NEW DATA ON ELPASOLITE AND HAGEMANNITE*

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ABSTRACT

Restudy of type elpasolite of Cross and Hillebrand (1885) proves it to be a species distinct from cryolite and identical with artificial K_2NaAlF_6. Isometric, simple cell, with $a_o=8.093$ and cell contents $K_8Na_4Al_4F_{24}$. Hardness $2\frac{1}{2}$; specific gravity 2.995 (obs.), 3.015 (calc.). No cleavage, fracture uneven. Colorless, with the luster of cryolite. Isotropic, with $n=1.376\pm0.002$.

Hagemannite of Shepard (1866) from Ivigtut is shown to be a variable mixture of ralstonite and thomsenolite pigmented with iron oxide.

ELPASOLITE

Elpasolite was tentatively described by Cross and Hillebrand (1) in 1883 as a new aluminofluoride of sodium and potassium. The mineral occurred very sparingly with cryolite, pachnolite, thomsenolite, prosopite and gearksutite in vein-like bodies of quartz and microcline in the Pikes Peak granite at St. Peter's Dome, at the southern base of Pikes Peak, El Paso Co., Colorado. The cryolite was the original deposit and the other minerals, as at Ivigtut, were derived by alteration either directly therefrom or from other, earlier-formed, secondary fluorides.

Through the courtesy of Dr. W. F. Foshag, the original analyzed specimen of Cross and Hillebrand, preserved in the type collection of the U. S. National Museum, was made available for study. The elpasolite forms indistinct aggregates of crystals ranging up to 0.5 mm. in size lining solution cavities in massive pachnolite. A little powdery gearksutite is present on the specimen and is formed later than the elpasolite. No recognizable or measureable crystal faces were observed on the elpasolite, although Cross and Hillebrand state that they saw a few crystals with a semblance of cube and octahedral faces. The mineral is quite isotropic and has an index of refraction of 1.376 ± 0.002. The specific gravity as measured on the microbalance is 2.995 ± 0.01. The hardness is $2\frac{1}{2}$. Cleavage is lacking and the fracture is uneven. Fragments are colorless and have the weak vitreous to slightly greasy luster typical of cryolite.

The x-ray powder diffraction pattern, given in Table 1, was completely indexed in terms of an isometric, simple cell with $a_0=8.093$. The pattern differs entirely from that of the two isometric aluminofluorides ralstonite and cryolithionite, and from that of cryolite, thomsenolite, pachnolite, prosopite, gearksutite, chiolite and fluellite. Specimens of weberite and

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TABLE 1. X-RAY POWDER DIFFRACTION DATA FOR ELPASOLITE

Cu radiation, Ni filter

d obs.	*d calc.*	*I*	*hkl*	*d obs.*	*d calc.*	*I*	*hkl*
4.655	4.673	1	111	1.132	1.133	1	551 711
4.000	4.047	0.5	200	1.080	1.082	3	642
2.863	2.862	10	220	1.053	1.054	0.5	731 553
2.336	2.336	8	222	1.013	1.012	2	800
2.237	2.244	0.5	320	.955	.954	3	660 882
2.024	2.023	10	400	.928	.928	1	662
1.846	1.852	1	331	.905	.905	5	840
1.650	1.652	4	422	.889	.888	0.5	911 753
1.578	1.587	0.5	510 431	.863	.863	3	664
1.556	1.558	2	511	.849	.848	0.5	931
1.428	1.431	6	440	α_1 .827	.826	4	844
1.367	1.368	0.5	531	α_2 .827	.826		
1.277	1.280	3	620	α_1 .795	.793	6	10.2.0 852
1.220	1.220	2	622	α_2 .793	.793		
1.168	1.168	3	444				

jarlite = metajarlite were not available, but the reported properties of these minerals do not suggest any relation to the mineral at hand. There is a certain relation between the powder patterns of elpasolite and cryolite, however, in that most of the stronger lines in the latter correspond roughly in position and intensity to strong lines in the former pattern. Cryolite, Na_3AlF_6, is markedly pseudoisometric in many characters, although strictly monoclinic in crystallization, and as appears beyond belongs in the same formula-type as elpasolite.

