

COLUMBOMICROLITE FROM ESHOWE, NATAL

J. E. DE VILLIERS, *Geological Survey of the Union of
South Africa, Pretoria.*

ABSTRACT

Columbomicrolite, a new member of the pyrochlore group occurring as tiny grains in albitite, has the following composition (recalculated to 100%): Cb_2O_6 72.2%, Ta_2O_5 nil, TiO_2 1.8%, Fe_2O_3 trace, Ce_2O_3 nil, CaO 15.2%, Na_2O 10.0%, H_2O 1.8%. Total 100.0%. $G.=4.16$. $n=2.152$. A brief summary is given of what is regarded as the essential chemical character of each member of the group.

OCCURRENCE

While examining a rock sample from Natal during 1938, the writer observed a few grains of a highly refracting, isotropic mineral in the heavy concentrate. Its optical properties closely resembled those of diamond but chemical tests on a micro-scale showed the presence of columbium. At a later date more of the material was obtained and the mineral provisionally identified as microlite.

The parent rock is a somewhat weathered albitite which, according to Dr. Willémse of the Geological Survey, occurs in the Basement gneiss about fifteen miles north of the village of Eshowe. The rock usually has a sugary texture, but may also be lamellar or platy. Subordinate amounts of potash feldspar and muscovite are present and the latter mineral also occurs as veinlets traversing the specimens. It seems likely that the albitite has resulted from post-magmatic activity.

The specimens investigated did not contain a great variety of heavy minerals, and apart from the columbomicrolite only ilmenite and zircon were present in appreciable amounts. Columbomicrolite is distributed through this rock in small, variable amounts, the highest percentage recovered being .05%.

The mineral was extracted by crushing and panning the rock and separating the concentrate by means of bromoform. Ilmenite was removed with the electromagnet, leaving a mixture composed exclusively of columbomicrolite and zircon.

PHYSICAL PROPERTIES

Grains of columbomicrolite are typically colorless and transparent, but are in part also somewhat turbid. Tiny films and flakes of a reddish translucent mineral, which may be hematite, are sometimes present as inclusions. In thin sections of the rock, columbomicrolite was observed in a few cases. It forms small patches and irregular vein-like structures made up of individual crystals that showed some tendency toward idiomorphic outline. The aggregates are up to 0.2 mm. in diameter,

while individual crystals have a cross section of the order of 0.05 mm.

A specific gravity determination made on about 200 milligrams of the mixture of columbomicrolite and zircon, using a small, specially made pycnometer, gave the following result: $G=4.33$. Correcting this figure for the presence of 37% zircon with a specific gravity of 4.65, the result for columbomicrolite was found to be 4.16. The zircon has normal refractive indices but it shows some signs of alteration and it is thus likely that its assumed specific gravity is too high. The figure for columbomicrolite cannot be considered as more than an approximation and may have an error of ± 1 .

The refractive index was determined by immersion in sulphur-selenium melts. These melts were prepared by heating together the constituents in a test tube to a temperature near to the boiling point of sulphur and then pouring the product into a cool dish. A small fragment of this elastic material was next placed on a glass slide together with a few grains of columbomicrolite, covered with a small cover glass and heated until melting just took place. The melt after being quickly cooled on a metal slab proved to be fairly transparent and remained amorphous long enough for index determinations to be made. This method, whereby the mixture does not need to be heated to a high temperature in the presence of the mineral, has the advantage that the mineral is less likely to suffer a change of index through heating. It has indeed been found possible to make mounts of a mineral in the elastic medium in the cold. These mounts were not, however, very satisfactory.

The composition of the mixture was altered until its index matched that of the mineral for sodium light. Another portion of the same mixture was then pressed into a glass prism and its refractive index determined on the goniometer. The refractive index of columbomicrolite obtained in this way gave the result: $n_D=2.152 (\pm .005)$. No marked differences in index were observed among individual grains, a fact which indicates that the mineral is of fairly uniform composition.

