

*Simpsonite and other tantalates from Bikita, Southern Rhodesia.*

By A. M. MACGREGOR, M.A., F.G.S.

Geological Survey of Southern Rhodesia.

[Read November 1, 1945.]

THE Bikita tin and tantalum field is centred about 43 miles east-north-east of Fort Victoria, in the south-eastern part of Southern Rhodesia. It forms the end of a tongue of basic and sedimentary schists surrounded on three sides by granite. Tin and tantalum minerals have been known in the area for over thirty years, and at various times attempts to work them have been made, but with indifferent success. During recent years the demand for tantalum has led to the re-opening of the field and several tons of tantalite and simpsonite concentrates have been exported to America. The area was mapped geologically by Mr. R. Tyndale-Biscoe in 1942, but the publication of the map and report have been held up during the war. The principal workings are the Mdara mine and the Al Hayat claims situated about three-quarters of a mile apart.

The Mdara mine has been worked as open quarries in a small hill composed of a tangle of dikes and lenses of partly greisenized pegmatite and felspar-rock which form an oval area in epidiorite country. The hill is surmounted by a mass of purple lepidolite. Later dolerite has been intruded as sills through and beneath the hill. Crystals of tantalite occur sporadically in knots or bunches in felspar-rock, generally in association with lenses of quartz. The concentration throughout the whole hill has been proved to be sub-economic at present prices. The discovery of simpsonite in a more consistent body has somewhat improved the working conditions. The Al Hayat claims contain small scattered workings for tantalite in pegmatite dikes with quartz lenses. One dike contained a small mass of greisen with rather abundant microlite.

The exploitation of the area has thrown a great deal of work on Mr. Ernest Golding, Chemist to the Southern Rhodesia Geological Survey, who has made assays for tantalum and columbium, tin, titanium, zirconium, &c., of samples from every consignment of concentrates which has been dispatched. In general there is little of scientific interest in the results of these assays, except that they show that the proportion of columbium to tantalum varies considerably. At the Mdara mine the ratio of  $Ta_2O_5$  to  $Cb_2O_5$  varies in different consignments from 2.5 : 1 to 8.3 : 1, with an average of about 5.3 : 1. At the Al Hayat claims the proportion of  $Ta_2O_5$  has generally been lower.

In the course of his work in 1940 Golding observed an unfamiliar brown translucent mineral in one of the samples from the Al Hayat claims. He collected sufficient of the mineral for a full analysis and retained a few specimens for record. The composition corresponded to that of a manganotantalite very low in iron. The specimens were not examined physically until recently, when it was found that they show optical characters suggesting monoclinic symmetry. This mineral is at present under further investigation, and it is hoped to publish a full description later.

In May 1943 simpsonite was found by Golding in a sample from the Mdara mine, which included ore from a new prospecting shaft then being sunk. Analysis proved the mineral to be essentially a tantalate of aluminium. For a time there was a doubt whether it conformed with the original simpsonite from Western Australia, but these doubts have been removed by Dr. W. T. Schaller of the United States Geological Survey, who has very kindly put his information at my service.

To determine the refractive indices of the minerals, a series of liquids with intervals of 0.01, ranging from 1.90 to 2.06 were made according to C. D. West's method.<sup>1</sup> The refractive index of the 1.90 liquid was determined on the Leitz-Jelly refractometer, and the liquid 2.00 and 2.05 were verified by comparison with  $\omega$  of cassiterite and pyromorphite respectively. In computing formulae from chemical analyses the atomic weights of tantalum and columbium used are 180.88 and 92.92 respectively.

Chemical analyses of simpsonite, manganese tantalate, and microlite.

