3.08		
3	3.49	1	2.05	10	3.23	3	1.934	10	2.75		
2	3.40	3	2.02	7	3.20	5	1.928	2	2.61		
2	3.34	1	1.989	8	3.03	1	1.902	1	2.52		
6	3.28	3	1.962	7	2.86	3	1.852	1	2.45		
10	3.17	1	1.923	5	2.84	4	1.828	1	2.33		
8	3.02	2	1.875	2	2.80	6	1.801	2	2.17		
3	2.95	4	1.839	6	2.69	3	1.744	1	2.13		
4	2.86	4	1.813	7	2.66	5	1.730	2	2.08		
6	2.79	7	1.788	7	2.63	5	1.722	1	2.02		
8	2.68	6	1.708	3	2.57	6	1.690	4	1.894		
4	2.62	6	1.689	4	2.52	2	1.672	1	1.875		
7	2.57	4	1.656	7	2.46	2	1.657	1	1.790		

BETA-ROSELITE, $Ca_2Co(AsO_4)_2 \cdot 2H_2O$

In connection with the study of neomesselite an examination was made of all of the available specimens of minerals belonging to the $A_2B(XO_4)_2 \cdot 2H_2O$ family. No new data were obtained except in the case of roselite. Nine specimens of this mineral, all from Schneeberg, Saxony, were available for study. These included the specimens earlier described by Peacock (1936) and by Wolfe (1940) in their studies of these species. Eight of these specimens conformed to the definitive description of roselite given by Peacock. One specimen, however, gave an *x*-ray powder pattern identical with that of collinsite, and similar to those of fairfieldite and neomesselite, but quite distinct from that of roselite proper. A chemical analysis established the composition as $Ca_2Co(AsO_4)_2 \cdot 2H_2O$, identical with that of roselite. The mineral thus is a member of the triclinic fairfieldite group and is dimorphous with roselite. The name beta-roselite is proposed for it.

Beta-roselite occurs as granular masses and distinct crystals were not found. The mineral is associated with pale pink cobaltian calcite and a few grains of dark rose-colored roselite in vein material consisting principally of quartz and pyrite. All of the minerals appear to be primary hydrothermal deposits.

Beta-roselite has a dark rose-red color and is indistinguishable in the hand specimen from the darker-colored types of roselite. There is one almost perfect cleavage, here taken as on {010}. No other cleavages were observed, although additional cleavages have been found on other members of the group. Hardness $3\frac{1}{2}$ to 4; specific gravity 3.71. Luster is weakly vitreous. Cleavage fragments are markedly composite on a fine scale. with irregularly curved surfaces much like neomesselite and fairfieldite, and this circumstance has precluded getting useful single-crystal *x*-ray photographs. The *x*-ray powder spacing data are given in Table 3. Beta-roselite may have been represented among the crystals of the several rather conflicting types of so-called roselite described by Schrauf (1874, 1873), and it may prove possible in the future to identify any such crystals if crystallographic data can be obtained on the present species.

Optically, beta-roselite is biaxial negative (−). Grains resting on the perfect {010} cleavage show the acute bisectrix X at a considerable angle thereto with Y′ and Z in the plane of {010}. An optic axis appears just outside the field of view. Turned on edge, so that the line of view is parallel to the cleavage, the flakes show inclined extinction up to about 40°. Small grains are colorless; larger grains are faintly pleochroic, nearly colorless to pink. The dispersion is rather strong, distinctly crossed, with $r < v$. The indices of refraction are given in Table 4 in comparison with those of roselite as cited by Peacock (1936). The chemical analysis of

TABLE 4. OPTICAL PROPERTIES OF BETA-ROSELITE AND ROSELITE

	Beta-roselite	Roselite (dark rose)	Roselite (pale rose)
nX (Na)	1.723 ± .003	1.725 ± .003	1.694 ± .003
nY	1.737 ± .003	1.728 ± .003	1.704 ± .003
nZ	1.756 ± .003	1.735 ± .003	1.719 ± .003
2V	80°–90°	60°	75°
Dispersion	$r<v$	$r<v$	$r<v$
Pleochroism			
X	pink	deep rose	pale rose
Y	pale pink	pale rose	paler rose
Z	nearly colorless	paler rose	palest rose

beta-roselite, cited in Table 5, affords the formula $Ca_2Co(AsO_4)_2 \cdot 2H_2O$. Small amounts of Mg, Ni and Fe'' substitute for Co. The analysis shows a slight excess of Ca over the 2:1 ratio required by the A and B positions.

TABLE 5. CHEMICAL ANALYSIS OF BETA-ROSELITE

	CaO	CoO	MgO	NiO	FeO	As_2O_5	P_2O_5	H_2O	Total
1	24.76	16.54				50.74		7.96	100.00
2	26.29	13.28	0.92	1.43	0.32	49.66	tr.	8.41	100.31

1. Theoretical weight percentages, $Ca_2Co(AsO_4)_2 \cdot 2H_2O$.
2. Beta-roselite. Schneeberg, Saxony. H. J. Hallowell analysis, July, 1949.

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