CHEMICAL PROPERTIES

About 350 milligrams of the mixture of columbomicrolite and zircon were kindly analyzed by Mr. C. F. J. van der Walt of the Division of Chemical Services. Mr. van der Walt's report is given below:

"Loss on ignition was taken to be H_2O . The material was decomposed with HF and then fumed with H_2SO_4 to remove all HF. The earth acids plus zircon were filtered off and the CaO and Na_2O were determined according to the usual methods in the filtrate after the metals of the ammonia group had been removed (CaO was determined according to the oxalate method, and the Na_2O by weighing as Na_2SO_4).

"The insoluble residue (earth acids plus zircon) was fused with $K_2S_2O_7$, taken up in tartaric acid solution and filtered. The earth acids were now precipitated from the filtrate according to the tartaric hydrolysis method of Schoeller, weighed and tested for tantalum according to the tannic acid method of Schoeller. Tantalum was found to be absent, as no yellow precipitate could be obtained. The precipitate was red from the start, showing that only columbium was present.

ANALYTICAL DATA

	1	2	3	4	5	6
	%	%				
Cb_2O_5	43.5	71.2	0.267	0.535	0.535	71.3
Ta_2O_5	nil					
TiO_2	1.1	1.8	0.023	0.023	0.023	1.8
Fe_2O_3	tr.					
Ce_2O_3	nil					
CaO	9.3	15.2	0.271	0.271	0.271	15.2
Na_2O	6.1	10.0	0.161	0.322	0.287	8.9
H_2O	1.1	1.8	0.100	0.200	0.310	2.8
Insol.	36.9					
	98.0	100.0				100.0

1. Analysis by C. F. J. van der Walt.
2. Analysis of columbomicrolite recalculated to 100%.
3. Molecular ratios.
4. Atomic ratios.
5. Atomic ratios adjusted to conform to the formula $(Ca, Na)_2(Cb, Ti)_2(O, OH)_7$.
6. Theoretical composition for $Ca=0.97$, $Na=1.03$, $Cb=1.92$, $Ti=0.08$, $O=5.89$, $OH=1.11$.

"The insoluble residue (zircon) was determined by fusing a fresh sample with $K_2S_2O_7$ and dissolving in tartaric acid. The residue was ignited and weighed. The TiO_2 was determined colorimetrically in the filtrate.

"The percentage of insoluble residue (zircon) is slightly low, because zircon is slowly attacked by $K_2S_2O_7$, so that some zirconium found its way into solution, and is not accounted for in the analysis.

"A test was made for rare earths by means of oxalic acid. No precipitate was obtained."

The agreement between the recalculated analysis and the theoretical composition for a mineral of the pyrochlore type will be seen by comparing columns 2 and 6. Discrepancies in the soda and water values are rather large ($\pm 1\%$ in either case) but when it is borne in mind that the

analysis was carried out on very little material the agreement must be considered satisfactory.

The molecular weight calculated from the theoretical composition was found to be 358. Von Gaertner (1930) has stated that the unit cell of pyrochlore contains 8 molecules of the type $(\text{Na}, \text{Ca})_2 (\text{Nb}, \text{Ti})_2 (\text{O}, \text{F})_7$. With this information and the specific gravity, the edge of the cubic unit cell of columbomicrolite may be calculated. The value obtained (10.43Å) agrees closely with Machatschki's (1932,*b*) determinations on minerals of the pyrochlore-romeite group.

NOMENCLATURE OF THE PYROCHLORE GROUP

No suitable name for the Eschowe mineral could be found in relevant literature. Indeed, considerable confusion seemed to exist in regard to the definitions applied to the various members of the pyrochlore group. It was thus thought necessary to undertake a survey of these minerals and to apply to each a brief definition which would be in accord with its known composition and properties, and would enable any member of the group to be identified by means of a qualitative chemical analysis in conjunction with optical and physical tests.