	A.	B.	C.	D.	E.	F.	G.
Ta <sub>2</sub> O <sub>5</sub> ...	60.01	69.46	66.20	72.31	71.48	71.10	74.36
Cb <sub>2</sub> O <sub>5</sub> ...	6.05	1.84	1.80	0.33	0.32	5.04	4.78
SnO <sub>2</sub> ...	0.42	1.45	1.31	2.00	1.19	2.54	nil
SiO <sub>2</sub> ...	8.01	1.60	2.40	1.78	2.34	7.20	1.20
TiO <sub>2</sub> ...	trace	0.10	0.08	—	—	trace	nil
ZrO <sub>2</sub> ...	0.05	trace	trace	—	—	nil	nil
Al <sub>2</sub> O <sub>3</sub> ...	22.58	23.79	23.52	16.75	18.64	1.05	0.56
Fe <sub>2</sub> O <sub>3</sub> ...	0.11	—	0.88	0.14	0.48	trace	—
FeO ...	0.82	0.60	0.69	0.16	0.44	0.69	0.77
MnO ...	0.03	0.32	0.38	0.08	0.04	10.00	nil
PbO ...	—	—	—	0.42	nil	—	—
BeO ...	—	—	—	—	—	—	nil
MgO ...	trace	trace	trace	—	—	0.24	nil
CaO ...	0.32	0.41	1.40	3.40	3.19	1.34	11.68
Na <sub>2</sub> O ...	0.39	0.35	0.46	1.16	0.68	0.48	5.13
K <sub>2</sub> O ...	0.23	0.13	0.44	0.24	0.42	0.20	0.47
H <sub>2</sub> O+ ...	0.19	0.12	0.62	1.35	1.39	0.46	0.24
H <sub>2</sub> O- ...	0.27	0.32	0.03	0.20	0.03	0.02	0.02
P <sub>2</sub> O <sub>5</sub> ...	0.55	nil	nil	—	—	—	0.30
F ...	trace	trace	trace	0.21+	0.38+	—	0.58
Total ...	100.03	100.49	100.21	100.53	101.02	100.36	100.09
Sp. gr. ...	—	—	—	6.525	6.27	7.7	6.016

A. Simpsonite, Mdara mine, Bikita. E. Golding (GM. 654).

B. Fluorescent simpsonite, Mdara mine, Bikita. E. Golding (GM. 706).

C. Altered simpsonite, not fluorescent, Mdara mine, Bikita. E. Golding (GM. 709).

D. Simpsonite, Tabba Tabba, Western Australia. D. G. Murray (H. Bowley, 1939).

E. Simpsonite, Tabba Tabba, Western Australia. J. N. A. Grace (H. Bowley, 1939).

F. Brown manganese tantalate, Al Hayat claims, Bikita. E. Golding (GM. 488).

G. Microlite, Al Hayat claims, Bikita. E. Golding (GM. 508).

Tests for S, CO<sub>2</sub>, WO<sub>3</sub>, Th, and rare-earths gave negative results in Golding's analyses.

#### SIMPSONITE.

Simpsonite was discovered in a prospecting shaft sunk in a dike of felspathic pegmatite a quarter of a mile north of the main Mdara workings. It appears to

<sup>1</sup> C. D. West, Amer. Min., 1936, vol. 21, p. 245. [M.A. 6-460.]

be limited to a band one to two feet thick, underlying a large lens-shaped mass of quartz. The gangue is felspar-rock composed mainly of plagioclase between albite and oligoclase in composition. Close to the quartz this rock is sometimes sericitized and greisenized. Below the simpsonite band the felspar-rock with sparse tantalite and some cassiterite continues for several feet, until it is cut by a thick sill of dolerite. Narrow dikes of dolerite are also found cutting the simpsonite-bearing rock close to the quartz body.

The mineral simpsonite was first discovered in 1934 at Tabba Tabba in Western Australia, and is described by H. Bowley and L. E. R. Taylor.<sup>1</sup> Miss Taylor's X-ray photographs indicate that the mineral belongs to the apatite (diplohedra) class of the hexagonal system. The chemical formula was deduced by Mr. Bowley, making allowance for impurities, as  $2\text{H}_2\text{O} \cdot \text{CaO} \cdot 5\text{Al}_2\text{O}_3 \cdot 4\text{Ta}_2\text{O}_5$ , with a very little columbium replacing the tantalum. The mineral is described as very hard. Specific gravity 6.525 and 6.27 (two specimens). Uniaxial, positive. Refractive index 2.06, and birefringence 0.1.

The Bikita mineral resembles simpsonite as described by Bowley in respect of its colour, uniaxial character, hardness, high specific gravity, and general composition. Thin sections showing the alteration also resemble the photograph figured by Bowley. It differs in being optically negative, in having a lower birefringence, and in the fact that it does not contain sufficient water or lime to satisfy Bowley's formula.

