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REFERENCES

- Barth, T. F. W. (1931) Proposed change in calculation of norms of rocks, Min. Pet. Mitt. 42 (1), 1-7.
- ---- (1955) Presentation of rock analyses. Jour. Geol. 63, 348-363.
- ---- (1962) Theoretical Petrology. 2nd Ed. New York, John Wiley & Sons, Inc.
- ESKOLA, P. (1954) A proposal for the presentation of rock analyses in ionic percentage. Ann. Acad. Sci. Fennicae, Ser. A, III (Geol.-Geog.) 38.
- JOHNSON, K. S. (1962) CIPW flow chart. Okla. Geology Notes, 22 (6), 143-155.
- Sun, M. S. And B. Baldwin (1958) Volcanic rocks of the Cienega Area, Santa Fe County, New Mexico. New Mexico Inst. Mines Tech., New Mexico Bur. Mines Mineral Res. Bull. 54.
- THORNTON, C. P. AND D. D. McINTYRE (1958) Modified CIPW norm calculation and its programming on a digital computer (abs.) Geol. Soc. Am. Bull. 69, 1652.
- VITALIANO, C. J., R. D. HARVEY AND J. H. CLEVELAND (1961) Calculation of normative analysis of igneous rocks by means of IBM digital computer (abs.) *Geol. Soc. Am. Program*, 1961, 166A.

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STILPNOMELANE AND SPESSARTITE-GROSSULARITE FROM FRANKLIN, NEW JERSEY $^{\scriptscriptstyle 1}$

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STILPNOMELANE

Stilpnomelane occurs at Franklin as thin coatings upon crystals of dolomite and pale green sphalerite in hydrothermal veinlets that locally cut the main orebody. Specimens are contained in many collections of Franklin minerals, where they are usually found labelled chlorite. A chemical analysis is cited in Table 1. It yields a total of 8 Si atoms in the talc-layer of the structure when calculated on the basis of 30 (O, OH) ions, and thus conforms to the interpretation of the composition of this

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TABLE 1. CHEMICAL ANALYSIS OF STILPNOMELANE

	1	2	Atoms per 30 (O,OH)	
SiO ₂	43.67	45.11	Si	7.96
Al_2O_3	4.64	4.79	Al	0.99
Fe_2O_3	6.92	7.15	Fe^3	0.95
FeO	7.09	7.32	$\mathrm{Fe^2}$	1.08
MnO	6.02	6.22	$\mathbf{M}\mathbf{n}$	0.93
ZnO	5.22	4.92	Zn	0.64
MgO	11.63	11.39	Mg	3.00
CaO	1.42	0.59	Ca	0.11
BaO	0.88	0.91	Ba	0.06
Na ₂ O	0.37	0.38	Na	0.13
K ₂ O	2.67	2.76	K	0.62
S	0.18		H	9.95
CO_2	1.33		O	30
H_2O+	8.19	8.46		
	-			
	100.23	100.00		

^{1.} J. Ito, analyst. Cu, Pb, Ti, P and Cl lacking.

problematic mineral given by Hutton (1956). The composition is of interest not only in the presence of Zn—found also in pyroxenes and other ferromagnesian gangue minerals of the locality—but in the relatively high content of Mg and H₂O(+). The analysis sample was found optically to contain a small amount of dolomite that remained after repeated separations in heavy liquids. The CO₂ reported corresponds to 2.78 per cent CaMg(CO₃)₂, and this has been deducted. Fragments of the mineral are quickly leached by hot HCl leaving a white pseudomorphous residue of silica.

The stilpnomelane is grayish green to brownish green in color with a suggestion of a bronzy luster. A scaly habit is sometimes apparent to the unaided eye, but most material consists of dense crusts with an earthy fracture that show a micaceous structure only under the microscope. Optically negative with 2V 0°; $\beta = \gamma = 1.583$ (dark olive brown); α , difficult to determine, is approximately 1.539 (pale yellow brown). These values are among the lowest reported for stilpnomelane. The value of c was measured as 12.18 Å from the (004) relection on x-ray powder photographs taken in Fe radiation, using the indexing of Gruner (1937, 1944). The density could not be determined with precision, but is near 2.80.

The occurrence of stilpnomelane as a low temperature, hydrothermal

^{2.} Recalculated to 100 after deduction of CO₂ as dolomite and S as sphalerite. Formula: (K,Na,Ca,Ba).₉₂(Mg,Al,Fe³,Fe²,Mn,Zn)_{7,56}(Si,Al)₈O₂₀(OH,O)₁₀.

sulfide vein mineral is unusual. It also has been noted by Stewart (1956) with calcite, epidote and chlorite in a metamorphosed sulfide vein deposit at Dunham's Point, Deer Isle, Maine.