All the minerals for which definitions are proposed (except "marignacite" which is described as a variety of pyrochlore; and columbomicrolite) have been investigated with the aid of *x*-rays by Machatschki (1832,*b*) and others. They belong to the pyrochlore group and have the general formula $X_2Z_2(\text{O}, \text{OH}, \text{F})_7$, where $X = \text{Na}, \text{Ca}, \text{Ce}, \text{etc.}$, and $Z = \text{Nb}, \text{Ta}, \text{Ti}, \text{Sb}$. Unfortunately, the writer has not been able to obtain Machatschki's publication and has had to be content with abstracts.

In determining which constituents should be considered diagnostic for any species, it was decided to emphasize where possible the presence of elements unique to such a species and to give less consideration to constituents like sodium, iron, water, fluorine, etc., which are very often present and usually in subordinate amounts.

Pyrochlore. Wöhler, *Pogg.*, **7**, 417 (1826). Larsen and Berman (1934) define pyrochlore as a "Columbate and titanate of Ce, Ca, etc., with Th, F, etc.," while Winchell (1933) gives the following formula (after Machatschki, 1932,*b*): $(\text{Na}, \text{Ca}, \text{Fe}, \text{Ce})_2 \text{Nb}_2\text{O}_6 (\text{OH}, \text{F})$. A study of the available analyses of pyrochlore shows that both cerium and titanium are invariably present in appreciable amounts and must therefore be regarded as essential constituents. From a consideration of these facts the mineral can be shortly defined as a calcium-cerium titano-columbate which usually, but not necessarily, contains iron and sodium and small amounts of fluorine, water, etc.

Microlite. C. U. Shepard, *Am. Jour. Sci.*, **27**, 361 (1835). It appears to

be generally accepted that this mineral is chiefly a calcium tantalate. Sodium and water are usually present but are not considered essential.

Columbomicrolite. This mineral can be defined as a calcium columbate ($\text{Ca}_2\text{Cb}_2\text{O}_7$) which in the case of the Eschowe mineral also contains sodium and water.

Hatchettolite. J. L. Smith, *Am. Jour. Sci.*, **13**, 365 (1877). A tantalocolumbate of uranium and calcium, which may contain small amounts of iron, water, titanium, etc. Uranium is considered to be the significant constituent of this species and it is proposed that any uranium-rich pyrochlore be named hatchettolite. Microlite containing much uranium may be named tantalohatchettolite.

Koppite. Knop, *Jb. Min.*, **67**, (1875). Winchell (1933) describes this mineral as "a pyrochlore containing K" while Brandenberger (1931) states that koppite should be regarded as an iron-columbium pyrochlore. From an examination of the available analyses of koppite it must however be concluded that the significant difference between this mineral and pyrochlore lies in the absence of appreciable amounts of titanium in koppite. The mineral can thus be defined as a calcium-cerium columbate which may, or may not, contain accessory iron, sodium potassium, etc.

Weidman and Lenher's marignacite, *Am. Jour. Sci.*, **23**, 287 (1907), which contains only 2.88% TiO_2 should, according to this definition, also be named koppite.

Pyrrhite. G. Rose, *Pogg.*, **48**, 562 (1840). Information on the composition of this mineral is very scanty. A partial analysis by Brauns (quoted by Machatschki, 1932,*a*) showed the presence of characteristic pyrochlore constituents and Machatschki (1932,*a*) describes the mineral as a tantalum-rich member of the pyrochlore series. Since no differences between pyrrhite and pyrochlore are apparent, it is proposed that the former name be discarded in favor of the latter which has priority.

Neotantalite. Pierre Termier, *Bull. Soc. Min.*, **25**, 34 (1902). This mineral was assigned to the pyrochlore group by Machatschki (1932,*b*) who proposed the formula $(\text{Fe}, \text{Mn}, \text{Na})_2 (\text{Ta}, \text{Cb})_2 (\text{O}, \text{OH}, \text{F})_7$. Pisani's analysis however shows little correspondence to a formula of this type. In view of this lack of agreement it seems advisable for the present to use the name neotantalite only in referring to the type mineral.

