Art. II.—*On Hortonolite, a new member of the Chrysolite group;* by Geo. J. Brush, with measurements and observations on the crystalline form of the mineral, by John M. Blake.

Several years since Mr. Silas R. Horton called my attention to peculiar dull black crystals from an iron mine at Monroe, in Orange county, New York. On a simple inspection I determined that the crystals represented two species, the one, magnetite, in dodecahedrons; the other a prismatic mineral with somewhat rounded planes, which I took to be pyroxene. At the time I was deterred from making a chemical examination of the latter mineral by the fact that the crystals appeared to be very impure from admixture with magnetite and graphite. I have, however, never been quite satisfied that it was correctly determined, and on recently selecting with care a portion of the substance free from impurities, it proved to gelatinize with acids and to have the pyrognostic characters of an iron chrysolite; and on a more careful examination of the crystals they seemed to be orthorhombic rather than monoclinic, a conclusion confirmed by Mr. Blake's measurements, further on.

The mineral has a yellow to dark yellowish green color on the fresh fracture and a vitreous to resinous luster, although the crystals have a black coating and are quite dull. In large masses the mineral is sometimes nearly black, but on the thin edges by transmitted light the color is almost honey-yellow. Minute specks of magnetite are disseminated through the mass with occasional flakes of graphite. The crystals are sometimes imbedded in calcite, as also associated in cavities with dodecahedral magnetite. They are frequently half an inch long by one quarter broad and one eighth of an inch thick, in some instances much larger. H. = 6·5. Sp. gr. = 3·91. Before the blowpipe in the closed tube no change takes place; in the open tube and on charcoal the mineral becomes dull and magnetic, and fuses in the platinum forceps at 4; with borax and salt of phosphorus, it reacts for iron and silicic acid, and with soda for manganese. The pulverized mineral forms with chlorhydric acid a gelatinous mass and is almost completely decomposed. Qualitative analysis showed the presence of silica, protoxyd of iron, manganese and magnesia, with a minute quantity of potash and a trace of lime. It was found by pulverizing the mineral and suspending the fine powder in water in a beaker and stirring with an electro-magnet of soft iron, that the magnetite could be completely separated from the silicate. Two quantitative analyses made on material thus prepared gave Mr. Wm. G. Mixter—

	1.	2.	Mean.	Oxygen.	
Silica,	33·52	33·66	33·59	17·91	
Ferrous oxyd,	44·28	44·46	44·37	9·85	17·56
Manganous oxyd,	4·72	3·98	4·35	·98	
Magnesia,	16·79	16·56	16·68	6·67	
Lime,	trace	trace			
Potash,	·30	·47	·39	·06	
Ignition,	·26	·26	·26		
	99·87	99·39	99·64		

These analyses represent two different samplings by means of the electro-magnet, and demonstrate that the method of purification was as perfect as could be desired. In the decomposition by chlorhydric acid it was found that the silica separated contained a very small portion of undecomposed mineral, and this was consequently fused with carbonate of soda to effect a complete decomposition. The iron was separated as basic acetate, redissolved and reprecipitated; the manganese in the solution was oxydized and separated by bromine, then redissolved and precipitated as phosphate. The magnesia was weighed as pyrophosphate, and the alkali determined by Smith's method. A spectroscopic examination of the concentrated chlorhydric solution showed sodium, potassium and calcium lines only. A direct determination of the protoxyd of iron on mineral selected as free as possible, by aid of the magnifier, from magnetite, gave 42·69 per cent; this, considering the difficulty of selecting absolutely pure material and the fact that the mineral, although almost entirely, is not completely, decomposed by acid, shows that the iron is most probably present only as protoxyd.

The calculation of the oxygen for the mean of the two analyses gives the ratio of $\ddot{\mathrm{Si}}:\dot{\mathrm{R}}$ as 17·91 : 17·56 or 1 : 1, in which the relation of the iron to the magnesia is very nearly as 3 : 2, and the composition of the mineral is that of an iron-magnesia-manganese chrysolite. In chemical composition this member of the chrysolite family is between hyalosiderite and fayalite, although it differs very materially from both, as will be seen by comparing the analysis with these and allied varieties.

	$\ddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{Al}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Cu}}$	
1. Hyalosiderite,	31·63	2·21	29 71	0·48	32·40	—	2·79	—	$\dot{\mathrm{C}}$r tr.=99·22, W.
2. Dalarne chrysolite,	35·20	1·93	35·55	0.58	26·24	---	—	tr.	Ni,Sn tr.=99·51, S.
3. New chrysolite,	33·59	—	44·37	4·35	16·68	tr.	0 39	—	=99·64, Mixter.
4. Eulysyte "	29 16	1·56	55·87	8·47	3·23	2·29	—	—	=100·58, Erdm.
5. Fayalite, Fayal,	28·27	3·45	63·80		tr.	0·45	—	1·29	FeS3·35=100·61, R.