Some correspondence took place with the purchasers of the mineral in America, who were inclined to consider in view of these differences that a new name for the mineral was required. Doubts were removed by the work of the United States Geological Survey when in August, 1944, a letter was received from Dr. W. T. Schaller, who writes:

'Recently I received from the Minor and Rare Metals Section of the Office of Economic Warfare, samples of a mineral from Bikita, Rhodesia, together with a copy of your letter of August 27, to Mr. Sharpstone, and a letter from the Fansteel Corporation stating their belief that the Bikita mineral was distinct from simpsonite. Simpsonite from Tabba Tabba (U.S. National Museum 103440), the Bikita mineral, and two samples of "aluminum tantalate" from Brazil were found to be uniaxial negative, so that Bowley's statement seems to be incorrect. X-ray powder patterns [reproduced here in fig. 1] of the four samples, made by Mr. J. M. Axelrod of this Laboratory, are identical, confirming your identification of the Bikita mineral as simpsonite, and giving two new Brazilian occurrences. I shall be interested in seeing the description of the Bikita deposit which I understand you plan to publish. You are free to use the information in this letter in any way you desire.'

The colour of the Bikita simpsonite is pale yellowish-buff varying somewhat to light brown. There is always a red or brown coating on the outer surface and often on the surfaces of cracks through the crystals. The lustre of the fresher parts is greasy. The mineral scratches quartz and some beryl easily, but is not as hard as topaz. Three specimens were found to have specific gravity of 6.678, 6.83, and 6.84 respectively, but the value is often lower owing to alteration.

The mineral usually breaks with the matrix and no well-shaped crystals have been isolated. A tabular habit is sometimes distinguishable with a base perpendicular to the optic axis. The largest crystal mass seen measures  $5 \times 5 \times 4$  cm.

<sup>1</sup> H. Bowley, Simpsonite (sp. nov.) from Tabba Tabba, Western Australia. Journ. Roy. Soc. Western Australia, 1939, vol. 25, pp. 89-92. L. E. R. Taylor, X-ray studies of simpsonite. Ibid., pp. 93-97. [M.A. 7-369.]

It appears to be built of sub-parallel hexagonal prisms. Some crystals can be clearly seen to have grown on felspar crystals. There is probably a poor pyramidal cleavage. This is suggested by the frequency of grains in the powdered mineral which show the negative optic axis to emerge just outside the field of view of the microscope. Thin sections show roughly parallel cracks in many directions.

The refractive indices were determined as  $\epsilon$  1.995 $\pm$  and  $\omega$  2.035 $\pm$ . The birefringence determined by the examination of grains and thin sections appears to have a maximum between 0.040 and 0.045. The unaltered mineral fluoresces rather strongly with a bluish-white colour in the light of a 'mineralight' lamp, (wave-length 2540Å.). This shows very clearly the extent of the alteration throughout the simpsonite crystals.

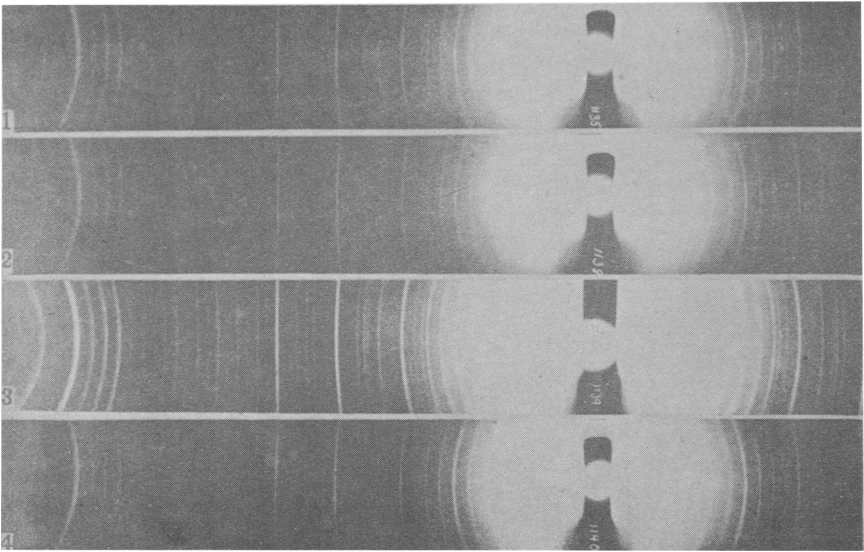


FIG. 1. X-ray powder photographs (Fe-radiation) made by United States Geological Survey, Washington, proving the identity of simpsonite from four localities.

