

RECORDS
OF
GENERAL SCIENCE,

BY

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CHEMISTRY, IN THE BLENHEIM STREET MEDICAL SCHOOL.

WITH THE ASSISTANCE OF

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V O L. IV.

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again seeing the new star. Cacciatore has addressed these observations to the *Bibliothèque Universelle*, for the purpose of attracting the attention of astronomers; and we have inserted them here, in order that the scientific men of this country may be aware of the facts.

ARTICLE III.

On the Minerals containing Columbium. By THOMAS THOMSON, M. D., F. R. S., L. & E., Regius Professor of Chemistry in the University of Glasgow.

THE minerals containing columbium are so scarce, that I am not aware of any attempt hitherto made to draw up a mineralogical description of them; far less to subject them to a chemical analysis. Dr. Torrey of New York, was kind enough during the course of the present summer to send me several specimens of columbite, from a new American locality, together with a request to subject the mineral to a chemical analysis. It turned out on examination to be a new species, not hitherto mentioned by mineralogists. This led me to examine the Bohemian columbite, a specimen of which, liberally presented to me more than 20 years ago, by Mr. Heuland, I have in my cabinet. This last is the variety to be found in mineral collections, and seems to be the same with the specimen of columbite in the British Museum, originally examined by Mr. Hatchett. From a statement in Haidinger's edition of Mohs's Mineralogy,* it appears that this mineral has been analyzed by Vogel and Count Borkowski, the results of whose analyses are given; though I do not know where they were published.†

The tantalite from Kimito in Finland, originally examined by Ekerberg, and afterwards analyzed by Berzelius, constitutes a third species.‡ While another specimen from

* Vol. ii. p. 392.

† These results are as follows:—

Columbic acid,	75	74
Oxide of tin	1	0·4
Oxide of iron	17	20
Oxide of manganese	5	4·6
	<hr/>	<hr/>
	98	99

‡ Afhandlingar, iv. 262.

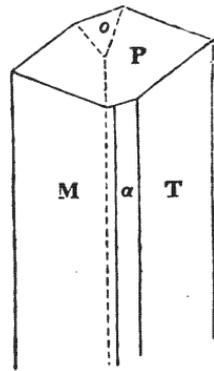
the same locality discovered by Nordenskjöld, and likewise analyzed by Berzelius, constitutes a fourth species.* I propose in this paper to give a short account of the characters and chemical constitution of these four species.

1. *Torrelite*.

I give this name to the new species, which I have just received from New York, by the liberality and kindness of Dr. Torrey. I have been induced to name it after my much respected friend, as a slight acknowledgment to him for the many interesting and new minerals with which he has from time to time favoured me.†

Torrelite has been found lately in a granite rock at Middleton, in the state of Connecticut, where it is occasionally disclosed by the workmen, who are blasting out felspar for a porcelain manufactory.

It occurs most commonly in irregular masses about the size of a filbert; though occasionally, as appears from a fragment of a crystal in my possession, it is crystallized. The figure in the margin represents this fragment. It is a four sided prism, the base of which, P, is so rough and irregular, that we cannot decide whether it forms a right angle with the faces of the prism. The longitudinal faces of the prism are sensibly equal. The edge between M and T is re-placed by a narrow face *a*. The only measurements that I could make are the following :



M on T (mean of 5 trials)	. . .	84° 20'
T on <i>a</i> (mean of 3 trials)	. . .	152°
M on <i>a</i> (mean of 3 trials)	. . .	110° 20'

* Afhandlingar, vi. 237.

† The name *Torrelite* has been already given by Professor Renwick to a mineral of a vermilion colour, which he subjected to analysis, and which he found to contain oxide of cerium, but which was afterwards examined by Mr. Children and Mr. Faraday, without their being able to discover any cerium (see *Annals of Philosophy*, 2nd series, ix. 217 and 221). Ten years having elapsed since these experiments were made, and no mineralogist, so far as I know, having noticed Mr. Renwick's torrelite, I take it for granted that its claims to rank as a new species have not been admitted.

