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NOTE ON ENSTATITE, HYPERSTHENE, AND ACTINOLITE

H. S. WASHINGTON AND H. E. MERWIN, *Geophysical Laboratory,
Carnegie Institution of Washington*

In the course of an investigation of the compressibility of minerals and rocks, L. H. Adams and E. D. Williamson,¹ of this Laboratory, have examined the minerals which form the subjects of this paper. We have studied, optically and chemically, the specimens examined by them, so as to collate some of their properties. The results of our observations are presented here, in the belief that such determinations, made on identical material, may be of more general value than similar determinations made on materials which are not definitely identical.

ENSTATITE, ESPEDALEN, NORWAY

The material was a portion of a large, rough crystal, which was collected by Dr. Olaf Anderson, in 1914. The exact locality is "Espedalen, Vegaardsheien," in the Parish of Nedenes, about 15 kilometers west of Risør.

The mineral is light smoke gray, translucent, and almost colorless in thin plates. The optical examination (by H. E. M.) shows that the material is homogeneous, except for about 1 to 2 per cent of an intergrown mineral, which perhaps is muscovite. The optical properties are: optically positive, $a = 1.666$, $\gamma = 1.675$, β (calculated) = 1.670, $2V =$ about 75° . Adams found the *density*² to be 3.254 at 29° .

A chemical analysis (by H. S. W.), on material dried at 110° , gave the following results.

¹ To be published in *Jour. Franklin Inst.*, 195, 1923.

² The distinction is made here between *density* (the number of grams per cubic centimeter) and *specific gravity* which is the ratio of the density of the mineral to that of water, usually, among mineralogists, at the same temperature. Density is much to be preferred because it varies very little with temperature. The density of a mineral is obtained by multiplying the specific gravity of the mineral by that of water at the given temperature.

SiO ₂	57.28	.955	.956	1.000
TiO ₂	0.05	.001		
Al ₂ O ₃	0.90	.009		
Fe ₂ O ₃	0.42	.003	.965	1.009
FeO	6.43	.089		
MnO	trace	.000		
MgO	34.94	.874		
CaO	0.13	.002		
Na ₂ O	0.22	.003		
K ₂ O	0.01	.000		
H ₂ O+	0.13			
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	100.51			

Enstatite, Espedalen, Norway. Washington analyst.

It will be seen that the molecular ratios of the SiO₂+TiO₂ and (Fe, Mg, Ca)O are nearly equal. The small amounts of alumina and alkalis may be ascribed to the micaceous (?) mineral, and the Fe₂O₃ to slight oxidation.

HYPERSTHENE, NAIN, LABRADOR

The material studied was a large crystal, obtained from the U. S. National Museum, No. 93,527. The color is a slightly grayish black, with a marked silky luster on the cleavage surfaces. Microscopic study shows that the mineral contains from 5 to 10 per cent of finely lamellar intergrowths of what appears to be a monoclinic pyroxene, which has decidedly lower refractive indices than the hypersthene. There is also less than 1 per cent of a dark brown mineral in extremely thin plates. The hypersthene itself is practically colorless. The refractive indices were found by Merwin to be: $\alpha=1.690$, $\gamma=1.700$. These values are very slightly smaller than those found by Michel Lévy and Lacroix for Labrador hypersthene.³ L. H. Adams found the density of the specimen as a whole to be 3.415 at 29°.

An analysis was made of material carefully selected and free from a rusty brown secondary substance which forms thin coatings along cracks. The powder was dried at 110°. Two earlier analyses are given for comparison.

	1	2	3	4
SiO ₂	51.81	.864	49.85	51.36
TiO ₂	0.76	.009	n.d.	n.d.
Al ₂ O ₃	2.16	.021	6.47	0.37
Fe ₂ O ₃	4.52	.028	2.25	n.d.

³ Michel Lévy and Lacroix, *Minéraux des Roches*, 262, 1888.

FeO	13.96	.194	14.11	21.27
MnO	0.16	.002	0.67	1.32
MgO	24.57	.614	24.27	21.31
CaO	1.95	.035	2.37	3.09
Na ₂ O	0.39	.006	n.d.	n.d.
K ₂ O	0.03	.000	n.d.	n.d.
H ₂ O+	0.19		n.d.	n.d.

	100.50		99.99	98.72
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Sp. gr.	3.415		3.402	3.392
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1. Hypersthene, Nain, Labrador. Washington analyst.
2. Molecular ratios of No. 1.
3. Hypersthene, Labrador. F. Remelé analyst. *Zeits. deutsch. geol. Ges.*, 21, 658, 1868.
4. Hypersthene, Labrador. A. Damour analyst. *Ann. Mines*, 5, 137, 1844.