(1) Bikita, Southern Rhodesia. (2) Tappa Tappa, Western Australia. (U.S. National Museum, no. 103440.) (3) Brazil. (Ditto, no. 104738.) (4) Brazil. (Ditto, no. 104739.) (For spacings compare Kerr and Holmes, loc. cit., 1945, p. 494, pl. 2.)

*Alteration of Simpsonite.*—All the simpsonite examined has undergone some alteration, which varies greatly in degree in different specimens and parts of the same crystal. The principal product is an unidentifiable mineral in the form of minute colourless, apparently rhombic (110) prisms with approximately straight extinction and positive elongation. The birefringence (0.12 $\pm$ ) is higher than that of simpsonite, and the indices of refraction are above 2.06. The axial angle is large and positive. The alteration is accompanied by a fall of specific gravity. The average specific gravity of several small altered specimens of dull appearance was determined as 6.49. In addition to this product there is a second mineral

which forms dusty clouds in the clearer parts of the simpsonite between the cracks. This mineral may be microlite.

In describing the Tappa Tappa simpsonite Bowley writes:

'Under the microscope with reflected light it appears as colourless masses intergrown with a pale cream alteration product. With transmitted light a section of a crystal showed irregular cores of a transparent colourless anisotropic mineral bounded by interlacing veinlets of a small amount of a colourless isotropic mineral, which is intergrown with a pale cream almost opaque granular mineral without any crystal habit whatever.'

Camera-lucida drawings of altered Bikita simpsonite are given in figs. 2 and 3. In these simpsonite forms the clear portions of the field, except the bottom part of fig. 2 which represents feldspar partly altered to sericite. The stippled areas represent the cloudy alteration which may be microlite. The prisms of the unidentified alteration product appear to be generally parallel to the optic axis of the simpsonite in fig. 2. Cross-hatched areas represent aggregates of goethite.

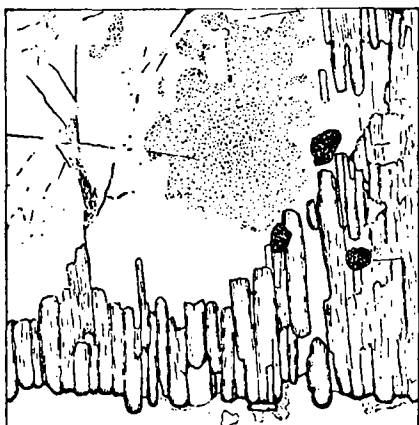


FIG. 2.

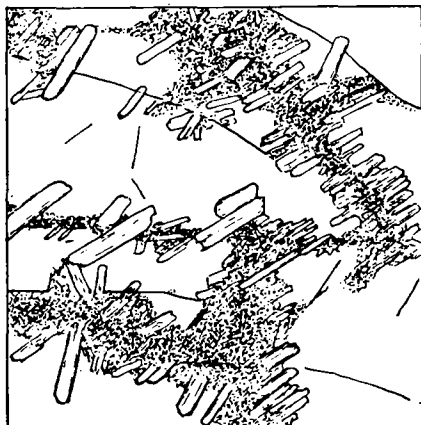


FIG. 3.

Alteration of simpsonite. Clear areas unaltered material. Sides of squares represent 0.4 mm. Slide 10967.

*Chemical Composition.*—Three analyses by Golding of the Mdara simpsonite are given in columns A, B, and C of the table. Analysis A was made in 1943 on selected crystals from a concentrate. Since the composition found differs materially from Bowley's formula, it was considered advisable to have a second analysis made as confirmation. An attempt to grind away the outer, altered portions of a large crystal to obtain a clean sample, proved unsatisfactory owing to the depth to which the alteration penetrates. Sample B, showing uniform fluorescence, from coarsely crushed mineral was therefore preferred. This was washed in bromoform to remove quartz and feldspar. The third analysis, C, was made on altered simpsonite selected to include as little fluorescent material as possible, in the hope of elucidating the alteration product.

There are of course many ways of interpreting the accessory constituents. But the analyses suggest that the formula for simpsonite is  $4\text{Al}_2\text{O}_3 \cdot 3\text{Ta}_2\text{O}_5$  (theoretically  $\text{Al}_2\text{O}_3$  23.58,  $\text{Ta}_2\text{O}_5$  76.42%).