The longitudinal faces of the prisms are quite smooth. It is probable, from this crystal that the primary form of torrelite is a right oblique prism terminated by a rhombic bar, whose angles are $84^{\circ} 20'$ and $95^{\circ} 40'$. The triangular face *o* is too rough on the surface for measurement. It is sensibly an equilateral triangle, and its inclination to the adjacent edge, is about $143^{\circ} 45'$ from a mean of several trials.

The colour is black, or at least much darker than that of columbite. The surface is iridescent, with a play of blue and red colours.

Lustre imperfectly metallic, almost resinous, being very similar to that of cherry coal. In one direction (parallel to face M) it is imperfectly foliated. Cross fracture granular. Opaque.

Hardness 4.25. Specific gravity 4.8038.

Before the blow-pipe both with carbonate of soda and borax, it fuses into a dark red bead, shewing the presence of iron. With a great excess of carbonate of soda, the green colour characteristic of manganese makes its appearance. When reduced to a fine powder the colour is dark chocolate brown.

1. 100 grains being exposed to a red heat, lost 0.35 grains of weight, which was considered as water.

2. 20 grains of the mineral in fine powder were mixed with 160 grains of crystallized bi-sulphate of potash, and gradually heated in a platinum crucible, over an Argand's spirit lamp. Care was taken to keep the heat moderate till the ebullition of the salt was at an end. It was then raised to redness, and the whole was kept in fusion for, at least, a quarter of an hour.

3. The red mass on cooling became white with an exceedingly slight tint of slate blue. It was softened in water and finally digested in muriatic acid for 24 hours. The whole was then thrown on a filter, and the white powder collected on the filter was thoroughly washed with boiling hot water. It was then dried in the open air, and digested for 24 hours in a solution of caustic ammonia.

4. The ammoniacal solution was then filtered off, and saturated with muriatic acid. A white flocky precipitate fell, which, after ignition, assumed a shade of brown, and weighed 0.09 grain.

Tested by the blow-pipe, it fused with effervescence, with carbonate of soda forming a very white opaque bead. With borax and bi-phosphate of soda, it fused into transparent beads, the latter of which, had a very slight tint of yellow. From these phenomena, I considered it as columbic acid very slightly contaminated with iron. It was evidently not tungstic acid, in order to discover which, I had been induced to digest the columbic acid in ammonia.*

I was not aware before that columbic acid is soluble in ammonia; but verified the fact by subsequent trials. The quantity dissolved, however, is always very small; and after ignition columbic acid becomes quite insoluble in ammonia.

5. The residual columbic acid being ignited, weighed 15·24 grains. While red hot, it had a distinct tint of yellow, and when allowed to cool it retained a perceptible brownish tinge. It was therefore, mixed with six times its weight of anhydrous carbonate of soda and fused.

The fused mass, when cold, had a light green colour shewing the presence of manganese. It was softened with water, digested in muriatic acid, and the whole thrown on a filter to collect the columbic acid; which was thoroughly washed with boiling water, dried and ignited. It weighed after ignition 14·69 grains. Thus, making the whole columbic acid 14·78 grains (adding what had been dissolved in ammonia). It was beautifully white, and apparently pure.

The muriatic solution, containing the soda and impurity from the columbic acid, was boiled with an excess of carbonate of soda in a flask. A dark brown matter fell, which beingedulcorated, dried, and ignited, weighed 0·55 grain, and was red oxide of manganese.

6. The muriatic acid solution (paragraph 3) was as nearly neutralized as possible, and then mixed and digested with benzoate of ammonia. The iron was thrown down in the state of benzoated peroxide. After ignition, it weighed 3·48 grains = 3·13 grains protoxide of iron.

7. The liquid thus freed from iron was mixed with an excess of carbonate of soda and boiled. The precipitate that fell, afteredulcoration and ignition, was red oxide of manganese, and weighed 1·23 grains: making, with the

* Tungstic acid had been discovered by Ekeberg in *tantalite*, and his discovery had been confirmed by Berzelius.

0.55 grain, (of paragraph 5) 1.78 grains of red oxide of manganese = 1.6 gr. protoxide.

