IV.—*Note on New Minerals from West Phœnix Mine, and from St. Agnes.*

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HENWOODITE.

THE Mineral from West Phœnix occurs in globular masses of a Turquoise blue or bluish green color upon Limonite. The interior of each spherule is composed of Limonite within which is sometimes a minute quartz crystal; the exterior surface usually shews indistinct crystalline facets. Fragments examined with a hand-lens shew a conchoidal fracture, but a thin section exhibits faint indications of radiated and concentric structure.

The first specimen which came under my notice was given to me by Mr. Simmonds of Liskeard, in October 1875 as a variety of Chalcosiderite or Andrewsite. These minerals had recently been described by Professor N. S. Maskelyne and Dr. Flight, and as there is occasionally a certain resemblance between them and the new mineral, and they all occur together, it was supposed to be the same as one of them.* As the specimen was small I placed it in my cabinet, being unwilling to destroy it by making an analysis.

More recently specimens have been examined by Dr. Le Neve Foster who found in them, by means of the blowpipe, Phosphoric Acid, Copper and Water, with indications of Alumina and Lime. He also noticed that it was infusible and contained no iron, so that it could not be either Andrewsite or Chalcosiderite.

Dr. Foster very kindly supplied me with a few fragments, and of these I have made an analysis with the results given below.

Having carefully picked over the fragments by the aid of a hand-lens, I treated some of them for a short time with warm dilute HCl. having found that acid to have but little effect on the mineral itself. By this treatment I was able to dissolve off most of the obstinately adhering Limonite, and to obtain the mineral in a nearly pure state. I had previously found the $H = 4\text{-}4 \cdot 5$, and the streak white with a bluish green tinge. I now determined the Sp. G. to be $2 \cdot 67$.

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* The new mineral is often superficially coated with chalcosiderite.

I found I had ·221 grm. at my disposal, which was gently ignited in a glass tube. It gave off much water and turned dark brownish olive green and lost ·046 grm., indicating 19·5 p.c of water and volatile matter. It was then powdered in an agate mortar and treated with warm HNO_3 in which it dissolved with some difficulty. Phosphoric Acid was then determined by the Molybdate of Ammonia method and found to be ·0343 grm. = 48·2 p.c. The copper was then precipitated in the metallic state and amounted to ·0098 grm=to ·0123 of oxide of copper or 7·0 p.c. The solution, which I had intended to examine further, after separation of the Molybdenum, was unfortunately upset.

I now obtained a further supply from Dr. Foster amounting to ·3562 grm. which yielded.

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\begin{array}{lll}
\text{Lost by ignition} & \cdot 0609 = 17\cdot 10 & \text{p.c.} \\
\text{Si } O_2 & \cdot 0049 = 1\cdot 37 & ,, \\
\text{Cu } O. & \cdot 0253 = 7\cdot 10 & ,, \\
\text{Al}_2 O_3 & \cdot 0649 = 18\cdot 24 & ,, \\
\text{P}_2 O_5 & \cdot 1743 = 48\cdot 94 & ,, \\
\text{Fe}_2 O_3 & \cdot 0098 = 2\cdot 74 & ,, \\
\text{Ca } O & \cdot 0019 = 0\cdot 54 & ,, \\
\text{Loss} & 3\cdot 97 & ,, \\
\hline
\text{Total} & 100\cdot 00 &
\end{array}
$$

The iron alumina and phosphoric acid were determined by Dr. Flight's method.*

The Mineral is therefore essentially a phosphate of Copper and Alumina, with much water, most of which is probably basic as it is not given off at a low temperature. As the quantities operated upon were small and the mineral could not be obtained quite free from foreign admixture, I do not claim a high degree of accuracy for these results—especially as the loss is considerable. The iron, lime, and silica are probably altogether foreign. The composition as thus determined shews that it is most nearly allied to Callainite, Lazulite, Wavellite and Turquoise, but differs greatly from all in the relative proportions of Alumina and Phosphoric Acid.

This difference is so remarkable as to warrant its being considered a new species, and I propose to give it the name of HENWOODITE

* Journal of the Chemical Society, July 1875.

in honor of my late distinguished friend, Mr. Wm. Jory Henwood, F.R.S.

In the following table I have tabulated the results of the 1st and 2nd analyses (a and b); the corrected percentages excluding the iron, silica, and lime, the first two of which are certainly and the third probably extraneous (c), the "loss" being distributed; and the theoretical percentages required for the suggested formula, $2Al_2 O_3 + 2 (\frac{1}{6} Cu O \frac{5}{6} H_2O)_3 P_2 O_5 + 5H_2 O$.

	a. (1st analysis)	b. (2nd analysis)	c. (Corrected)	d. (Theory)
Water	19·50	17·10	18·71	17·42
Copper oxide	7·00	7·10	7·77	7·69
Alumina	..	18·24	19·96	19·93
Phosphoric acid	48·20	48·94	53·56	54·96
Lime	..	0·54	..	..
Silica	..	1·37	..	..
Peroxide of Iron....	..	2·74	..	..
Loss	..	3·97	..	..
		100·00	100·00	100·00

Disregarding the ingredients which appear to be extraneous or non-essential, the theoretical per centage composition of the five minerals named may be given tabulated as follows:—

	$P_2 O_5$	$Al_2 O_3$	Cu O.	Mg O.	$H_2 O.$
Callainite ..	42·39	30·75	——	——	26·86 =100·00
Lazulite ..	46·80	34·00	——	13·20	6·00 =100·00
Wavellite ..	34·40	37·30	——	——	28·30 =100·00
Turquois ..	32·60	46·90	——	——	20·50 =100·00
Henwoodite	54·96	19·93	7·69	——	17·42 =100·00

It should be mentioned that Turquoise often contains from 3 to 5 p.c. of oxide of copper, but the great difference in the proportions of Phosphoric Acid and Alumina separate the mineral from turquoise.