In A minor constituents can be allotted to probable minerals to fit the formula exactly. In B there is a slight excess of alumina. This may be explained by a slight underestimate of the  $\text{Cb}_2\text{O}_5$  in the mixed oxides.

Bowley derived his formula,  $2\text{H}_2\text{O} \cdot \text{CaO} \cdot 5\text{Al}_2\text{O}_3 \cdot 4\text{Ta}_2\text{O}_5$  from analyses D and E, which are reprinted from his paper, by assuming that microlite has an invariable formula  $\text{CaNaTa}_2\text{O}_6\text{F}$ . In three additional partial analyses fluorine was found to vary from 0.81 to 0.89. He limited the microlite in the altered simpsonite to the available fluorine and allocated the remaining lime and water to the simpsonite formula. To the writer it appears reasonable to assume that microlite is an isomorphous mixture, that the lime-soda ratio may be variable, and that fluorine may be replaced by hydroxyl. When all the lime and soda are taken out as microlite with a formula  $6\text{CaO} \cdot 3\text{Ta}_2\text{O}_5 \cdot \text{CbOF}_3$  and the potash as muscovite, the molecular proportions of the remaining  $\text{Ta}_2\text{O}_5$  and  $\text{Al}_2\text{O}_3$  have the ratio of 0.757 and 0.728 to 1 in the two analyses respectively, in close agreement with the formula here proposed.

The analysis of the altered simpsonite C, when compared with A and B, shows increased iron, lime, potash, silica, and combined water, and a lower content of mixed oxides. It is otherwise very similar. Interpreting the silica as sericite, the lime and excess soda as microlite, and the iron and manganese as oxides the  $\text{Al}_2\text{O}_3 : \text{Ta}_2\text{O}_5$  ratio is very near 3 : 2. A mineral of this composition and specific gravity 6.5 has a calculated mean refractive index of 2.00 compared with 2.04 for simpsonite, which is anomalous in view of the observation that the alteration product has the higher refractive index.

Since this description was written, a detailed study of the Brazilian simpsonite has been published by Kerr and Holmes,<sup>1</sup> in which reference is made also to the Australian and Southern Rhodesian material. These authors point out the mistake in the original determination of the optical sign of the Australian simpsonite and also conclude that the ideal composition is that of an aluminium tantalate. They publish analyses of the Brazilian material from which they compute the formula  $3\text{Al}_2\text{O}_3 \cdot 2\text{Ta}_2\text{O}_5$ , which is also the formula suggested by Guimarães<sup>2</sup> for 'calogerasite'. The seventh edition of Dana's 'System of mineralogy' (1944, vol. 1, p. 771) gives a formula  $\text{Al}_2\text{O}_3 \cdot \text{Ta}_2\text{O}_5$ . Evidently the range of composition in simpsonite is a matter for further study.

#### ABNORMAL MANGANESE TANTALATE.

This mineral attracted attention owing to its high specific gravity and the large tantalum content compared with that of other concentrates from the Al Hayat claims. It was found in a vertical pipe-like body of fine-grained, dark purple greisen a few feet in diameter and less than twenty feet deep. The mica gives a definite lithium, and a strong potassium flame coloration, and reacts strongly for manganese. The optical characters of the mica are: optic axial plane parallel to (010), which is generally longer than the other sides of the hexagonal plates,

<sup>1</sup> P. F. Kerr and R. J. Holmes, X-ray study of the tantalum mineral simpsonite. Bull. Geol. Soc. Amer., 1945, vol. 56, pp. 479-504. F. H. Pough, Simpsonite and the northern Brazilian pegmatite region. Ibid., pp. 505-514. [M.A. 9-186.]

<sup>2</sup> C. P. Guimarães, Calogerasita, um novo mineral da família dos tantalatos. Mineração e Metalurgia, Rio de Janeiro, 1944, vol. 8, pp. 135-136. Anais Acad. Brasileira Ciências, 1944, vol. 16, pp. 255-260. [M.A. 9-127.]

2E  $75^\circ$ ,  $\alpha$  1.557  $\pm$ ,  $\beta$  1.585  $\pm$ ,  $\gamma$  1.590  $\pm$ . It is probably a manganiferous protolithionite. Thin sections of the rock show the presence of a little quartz and some microlite fringing the tantalate.