Thus, the constituents of torrelite are,

Columbic acid,	14.78	73.90
Protoxide of iron,	3.13	15.65
Protoxide of manganese, . .	1.60	8.00
Water,	0.07	0.35
	19.58	97.90

To determine the atomic constitution of this mineral, we must recollect, that the atomic weight of columbic acid is 25.75, of protoxide of iron 4.5, and of protoxide of manganese 4.5. If we divide the preceding numbers by these atomic weights we obtain,

	Atoms.
Columbic acid,	2.87 or 1.6
Protoxide of iron,	3.48 or 1.96
Protoxide of manganese, . .	1.77 or 1.

These numbers leave no doubt, that the true constitution of the mineral is,

- 1½ atoms columbic acid
- 2 atoms protoxide of iron
- 1 atom protoxide of manganese

The atoms of the bases being twice as many as those of columbic acid, we see that torrelite is composed of dicolumbates: and, as there are twice as many atoms of protoxide of iron as of protoxide of manganese, it is obviously composed of

- 2 atoms dicolumbate of iron
- 1 atom dicolumbate of manganese

So that the formula indicating its constitution is, $2f^2 Cl + mn^2 Cl$.

2. Columbite.

The name *columbite*, given by Mr. Hatchett to the original specimen in the British Museum, may with propriety be applied to the Bohemian specimens; because, there are strong reasons for considering the constitution of both as very nearly alike.* I do not know who was the discoverer of it at Bodenmais, in Bohemia. But as I have already mentioned, I got a specimen of the Bohemian columbite

* This, indeed, has already been done by M. Gustav Rose.

about 22 years ago from Mr. Henland, and I think it probable, that it was about that time, or not long before it, that this mineral was discovered. No allusion is made to it in Klaproth's paper on the analyses of the Finland Tantalite written in 1809.* And, what is more singular, Hoffman in the last volume of his Mineralogy, published in Freiberg in 1817, makes no mention of the Bohemian columbite, and says, that the specific gravity of the tantalite, as stated by Wollaston and Klaproth is too low,† shewing clearly, that at that time he was ignorant of the existence of the Bohemian columbite, though, before that period, I had a specimen of it in my cabinet. Haüy in his *Traite de Mineralogie*, 2nd edition, published in 1822, (tom. iv. p. 391) notices the Bohemian columbite, which he calls tantalite, and which, he says, had been recently discovered at Bodenmais, in a granite which contained also beryls, iolite and oxide of uranium. But it is obvious from his statement, that he was not aware that any difference existed between the Bodenmais columbite and the tantalite of Finland. For he gives 6·5 as the specific gravity of tantalite, shewing that he had never seen, or, at least, never examined the Bohemian columbite.

Mr. William Phillips, in the third edition of his Mineralogy (page 270), published in 1823, notices the Bohemian columbite. But he gives its specific gravity 6·464, and states its primary form to be an oblique four-sided prism of 94° and 86°. A statement inconsistent with the measurements of a crystal in possession of Mr. Brooke, and which he himself gives on the authority of that eminent crystallographer. A comparison of these measurements with those given in Haidinger's translation of Mohs's Mineralogy (vol. iii. p. 390), leaves no doubt, that Mr. Brooke's crystal was from Bodenmais, and that it is specifically different from the Finland tantalite.

M. Gustav Rose, in his *Elemente der Krystallographie*, published in 1833, has divided the minerals, previously confounded together on the continent of Europe under the name *tantalite*, into two species. The one, consisting of the specimens found at Bodenmais and the Massachusetts specimen in the British Museum, he calls *columbite*: the

* Beitrage, v. 1.

† Hoffman's Handbuch der Mineralogie, iv. 2, 193.

other, consisting of the specimens from Finland, discovered by Nordenskjöld, and which give a cinnamon brown powder when pounded, he calls *tantalite*. He mentions a fine crystal of *columbite* in the Royal Collection at Berlin, in which the faces on both sides of the crystal are exposed; but he was not able to measure its angles, nor to determine its structure.