The powder spacing data for elpasolite are found to correspond except for a very slight difference in cell dimensions to that given by Náray-Szabó and György (2) for the artificial compound K_2NaAlF_6 found by them in a study of the melt system Na_3AlF_6—K_3AlF_6. Earlier, Menzer (3) reported that artificial K_2NaAlF_6 formed by evaporation of a dilute solution containing KF, NaF and $Al_2(SO_4)_3$ was simple cubic with $a_0 = 8.09 \pm 0.02$, but the spacing data are not given. The cell contents found were $K_8Na_4Al_4F_{24}$. His material appeared as small octahedra with subordinate cube faces.

The original analysis of elpasolite by Hillebrand is cited in Table 2.

The K and Na determinations were said by Hillebrand to be only approximations. H_2O was shown to be absent. F was not directly determined, although shown to be present in large amount, and the value given here is calculated in amount necessary to satisfy the bases present. The cell contents calculated from this analysis, with the exception of the value for Al, diverge somewhat from the values $K_8Na_4Al_4F_{24}$ expected from the indicated identity with the artificial compound. The specific gravity calculated on the basis of the expected cell contents, 3.015, is in satisfactory agreement, however, with the observed value, 2.995, while the value calculated from the actual analysis, 2.969, is relatively low. The observed divergences thus appear to be due to the admitted analytical error.

TABLE 2. CELL CONTENTS OF ELPASOLITE

Analysis		Atomic quotients	Measured cell contents (M.W.=969.5)	Theoretical cell contents
Al	11.32	0.4197	4.070	4
Ca	0.72	0.0180	0.174	
Mg	0.22	0.0090	0.009	
K	28.94	0.7402	7.176	8
Na	9.90	0.4405	4.271	4
F	47.90	2.521	24.44	24
	99.00			

HAGEMANNITE

In connection with the study of elpasolite, an examination was made of the ill-defined mineral hagemannite from Ivigtut, Greenland. This substance was described by C. U. Shepard (4) in 1866 on the basis of an analysis by Hagemann as a new fluoride of Na, Ca, Mg, Al and Fe. It occurs as dull, ocher- to wax-yellow or brown crusts and veinlets with a compact structure much resembling yellow jasper. The specimens available comprised corroded masses of cryolite coated with drusy crystals of thomsenolite, ralstonite and pachnolite which were locally covered over by thick crusts of hagemannite. The crusts have a crude concentric layering or colloform structure and the grain size and color varies noticeably in successive layers. Dense jaspery material on several specimens, seemingly homogeneous to the unaided eye, were found on optical and *x*-ray study to consist of very fine grained ralstonite admixed with small amounts of thomsenolite. Minute amounts of several unidentified minerals also were present. The ralstonite had an index of refraction of 1.418

and a specific gravity of 2.60. Other layers in the crusts, somewhat more coarsely grained and lighter colored, were found to consist in large part of thomsenolite. Complete gradations occur between ralstonite-rich and thomsenolite-rich mixtures. Pure thomsenolite itself sometimes occurs at Ivigtut as white, opaline to chalcedonic masses. Locally, thin films of an ocherous yellow-brown iron oxide, doubtless goethite, are present in the hagemannite and the same substance occurs sparingly disseminated through the crusts as a pigmenting material. Hagemannite thus is a variable mixture of ralstonite, thomsenolite and goethite. The original analysis apparently was made on material relatively high in thomsenolite. The identity of this analysis with thomsenolite (or pachnolite) after deducting Fe, Mg and Si as impurities was early suggested by Groth (5).

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REFERENCES

1. CROSS AND HILLEBRAND: *U. S. Geol. Surv., Bull.* **20,** 57 (1883).
2. NÁRAY-SZABÓ AND GYÖRGY: *Matem. Termes. Ert.*, **60,** 364 (1941).
3. MENZER: *Fortschr. Min.*, **17,** 61 (1932).
4. SHEPARD: *Am. Jour. Sci.*, **41,** 246 (1866).
5. GROTH: *Zeits. Kryst.*, **7,** 480 (1883).