The greisen, which was evidently rich in tantalum, was mined, crushed, and the concentrate shipped. During a recent visit a few additional specimens of the mineral were found on the ground around the site. The larger specimens have the form of spheroidal aggregates of radiating needles. Terminal faces have not been identified. Smaller crystals 1 mm. or less in diameter have the form of flattened bipyramids with nearly square outlines, often with grooved edges suggesting polysynthetic twinning. The bipyramids themselves form interpenetrating twins, and look like orthorhombic crystals.

The powdered mineral has a pale buff colour. Under the microscope the distinctive features are yellowish-brown colour, with very slight pleochroism, translucence up to a thickness of about 0.4 mm., very high refractive indices and birefringence. Some grains show a positive biaxial figure with small axial angle and very strong horizontal dispersion. Owing to polysynthetic twinning, in which the extinction-directions in each twin of a pair are parallel, the figure is generally seen only when the elasticity axes  $\alpha$  and  $\beta$  are parallel with the cross-wires. In other positions the figure is masked by light transmitted by the adjoining twin.

Microscope sections were cut as nearly as possible parallel and transverse to the radiating crystal needles (slides 10972 and 10973). Longitudinal sections show straight extinction and frequently the acute bisectrix with the axial plane parallel with the length of the fibres. In transverse section the needles appear to be blade-shaped twins with the generalized form shown diagrammatically in fig. 4. The acute bisectrix  $\gamma$  makes an angle of about  $58^\circ$  in the acute angle with the twin composition-plane. The sketch makes it clear why in twinned crystals the optic figure is seen only in positions of extinction. Owing to mutual interference of the blades, the crystal form can be determined only very roughly. There appears, however, to be a tendency to bilateral symmetry about the composition-plane as shown in the diagram. This is taken to indicate that the axis of twinning is perpendicular to the plane, and also that the mineral probably belongs to the holosymmetric class of the monoclinic system.

Crystals scratch the pyramidal faces of quartz. The specific gravities of eight specimens were determined by Mr. N. E. Barlow by immersion, and found to range from 7.51 to 7.76. Neglecting the two lowest which were made on material visibly impure, the average specific gravity of the remaining six was 7.66.

The chemical composition is given in column F. The silica, alumina, and alkalis are explained as quartz and mica, and the tin as cassiterite. It will be seen by the following molecular ratios that the remaining bases—lime, iron, and magnesia—balance the tantalum and columbium oxides very closely indeed to give the general formula  $\text{MnO.Ta}_2\text{O}_5$ :

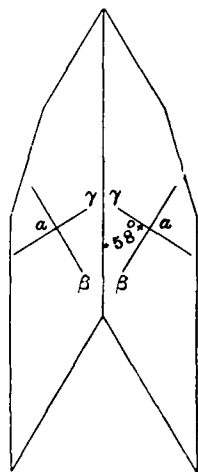


FIG. 4.

Generalized transverse section of twinned needle of manganese tantalate showing optical orientation.

				MnO	...	...	...	0.14099	} 0.18044
Ta <sub>2</sub> O <sub>5</sub>	...	...	0.16095	CaO	...	...	...	0.02390	
Cb <sub>2</sub> O <sub>5</sub>	...	...	0.01896	FeO	...	...	...	0.00960	
				MgO	...	...	...	0.00595	

The description of this unidentified mineral may be summarized as follows: Composition, manganese tantalate,  $MnTa_2O_6$ , with some manganese replaced by lime, iron, and magnesia, and some tantalum by columbium. Occurs as radiating aggregates of blade-shaped needles. Twinning common and sometimes repeated. H. 7; sp. gr. 7.7. Fracture hackly or conchoidal; an indistinct cleavage is sometimes discernible. Lustre resinous to adamantine. Colour between snuff-brown and cinnamon-brown as defined in Ridgway's colour standards. Streak and powder tiller-buff by the same standards.  $\alpha$ ,  $\beta$ , and  $\gamma$  are all above 2.06, probably between 2.10 and 2.40,  $\gamma - \alpha$  nearly 0.2. Pleochroism weak,  $\alpha < \beta < \gamma$ ,  $\alpha$  and  $\beta$  pale brownish-yellow,  $\gamma$  green. Biaxial positive,  $2E 75^\circ$ ,  $2V$  about  $34^\circ$  assuming  $\beta$  about 2.12. Apparent strong horizontal dispersion, axial dispersion  $r < v$ .