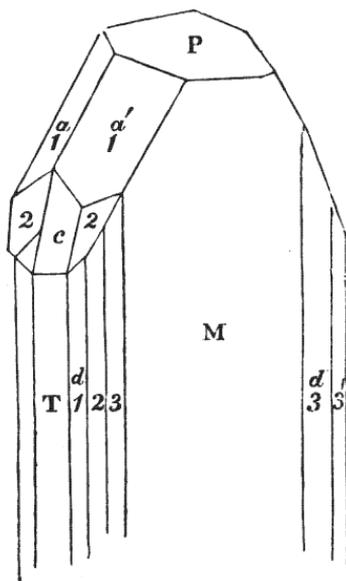
The specimen of Bohemian columbite in my cabinet is a portion of a crystal about an inch in length, and wanting both the terminations. Its length was originally about $1\frac{1}{2}$ inch; but I broke a fragment off it to enable me to subject it to a chemical analysis.

Its colour is *black*, but it is lighter than that of *torrelite*. And, when reduced to a fine powder, it still retains its black colour. But, when the powder is heated to redness, it changes to chocolate brown like that of *torrelite*; though it loses only $\frac{1}{2000}$ th of its weight.

The structure is foliated. Only two faces of the crystal, which is a flat four-sided prism, are smooth enough for measurement. They meet at an angle of 90° , shewing that the prism is rectangular; and Mr. Brooke has ascertained, that the primary form is a right rectangular prism. The faces of the prism are streaked longitudinally.

The following are the measurements by Mr. Brooke of a crystal in his possession :

P on M or T	90°
M on T	90
P on a^1 or \acute{a}^1	136 30'
P on c	120
T on d^1	156 30
T on d^2	114 30
T on c	150



Opaque. Lustre semi-metallic, inclining to resinous. Fracture imperfect conchoidal.

Hardness 6 or 6·25. Specific gravity by my trials 6·0380. This is exactly the specific gravity given in Haidinger's translation of Mohs's Mineralogy, shewing that his description is of the same mineral with that in my possession.

The phenomena, before the blow-pipe with columbite, are the same as with torrelite. The presence of iron and manganese being indicated.

I analyzed 20 grains of Bohemian columbite precisely in the same way as I had already analyzed torrelite. But as my quantity was limited, I was at more pains to prevent any loss. The consequence was (as is frequently the case under such circumstances), that I obtained a slight excess. It is proper to mention also, that when the peroxide of iron extracted from the mineral was ignited, and then digested in muriatic acid, it left 0·2 grain of columbic acid. Thus, shewing that columbic acid, before ignition, is not only slightly soluble in ammonia, but also in muriatic acid. The result of my analysis was as follows :

Columbic acid,	15·93	79·65
Protoxide of iron,	2·80	14·00
Protoxide of manganese,	1·51	7·55
Oxide of tin,	0·10	0·50
Moisture,	0·01	0·05
	20·35	101·75

Dividing these numbers by their atomic weights, we obtain,

	Atoms.
Columbic acid,	3·09 or 1·987
Protoxide of iron,	3·11 or 2·
Protoxide of manganese,	1·67. or 1·07

These numbers approach very nearly to

- 2 atoms columbic acid
- 2 atoms protoxide of iron
- 1 atom protoxide of manganese

which evidently shews the constitution of columbite to be

- 1 atom dicolumbate of iron
- 1 atom columbate of manganese

The formula indicating its composition is, $f^2 \text{Cl} + mn \text{Cl}$.

It differs from torrelite by containing half an atom of columbic acid more. Torrelite consists of $1\frac{1}{2}$ atom columbic acid united to 3 atoms of oxides of iron and manganese,

while columbite consists of 2 atoms columbic acid united to 3 atoms of the same bases.

Dr. Wollaston analyzed 5 grains of the original specimen of columbite in the British Museum, and obtained,

Columbic acid,	4	or 80
Protoxide of iron,	0.75	15
Protoxide of manganese,	0.25	5
	5.00*	100

This approaches pretty nearly to my analysis. We cannot expect minute accuracy in an analysis conducted on so small a scale. But it is near enough, I conceive, to leave no doubt about the identity of the columbite in the British Museum and that found at Bodenmais. This is farther corroborated by the specific gravity of the British Museum specimen, which Mr. Hatchett found to be 5.918.