The formulæ of the same five minerals may be written.

Callainite .. $Al_2 O_3$ $P_2 O_5$ +   5 $H_2 O$
Lazulite .. $Al_2 O_3$ $P_2 O_5$ + Mg $H_2 O_2$
Wavellite 3 $Al_2 O_3$ 2 $P_2 O_5$ + 12 $H_2 O$
Turquoise 2 $Al_2 O_3$, $P_2 O_5$ +   5 $H_2 O$
Henwoodite 2 $Al_2 O_3 P_2 O_5$ + 2 $(\frac{1}{6} Cu O \frac{5}{6} H_2 O)_3 P_2 O_5$ + 5 H O.

The hardness, specific gravity, &c., may be thus given for comparison.

	H.	G.	Form.
Callainite ..	3·5 – 4	2.5 – 2·52	Massive.
Lazulite ..	5 – 6	3·05 – 3·12	Oblique.
Wavellite ..	3·25 – 4	2·3 – 2·35	Rhombic.
Turquoise..	6	2·6 – 2·83	Reniform or Globular.
Henwoodite	4 – 4·5	2·67	Spherical crystalline groups

It is to be hoped that distinct crystals may be met with before long, so that there may be an opportunity of determining its true crystalline form.*

ENYSITE.

This new Mineral from St. Agnes has a hardness of 2-24, and a sp. gr. of 1·59. Its pyrognostic characters are given by Dr. Foster, and to these I would only add, that the water given off at a low temperature is neutral to test-paper, while that given off at a high temperature is strongly acid.

Exposed over oil of vitriol for three days, it loses 14·04 p.c. of its weight; heated to 150° C. it loses 18·21 p.c. more, and when strongly ignited loses 15·29 p.c. additional. This latter loss consists of Sulphuric Acid and water, but another experiment shews the total quantity of Sulphuric Acid to be 8·12 p.c.

The full composition is as under :—

Water lost over Oil of Vitriol.. ..	14·04	
Water lost at 150° C.	18·21	
Water lost at red heat	7·17	39·42
Sulphuric Acid		8·12
Silica..		3·40
Alumina		29·85
Lime..		1·35
Carbonic Acid		1·05
Chlorine		Trace
Soda..		Trace
Ferric Oxide		Trace
Oxide of Copper		16·91
		100·10

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* Since reading the above papers Dr. Heddle has suggested that the "loss" may be due to zinc, fluorine, or boracic acid—neither of which would be detected by the mode of analysis adopted above. Having only ·009 grams left for analysis I have carefully examined it before the blowpipe by the very delicate methods described in "Plattner," but without finding the least trace of either. I have not been able to test for boracic acid from want of material, but I may say further that I am not aware of any test delicate enough to detect a small quantity of boracic acid in the presence of a large quantity of phosphoric acid.

This composition corresponds pretty well with the formula, $Cu\ SO_4 + Cu\ H_2\ O_2 + 3\ Al_2\ H_6\ O_6 + 12\ H_2\ O$, if the Si. be regarded as replacing Alumina, and the Ca CO_3 be excluded. The actual percentages requiaed by theory are

Water .... 37·16 p.c.
Sulphuric acid .... 9·17 ,,
Oxide of copper .... 18·23 ,,
Alumina .... 35·43 ,,

99·99

If the carbonate of lime be regarded as replacing sulphate of copper the analysis comes still nearer to the numbers required by theory. The three equivalents of water supposed to be combined with the alumina would amount to 6·19 p.c., and this is pretty near the actual amount driven off at a red heat.

The Mineral is no doubt of comparatively recent formation; but as it has very marked characters, and none of the appearance of a mechanical mixture, Dr. Foster and myself have agreed to call it Enysite, after our kind friend, the late John S. Enys, F.G.S., to whom the cave belonged in which it was found.*

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* M. Pisani analysed a Mineral of somewhat similar composition (Phil. Mag., Ap., 1868), and Dr. Flight two others (Journ. Chem. Soc , 1871, Jan.) The analyses are as follows:—where C is, Pisani's mineral; A and B those of Dr. Flight; neither seem to have been named, but Pisani regarded his Mineral as a mixture of Langite and Allophane.

	A	B	C
Water lost at ord. temp. ...	15·390	13·938	
Water lost at 100°	10·413 }	23·864	
Water lost at 120° to 160 ...	7·333 }		
Water lost over 260°	5·392—38·528	6·167—43·969	38.7
Sulphuric Acid	——	2·433	4·7
Silica	6·689	7·538	6·7
Alumina	23·063	27.250	33·8
Lime	0·086	1·403	——
Carbonic Acid	——	0·528	——
Soda...	——	0·640	——
Magnesia...	0·749	6·183	——
Oxide of Copper	24·561	10 255	17·4
	100·451	100·199	101.3