In chemical composition and general physical properties this mineral resembles described manganotantalites. These, however, are orthorhombic, and artificial  $MnTa_2O_6$  has also been shown<sup>1</sup> to be isomorphous with columbite. The horizontal dispersion observed in the Southern Rhodesian material suggests monoclinic symmetry, unless it is accounted for by overlapping of twin-lamellae. It is hoped that further examination will determine the symmetry unambiguously.

#### MICROLITE.

On Al Hayat claims microlite occurs rather abundantly in a small body of greisen composed of muscovite, quartz, and pale blue topaz. Rubellite and zircon are also present. The microlite has the form of steely-grey octahedra. Under the microscope it is seen to be colourless and perfectly isotropic, but to contain minute specks of black powder, perhaps magnetite, which may account for the metallic appearance in the hand-specimens. The refractive index is between 2.03 and 2.04, varying somewhat. The values usually given for microlite are about 1.93, but Larsen<sup>2</sup> states that the value rises to 2.04 on ignition. An analysis of the microlite obtained by repeated panning of a sample after rejecting the fines, and the coarse portion which contained most of the topaz and quartz, is given in column G. After deducting apatite, magnetite, muscovite, and orthoclase, the molecular proportions of the remaining radicals are as follows:

(Ta,Cb) <sub>2</sub> O <sub>5</sub>	...	...	0.18631	= 2 × 0.09315
CaO	...	...	0.20120	} = 3 × 0.09456
Na <sub>2</sub> O	...	...	0.08274	
F + OH	...	...	0.04912	= ½ × 0.09836

This conforms approximately with the formula quoted by Bowley,  $CaNaTa_2O_6F$ , except that there is only a quarter of the requisite fluorine and hydroxyl, and that some of the soda is replaced by lime.

Late in 1944 a new deposit of microlite which may prove to have an economic importance was discovered about three-quarters of a mile east of the Mdara mine.

<sup>1</sup> K. Brandt, *Arkiv Kemi Min. Geol.*, 1943, vol. 17A, no. 15. [M.A. 9-100.]

<sup>2</sup> E. S. Larsen, *The microscopic determination of nonopaque minerals.* Bull. U.S. Geol. Surv., 1921, no. 679, p. 179.



The ore-body is an intrusive sheet inclined at about  $30^\circ$  in greenstone country. It appears to be between 10 and 20 feet thick and is exposed continuously along a line of over 400 feet with indications of greater extension. The sheet is formed mainly of albitite, but varies considerably owing probably to metasomatic changes. Much of the rock is fine-grained, and consists of plates of albite about 1 mm. long and 0.3 mm. thick. A little white mica and apatite are present amounting together to less than 1%. No quartz could be recognized (slide 11040). An associated rock is a lepidolite-albitite (slide 11041). The mica has crystallized with the albite and forms scales up to 3 mm. in diameter. The optic axial plane is parallel to (010), and the angle  $2E$  varies greatly from about  $60^\circ$  to  $0^\circ$ , often in the same crystal. This rock contains about 20 to 30% of mica, but probably grades into completely micaceous rock.

Microlite can be panned from the majority of the specimens, but it is most abundant in a coarse-grained rock composed largely of divergent leaf-like masses of albite (cleavelandite) in the form of curved plates about 1 mm. thick and several inches long (slide 11039). A little quartz is present in this rock; thin sections show that some of the albite contains it as a myrmekitic intergrowth. No potash-felspar is recognized (slide 11038). The albite plates are broken and traversed by minute cracks in which secondary mica has been deposited. Microlite is associated with this mica, and occurs as bunches of crystals often grouped round a small core of tantalite. It varies from yellow to colourless and is sometimes zoned, being darkest at the margins. A grab sample of this rock collected along the line of strike was concentrated by the Government Metallurgist and found to contain about 0.05–0.07% of microlite and tantalite.

In conclusion I wish to express my gratitude to the Geological Survey of the United States of America and to Dr. W. T. Schaller for allowing me to publish the results of their work, and my appreciation to Mr. Ernest Golding for his painstaking analytical work, without which these notes would have little value.

---