3. *Tantalite.*

The specimens of tantalite from Finland, by the examination of which Ekeberg discovered the metallic substance to which he gave the name of *tantalum*, were sent him by M. Geyer; and it is not accurately known from what part of Finland they came. Berzelius conjectures that they had been found at Skogsböle, in the parish of Kimito, where an attempt had been made to obtain tin, for the oxide of which tantalite had been taken. At Ekeberg's death, his mineral collection was purchased by Dr. Mac-michael, who was liberal enough to give to Berzelius all the specimens of tantalite which it contained. One of these consisted of a small piece, labelled by Ekeberg as having a specific gravity of 7.236. The rest had been reduced to powder, obviously for analysis.

Berzelius gives no description of this tantalite, and the quantity of it was so small, that he was able to use only one gramme or 15.433 grains; and, though some anomalies occurred in the analysis, it was not in his power to remove them by repeating it. Klaproth obviously employed the same mineral in his analysis of tantalite. He gives the following short description of it:

Colour, iron black, amorphous. Lustre, semi-metallic,

Phil. Trans. 1809, p. 248

hard, brittle. Colour of streak, grayish black with a shade of brown. Specific gravity 7.300.*

Its constituents, as determined by the analysis of Berzelius, are

Columbic acid,	83.2
Protoxide of iron, . . .	7.2
Protoxide of manganese, .	7.4
Oxide of tin,	0.6
	98.4 †

Dividing these numbers by the atomic weight of each, we obtain,

	Atoms.
Columbic acid,	3.23 or 2.018
Protoxide of iron, . . .	1.6 or 1.
Protoxide of manganese, .	1.64 or 1.025

These numbers leave no doubt, that the constitution of tantalite is

2 atoms columbic acid
1 atom protoxide of iron
1 atom protoxide of manganese

Thus, the number of atoms of the acid and of the bases is equal. It is composed obviously of

1 atom columbate of iron
1 atom columbate of manganese

So that the formula indicating its constitution is $f\text{C}l + mn\text{Cl}$.

It differs from columbite in containing 1 atom less of protoxide of iron, united with the same proportion of columbic acid and columbate of manganese.

4. Ferrotantalite.

Among the specimens of tantalite found in Ekeberg's collection, there was one in powder, which had the colour of rust, and which was marked as obtained from a single tantalite crystal, whose specific gravity was 7.936. This powder Berzelius attempted to analyze in 1815; but the result was unsatisfactory. In 1818, he received from Nordenskjöld a specimen of a tantalite from Kimito, which, when pounded, gave a cinnamon brown power, which he

* Beitrage, v. 2.

† Afhandlingar, iv. 262.

subjected to analysis.* This variety, or rather, this new species, I distinguish by the name *ferrotantalite*; because it consists almost wholly of columbic acid combined with protoxide of iron.

Colour black.

In irregular masses, with some indications of crystalline faces; though it is impossible to make out the shape of the crystal.

Lustre metallic, and, in general, greater than that of common tantalite. Internal lustre often less, owing to large rents in the mineral, the surfaces of which exhibit a rainbow tarnish.

Fracture uneven. Hard enough to scratch glass. Specific gravity 7·655.

Powder dark reddish brown, becoming lighter the more finely it is pounded.

Not acted on by acids.

Before the blow-pipe, *per se*, not altered. With borax, when in solid pieces, it dissolves very slowly, or not at all. In fine powder, it dissolves very slowly. The glass has a green colour, in which white particles float: and it does not become milky by flaming. In bi-phosphate of soda, it dissolves much more easily, and the glass has the same colour as when common tantalite is employed. The addition of saltpetre indicates a small quantity of manganese.

With carbonate of soda it does not dissolve. But when it is heated with a mixture of carbonate of soda and borax on charcoal, and exposed to a good reducing heat grains of tin are obtained.