1. Hyalosiderite, Walchner, Schweigger, Journ. xxxix. 65. 2. Analysis made by Struve, given by Svanberg in Ak. H. Stockholm, 1848, p. 2. 3. This article. 4. A. Erdmann, Min, 278. 5. Rammelsberg, Min. Chem., 435.

The new mineral contains more iron than hyalosiderite, with a correspondingly smaller amount of magnesia, while the opposite is true with fayalite. It more nearly approaches the variety of iron-manganese chrysolite described by Erdmann as occurring near Tunaberg in Sweden, associated with garnet and augite forming a rock which has been named *eulysyte;* from this, however, it differs in containing 13 per cent more magnesia, and about 16 per cent less iron and manganese, and no lime. The mineral therefore, forms a marked variety of iron-magnesia-manganese chrysolite.

In view of these facts, it is proper to designate this new variety with a special name, and I propose for it the name *Hortonolite*, after Mr. Horton, who first discovered the mineral. If found in quantity, this may prove to be a valuable iron ore, if smelted with more basic or calcareous ores. It is free from undesirable impurities, while it contains a considerable amount of manganese. There is reason to believe that it may occur in sufficient abundance to be of economic importance.

It gives me pleasure to acknowledge my indebtedness to Mr. Horton for kindly supplying me with specimens of this mineral for examination; to Mr. W. G. Mixter, assistant in the Sheffield laboratory, for aid in the chemical investigation; and to Mr. John M. Blake for his discussion of the crystallographic characters of the mineral which here follows.

2. *Observations on the crystalline form, optical characters, and cleavage of Hortonolite;* by JOHN M. BLAKE.

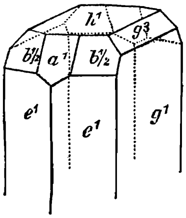
The examination and measurement of crystals of Hortonolite, which were placed in my hands for this object by Prof. Brush, show unmistakably that the mineral belongs to the chrysolite group. A comparison was made with other members of the group, to determine its relation to them. For this purpose, several species were measured, crystals having been placed at my disposal by Prof. Brush. The points compared were the occurrence and proportional development of planes, and to some extent the optical properties and cleavages. This examination is not yet completed, but it being desired that a description of this mineral should be furnished as soon as possible, the results must be given in a form that will require the least explanation. For the present purpose, the symbols of Des Cloizeaux are adopted, so that comparison can be more readily made with the figures in his mineralogy. It will be noticed that the "vertical prism" is differently selected.

The observed planes on this variety, are: h^1, g^1, e^1, a^1, g^3, $b\frac{1}{2}$ and γ; or in Dana's symbols: O, i-$\breve{\imath}$, i-$\bar{2}$, 1-$\bar{\imath}$, 1-$\breve{\imath}$, 1-$\bar{2}$ and 1-$\bar{4}$.

A deposition of some foreign substance had destroyed the brilliancy of the planes, and this could not be entirely removed so that they would give perfect reflections; and, besides this, some parts of crystals appear to have been originally rounded.

Fig. 1 is proportioned from some of the larger crystals. They were partially imbedded, so that but a portion of the planes could be distinguished on any one of them. The intersections with the other planes satisfactorily determined the planes $b\frac{1}{2}$, on these particular crystals.

1.



2.

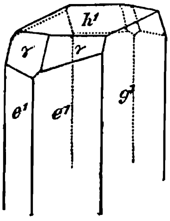


Fig. 2 is a common form of the medium-sized crystals. The upper planes on the front side, can be explained as the planes γ. The directions of their intersections with e^1 and an approximate measurement of their inclination on g^1 leaving little doubt of their identity with this plane. The goniometer readings were as follows on this crystal.

For the prismatic zone: g^1, 0°; e^1, 65° 35′; e^1, 116° 15′; g^1, 181° 20′; e^1, 245° 50′; e^1, 295° 15′ ?, g^1, 0° 45′.

For zone 2, including the front upper planes: g^1, 0°; γ, 78° to 80°; γ, 100° to 101°; g^1, 178°.

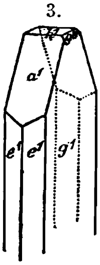
Zone 3, including the back, upper planes: g^1, 0°; $b\frac{1}{2}$, 69°; a^1, 90° ? $b\frac{1}{2}$, 110°.

From the first zone the average inclination of g^1 on e^1 is 65° (normals); Brooke and Miller give 65° 2′. From the second zone we have γ on g^1, 77° to 80°; B. and M. give 79° 40′. From zone 3: g^1 on $b\frac{1}{2}$, 69° to 70°. The same authority give 69° 57′. The following readings were taken from another crystal having the planes g^3 better defined: g^1, 0°; g^3, 320°; h^1, 268° 20′; g^3, 220° 30′; g^1 179°. From this the average for g^1 on g^3 is 40° 45′; B. and M. give 40° 27′.

An examination of the measurements above recorded will show that although the mean values deduced from them accord well with the angles of chrysolite, yet there is some variation when the angles are taken singly. This variation is not greater than the imperfections of the planes gave reason to expect.