Romeite. Damour, *Ann. Mines*, **20**, 247 (1841). Calcium antimonate ($\text{Ca}_2\text{Sb}_2\text{O}_7$) usually containing small amounts of sodium, manganese, iron and water.

Atopite. A. E. Nordenskiöld, *Geol. För. Förh.*, **3**, 376 (1877). Similar in composition to romeite. O. Zeidlitz (1932) has suggested that the name atopite be abandoned in favor of romeite which has priority.

Schneebergite. A. Brezina, *Vh. G. Reichs.*, 313 (1880). A calcium antimonate to which Schaller (1916,*a*) assigns the empirical formula CaSbO_3 ($= 2\text{CaO} \cdot \text{Sb}_2\text{O}_3 + 2\text{CaO} \cdot \text{Sb}_2\text{O}_5$). Zedlitz (1932) has however shown the mineral to be isomorphous with romeite. There thus seems to be no reason why the name *schneebergite* should be retained and it is proposed that the name *romeite* be substituted for this.

Lewisite. E. Hussak and G. T. Prior, *Min. Mag.*, 11, 80 (1895). Calcium titano-antimonate which may contain small amounts of iron, sodium and manganese.

Mauzeilite. H. Sjögren, *Geol. För. Förh.*, 17, 313 (1895). Schaller (1916,*b*) considers the mineral to be identical with *lewisite* and there seems to be some room for doubt as to whether the name should be retained. In view however of the presence of 6.79% PbO in the original analysis it is suggested that the name *mauzeilite* be used to describe a calcium-lead titano-antimonate.

Monimolite. L. J. Igelström, *Öfv. Ak. Stockh.*, 22, 227 (1865). Lead antimonate with or without calcium, iron, magnesium, etc.

Weslienite. G. Flink, *Geol. För. Förh.*, 45, 567 (1923). Calcium antimonate of similar composition to *romeite*. Aminoff (1933) states that the mineral is identical with *atopite* and it is therefore proposed that the name *weslienite* be discarded in favor of *romeite*.

REFERENCES

- AMINOFF, G., On the minerals "weslienite" and *atopite*: *Kungl. Svenska Vetenskapsakad. Handl.*, ser. 3, 11, no. 4, 14-18 (1933).
- BRANDENBERGER, E., Die Kristallstruktur von *Koppit*: *Zeits. Krist.*, 76, 322-334 (1931).
- LARSEN, E. S., AND BERMAN, H., The Microscopic Determination of Nonopaque Minerals: *U. S. Geol. Surv., Bull.* 848 (1934).
- a. MACHATSCHKI, F., Die Kristallstruktur des *Pyrrhit*: *Centr. Min.*, Abt. A, 33-37 (1932).
- b. MACHATSCHKI, F., Die *Pyrochlor-Romeit* Gruppe: *Chemie der Erde*, 7, 56-76 (1932).
- PALACHE, C., AND GONYER, F. A., *Microlite* and *stibiotantalite* from Topsham, Maine: *Am. Mineral.*, 25, 411-417 (1940).
- a. SCHALLER, W. T., *Schneebergite*: *Min. Notes, Ser. 3, U. S. Geol. Surv., Bull.* 610, 81-94 (1916).
- b. SCHALLER, W. T., The natural antimonites and antimonates: *Min. Notes, Ser. 3, U. S. Geol. Surv., Bull.* 610, 104-105 (1916).
- VON GAERTNER, H. R., Die Kristallstrukturen von *Loparit* und *Pyrochlor*: *Neues Jahrb. Min.*, Abt. A, Beil.-Bd. 61, 1-30 (1930).
- WINCHELL, A. N., *Elements of Optical Mineralogy*, Part II (1933).
- ZEDLITZ, O., Die Kristallstrukturen von *Romeit* und *Schneebergit*: *Zeits. Krist.*, 81, 253-263 (1932).