Being subjected to analysis by Berzelius, he obtained,

Columbic acid,	85·85
Protoxide of iron,	12·97
Protoxide of manganese,	1·61
Oxide of tin,	0·80
Lime,	0·56
Silica,	0·72

102·51†

* Afhandlingar, vi. 237.

† Afhandlingar, vi. 243. The excess is probably owing to over-rating the quantity of columbic acid in the mineral. Had the amount been 83·43, the atoms of acid and bases would have been the same. Now, the difference between 85·85 and 83·43 is 2·42, which is very nearly the amount of the excess.

Dividing these numbers by the atomic weights of the bodies, we obtain,

	Atoms.
Columbic acid,	3·33 or 1·
Protoxide of iron, . . .	2·88 } or 0·97
Protoxide of manganese, .	0·36 }

obviously, 1 atom columbic acid

1 atom protoxide of iron and manganese.

The difference between it and common tantalite is, that instead of 1 atom protoxide of iron and 1 atom protoxide of manganese, united with two atoms of columbic acid, it consists of 2 atoms of columbic acid, combined with 1·777 atoms protoxide of iron, and 0·223 atoms of protoxide of manganese. Or, which comes to the same thing, we may consider it as composed of

9 atoms columbic acid

8 atoms protoxide of iron

1 atom protoxide of manganese

So that the formula indicating its constitution is, $8f\text{Cl} + mn\text{Cl}$.

Such are the characters, and such the constitution of the four species of minerals composed of columbic acid, united to protoxide of iron and protoxide of manganese. The formulas indicating their constitution are as follow :

1. Torrelite, $2f^2\text{Cl} + mn^2\text{Cl}$.

2. Columbite, $f^2\text{Cl} + mn\text{Cl}$.

3. Tantalite, $f\text{Cl} + mn\text{Cl}$.

4. Ferrotantalite, . . $8f\text{Cl} + mn\text{Cl}$.

Let us now compare their specific gravities with each other.

1. Torrelite, 4·8038

2. Columbite, 6·0380

3. Tantalite, 7·3000

4. Ferrotantalite, . . 7·6550

Thus, as the columbic acid increases, the specific gravity increases, shewing the high specific gravity which must belong to columbic acid.

The crystalline shape of torrelite and columbite is different. It is probable, that tantalite and ferrotantalite have each a peculiar crystalline shape, although, from the variety of their minerals, and the imperfect state of the crystals, that point has not been ascertained.

Torrelite and columbite differ in their hardness, that of the former being 4·25, of the latter 6·25. Tantalite and ferrotantalite are described as hard; but we know not the exact amount.

From the preceding observations and analyses, I conceive, that no doubts can remain either with mineralogists or chemists, that the four minerals described in this paper constitute four different species.

ARTICLE IV.

Experiments and Observations on Visible Vibration.

By CHARLES TOMLINSON, ESQ.

(Continued from page 20.)

ON THE VIBRATION OF PORCELAIN AND EARTHENWARE
VESSELS.

116. The investigation of the vibratory action of vessels of other material than glass has been purposely deferred until now, because, from a few phenomena already alluded to (75), it would seem, that the vibration of porcelain, earthen, and wedgwood-ware vessels is peculiar, and, therefore, deserving a separate inquiry.

It has been said (75), that two tones can be produced from earthenware mugs, &c., and Mr. Dodd found that with a common blue cylindrical cup, two notes D and E were produced separately, and alternated four times during one revolution of the finger: that is, there were four points producing D, and four other points producing E. The additional phenomena noticed (75) are not very precisely stated, as the mode of vibration of these vessels, then adopted by Mr. Dodd, "by striking the edge gently with a quill," is a very imperfect one, and not capable of producing the decisive results, which the judicious application of a well rosined bow effects. I, therefore, propose in this paper, to commence a statement of the results of my inquiry into the vibratory action of vessels of porcelain, china, earthenware, metal and wood. The very curious results which I have obtained, may, probably, be thought sufficiently important to allow me to state them somewhat fully.