It is probable that the planes γ, a^1, and $b\frac{1}{2}$, occur together on some of the crystals. These planes lie very near together, and a slight rounding of the crystal might be expected to obliterate them. Fig. 3 represents an occasional form. It is introduced to show the variation in crystals upon the same specimen. Another small crystal had the prismatic planes nearly equal in breadth, and g^3 largely developed, while the other terminal planes were rounded.

3.



Notwithstanding this great variation in development, the crystals do not at all resemble those of hyalosiderite in habit; neither do they resemble certain crystals occurring as furnace products, which I have directly compared with them.

The crystals appear black externally, but some small portions are found which are transparent in thin sections, and have a yellowish color. A portion was selected from a section parallel to g^1, which admitted of an approximate measurement of the separation of the optical axes. The acute bisectrix was found perpendicular to g^1, and the axes to lie in a plane parallel to h^1. Their separation was, from 83° to 86°, measured in olive oil.

The smallness of the transparent part of the section and the presence of one or more oblique cracks in its interior, rendered it difficult to determine satisfactorily the direction of the dispersion of the axes, but it was judged that the separation of the red rays was greater than for the violet about the bisectrix normal to g^1. This agrees with Des Cloizeaux's observations on the dispersion and plane of the axes in a specimen from Torre del Greco, and in tephroite. In the former he found the separation to be 86° to 87° about a bisectrix normal to p, and in tephroite the separation of the axes for the red rays was 83° 41′, and 80° 29′ for the blue, measured in oil. The bisectrix in this case being negative, and normal to g^1.

For comparison, a measurement was made of olivine occurring in lava from the Sandwich Islands, and the separation of the axes about the normal to g^1 was found 107°; in a furnace product 68°. Both were measured in olive oil. Reducing the measurement on the chrysolite, from Torre del Greco, to the same bisectrix, but without making a correction for the refraction of the oil, and of the mineral which would be necessary to make the results compare accurately with the others measured in oil, we have 94°.

It so far appears that the optical axes in this group lie in a plane parallel to h^1, but vary in separation with the chemical composition, according to some law. It seems generally preferable to make sections parallel to g^1, for the purpose of comparing species; since this is usually a cleavage plane, and there is then a better chance of success in cutting some varieties which are brittle, and the plane p seldom occurs, while g^1 is often well defined, and serves as a guide. It is to be understood that reference is made to such sections as can be most readily cut for the purpose of comparing varieties of this mineral, as is done with the micas.

The cleavage which occurs parallel to h^1, is perhaps most clearly defined. There are two cleavages about the plane g^1, and possibly one not well defined parallel to this plane. They lie in the *prismatic zone*, g^1, e^1, etc. This was first discovered in the following way: a fragment showing several cleavage surfaces, and at least one plane of the crystal, was measured on a zone with the following result: first cleavage (goniometer reading) 0°; second cleavage, 49° 30′; a plane of crystal (g^1), 203° 30′. On plotting the normals, it was found that the normal of the plane of the crystal, when extended, bisected the angle of the normals of the two cleavages. Hence the cleavages are symmetrically situated about the plane g^1, and in the zone, g^1, e^1, $e\frac{1}{2}$, etc.; since another cleavage was found on this fragment perpendicular to the intersections of the two others, giving as an approximate measurement an inclination of 92° 20′ on one of them, and this cleavage had also a different appearance to the eye, and was therefore considered to be the cleavage parallel to the basal plane h^1. No reflection from a cleavage was detected on this specimen parallel to g^1. The three cleavages actually found gave bright reflections in a good light, but admitted of no very exact measurement; though sufficiently exact to show that those on the prism are not parallel to any observed plane, except it be the rarely occurring planes $e\frac{1}{4}$ or $e\frac{1}{5}$. The inclination of $e\frac{1}{4}$ to g^1, is given as 28°

13′, and of $e_{\frac{1}{5}}$, 23° 13′, (normals). The cleavage as above determined measures 24° 40′ on g^1. This result appeared so extraordinary, that a piece was clipped out of the plane g^1, on a crystal upon which there could be no mistake as to the exact location of these cleavages ; for the crystal had the prism well defined, with terminal planes, and a basal cleavage. The result just given was verified, although the measurement could not be so exactly made as upon the first fragment. The zone readings were : g^1, 0° ; cleavage, 24° ; e^1, 67° ; e^1, 114° ; g^1, 176° ; cleavage, 337° to 340°. It now becomes a matter of interest to discover these cleavages upon other members of the group. A rounded grain of olivine washed from the lava of the Sandwich Islands, was cleaved, and presented a bright surface judged to be the cleavage plane g^1. This gave three reflections, the readings for the instrument being: 0° ; 6° ; 13°, approximatively. In olivine in lava, also from the Sandwich Islands, there were indications of cleavages about the plane g^1, but they are not well defined, while, parallel to g^1, this variety cleaves readily ; although the surfaces developed are not brilliant.

Besides the interest these cleavages have crystallographically, they may be found to have an important bearing, in comparing some members of this group, which do not occur in well defined crystals.