The alumina and most of the ferric oxide of No. 1 are to be considered, as in the case of augite⁴ as existing in solid solution in the hypersthene and in the monoclinic pyroxene, and not as in the Tschermak molecule. The soda may be regarded as entering acmite. The composition of the Nain hypersthene is calculated to be as follows:

MgSiO ₃	57.90
FeSiO ₃	25.87
CaMgSi ₂ O ₆	7.56
NaFeSi ₂ O ₆	2.77
(Al, Fe) ₂ O ₃	5.72
	99.82

The molecular amount of silica needed for this composition is .869, while .864 is shown in the analysis. The molecular ratio of MgO to FeO is very close to 3:1, being almost exactly so (.579 : .196) when .035 MgO is allotted to form diopside. We may reasonably assume that much, if not all, of the diopside and acmite present form the monoclinic pyroxene intergrown with the hypersthene, and the amount calculated above corresponds roughly with that shown by the microscope. It is probable that part, at least, of the TiO₂ is present, perhaps, as ilmenite, in the small plates of the dark brown mineral.

Attention should be called to the fact that the optical data given above were determined on the hypersthene substance, not on the small amount of monoclinic pyroxene, so that they do not apply strictly to the substance as analysed, in which the intergrown material was necessarily included.

⁴ Washington and Merwin, *Am. Jour. Sci.*, 3, 119, 1922.

ACTINOLITE, KRAGEROE, NORWAY

Adams and Williamson determined the compressibility of the actinolite of Krageroe, using a large crystal which had been collected and given to them by Dr. Olaf Andersen. In accordance with the general plan, a chemical analysis of this was begun and had been almost completed before it was discovered that actinolite from Krageroe had been analysed by Stanley.⁵ Our analysis was, however, completed, and the optical characters were determined on our material, so that they might be compared with those determined by Ford⁶ on material from the same locality.

In the mass the mineral is slightly brownish black. Sections 0.1 mm. thick are pleochroic in dull yellow to greenish yellow, Ridgway's 21''' to 23''', and show the usual absorption formula. Powder 0.1 to 0.01 mm. is dark dull greenish yellow, Ridgway's 25'''k.

Adams determined the density as 3.079 at 28°, while Penfield and Stanley give the average specific gravity as 3.127.

Our material is practically homogeneous, with refractive index β varying from 1.650 to 1.653. If we assume similar variations in α and γ , their values, corrected from direct measurements, are 1.636 and 1.660, respectively.

The extinction angles of thin flat cleavage flakes from several large fragments were 15° to 17°, whereas numerous thin splinters from the same material powdered, as well as that used for analysis, showed extinctions of 20° to 22°. The estimated optic axial angle, from observation on the powder and by calculation from the refraction indices, is about 75°. By means of Daly's⁷ diagrams $c \wedge \gamma = 16^\circ$, as estimated from the cleavage flakes. This does not agree as well as had been anticipated with the value, 22°, estimated from the powder, probably because the grains in the powder were tilted with respect to c . The extinction angle and the refractive indices in our material are greater than those found by Ford.

Our analysis was carried out on the powder dried at 110°. Stanley's determination of fluorine was accepted.

	1	2
SiO ₂	51.86	51.85
TiO ₂	1.92	1.26
Al ₂ O ₃	3.81	4.36

⁵ Penfield and Stanley, *Am. Jour. Sci.*, 23, 34, 1907.

⁶ W. E. Ford, *Am. Jour. Sci.*, 37, 180, 1914.

⁷ R. A. Daly, *Proc. Am. Acad.*, 34, 311, 1899.

Fe ₂ O ₃	2.19	2.58
FeO	5.97	5.46
MnO	0.04	0.35
MgO	19.40	19.48
CaO	10.73	10.60
Na ₂ O	2.16	2.15
K ₂ O	0.28	0.35
H ₂ O+	0.98	1.21
F ₂	(0.46)	0.46
	<hr/>	<hr/>
	99.80	100.24
O=F	0.22	0.22
	<hr/>	<hr/>
	99.58	100.02

1. Actinolite, Krageroe, Norway. Washington analyst.
2. Actinolite, Krageroe, Norway. Stanley analyst. *Am. Jour. Sci.*, 23, 34, 1907.

The two analyses resemble each other very closely, so closely, indeed, for most of the constituents that these might be considered as duplicate determinations. It may be worthy of note that Stanley used the basic acetate method for the separation of iron and alumina from magnesia, whereas we used the simpler method of a triple precipitation with ammonia water in the presence of considerable ammonium chloride. The difference in result as regards magnesia is negligible, and the slightly higher alumina in Stanley's analysis may be attributed to some slight difference in the colorimetric determination of titanium, as the sum $Al_2O_3 + TiO_2$ is almost identical in the two analyses.

SCHOEPITE, A NEW URANIUM MINERAL FROM KASOLO, BELGIAN CONGO¹

T. L. WALKER, *University of Toronto*

Recently Professor Schoep² described six new uranium minerals from Kasolo in the Belgian Congo. These occur along with torbernite and uranotile apparently as alteration products of uraninite. The writer was fortunate in securing for the Royal Ontario Museum of Mineralogy a suite of specimens representing the various associated minerals. An examination of the specimens showed that there is still another mineral in this association. It is well crystallized but, unfortunately, there is not sufficient material for a quantitative chemical analysis.

¹ Read at the meeting of the Mineralogical Society of America, Ann Arbor, Michigan, Dec. 29, 1922.

² *Comptes Rendus*, 1921 and 1922.