Spessartite-Grossularite

Garnet was an abundant and widespread mineral in the Franklin orebody. The reported analyses (Palache, 1937) and unpublished data on specimens in the Harvard collections indicate that virtually all of it was a manganoan andradite, with MnO generally in the range from 2 to 10 weight per cent. Aluminum garnets also occurred, but very sparingly, and have not been previously described. Specimens probably from the Trotter shaft area showed a transparent, bright orange-red garnet as thin veinlets cutting massive andradite. A chemical analysis, cited in Table 2, proves it to be a calcian spessartite with Ca: Mn=1:2.1. Isotropic, with n 1.789 (Na); a 11.697 Å; specific gravity 4.01. A bright pink garnet forming tough, very fine-grained aggregates associated chiefly with axinite, manganophyllite, bustamite and calcite has long been known as rare specimens from the Parker shaft workings. An unpublished partial analysis on a sample inseparably intergrown with about 8 per cent barysilite and barite and traces of willemite was made in 1935 by L. H. Bauer. It yielded Al₂O₃ 21.66, CaO 26.77, MnO 8.10, FeO 0.77 and MgO 0.49, indicating the material to be a manganoan grossularite with Mn: Ca \sim 1:4.2. Isotropic, with n 1.742 (Na) and a 11.814 Å.

TABLE 2. CHEMICAL ANALYSIS OF CALCIAN SPESSARTITE

	1	Atoms per 12 oxygens
Na ₂ O	0.01	
K_2O	< 0.01	
CaO	10.89	Ca .944
$_{ m MgO}$	0.05	Mg .006
FeO	0.28	Fe .019 \ 2.97
MnO	28.90	Mn 1.977
ZnO	0.36	Zn .021
$\mathrm{Al_2O_3}$	19.27	Al 1.834
Fe_2O_3	2.95	Fe .179 2.01
SiO_2	37.18	Si 3.00
TiO_2	0.03	
H_2O-	0.00	
$_{\mathrm{H_2O}}+$	n.d.	O 12
	_	
Total	99.92	

J. Ito, analyst. Sr and V present in range 0.00x; Ga,Cr,Cu,Ag,Mo,Ni present in traces.

TABLE 3.	SPESSARTITE-	GROSSULARITE	SERIES
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Sp	Gr	An	Al	Ру	Reference
66.7	22.7	9.1	1.3	0.2	Franklin, N. J.
58.3	21.7	2.7	12.1	5.2	California. Bloxam (1959)
58	40				Algeria. Byramjee and Meindre (1956)
49.2	26.3	5.9	13.7	4.9	India. Fermor (1934)
42.8	41.4	3.4	12.4		Nevada. Lee (1962)
34.0	54.3	1.9	9.9		Nevada. Lee (1962)
25.3	56.1	7.2	11.4		Nevada. Lee (1962)
18.6	77.7		1.7	2.0	Franklin, N. J.

The solid solution series between spessartite and grossularite probably is complete under some natural conditions, as is suggested by the present analyses and those tabulated in Table 3. The cited analyses are restricted to those with (Sp+Gr) over 75 mol per cent and with Sp and Gr each over 18 mol per cent. Gentile and Roy (1960) found "practically no solid solution" between spessartite and grossularite in synthetic material.

REFERENCES

- Bloxam, T. W. (1959) Glaucophane schists and associated rocks near Valley Ford, California. Am. Jour. Sci. 257, 95–112.
- Byramjee, R. and M. Meindre (1956) Le gisement de manganese de Guettara. 20th Cong. Geol. Intl. Mexico. Symp. sobre yacimiento de manganese, Sect. 2, Africa, 179-196.
- FERMOR, L. L. (1934) Notes on the manganese-lime series of garnets. Geol. Surv. India Recs. 68, (3), 337-343.
- Gentile, A. L. and R. Roy (1960). Isomorphism and crystalline solubility in the garnet family. Am. Mineral. 45, 705-711.
- GRUNER, J. W. (1937) Composition and structure of stilpnomelane. Am. Mineral. 22, 912-925.
 - --- (1944) The structure of stilpnomelane re-examined. Am. Mineral. 29, 291-298.
- HUTTON, C. O. (1956) Further data on the stilpnomelane mineral group. Am. Mineral. 41, 608-615.
- LEE, D. E. (1962) Grossularite-spessartite from the Victory mine, Gabbs, Nevada. Am. Mineral. 47, 147-151.
- Palache, C. (1937) The minerals of Franklin and Sterling Hill, Sussex County, N. J. U. S. Geol. Surv. Prof. Paper 180.
- Stewart, D. B. (1956). Rapakivi granite of the Deer Isle region, Maine. Ph.D. Thesis, Harvard Univ., p. 26.