

KIMROBINSONITE, A NEW TANTALUM MINERAL FROM WESTERN AUSTRALIA, AND ITS ASSOCIATION WITH CESTTIBTANTITE

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ABSTRACT

Kimrobinsonite was found near Mt. Holland in Western Australia. It is white, isotropic and has a composition corresponding to $Ta_{0.82}Nb_{0.11}Na_{0.05}Fe_{0.01}Sb_{0.01}(OH)_{2.27}(CO_3)_{0.22}O_{1.02}$ or, ideally, $(Ta,Nb)(OH)_{5-2x}(O,CO_3)_x$ with $x \sim 1.2$. Its lattice is primitive cubic, with $a = 3.812(1)\text{\AA}$. The strongest five X-ray powder-diffraction lines [d in $A(I)(hkl)$] are: 3.808(10)(100), 2.696(7)(110), 1.907(3)(200), 1.702(5)(210) and 1.555(4)(211). Specific gravity (calc.) is 6.87, and index of refraction (calc.) is 2.23. Cesttibtantite has a cubic cell, with $a = 10.525(2)\text{\AA}$ and composition $Cs_{0.24}(Sb_{0.60}Na_{0.36})(Ta_{1.51}Nb_{0.20}Fe_{0.01})(O,OH)_{6.00}$ or, ideally, $Cs_{0.3}(Sb,Na)(Ta,Nb)_2(O,OH)_6$. Kimrobinsonite, intimately intergrown with cesttibtantite, occurs in a weathered pegmatite; it is thought to be a decomposition product of a Ta-Sb mineral, possibly stibiotantalite or cesttibtantite.

Keywords: kimrobinsonite, cesttibtantite, new mineral species, tantalum hydroxide, Australia, pegmatite, weathering.

SOMMAIRE

La kimrobinsonite se trouve près du mont Holland, Australie occidentale. Elle est blanche, et sa composition correspond à la formule $Ta_{0.82}Nb_{0.11}Na_{0.05}Fe_{0.01}Sb_{0.01}(OH)_{2.27}(CO_3)_{0.22}O_{1.02}$, soit idéalement, $(Ta,Nb)(OH)_{5-2x}(O,CO_3)_x$, avec $x \sim 1.2$. Son réseau est cubique primitif, de paramètre $a = 3.812(1)\text{\AA}$. Les cinq raies les plus intenses du cliché de poudre [d en $A(I)(hkl)$] sont les suivantes: 3.808(10)(100), 2.696(7)(110), 1.907(3)(200), 1.702(5)(210) et 1.555(4)(211). La densité (calc.) est de 6.87; l'indice de réfraction (calc.), 2.23. La cesttibtantite possède une maille cubique, d'arête $a = 10.525(2)\text{\AA}$ et de composition $Cs_{0.24}(Sb_{0.60}Na_{0.36})(Ta_{1.51}Nb_{0.20}Fe_{0.01})(O,OH)_{6.00}$, soit, idéalement, $Cs_{0.3}(Sb,Na)(Ta,Nb)_2(O,OH)_6$. La kimrobinsonite, se présente en intercroissance intime avec cesttibtantite dans une pegmatite altérée; on la considère comme produit de décomposition d'un minéral de Ta-Sb, lequel pourrait être la stibiotantalite ou la cesttibtantite.

(Traduit par la Rédaction)

Mots-clés: kimrobinsonite, cesttibtantite, nouvelle espèce minérale, hydroxyde de tantale, Australie, pegmatite, altération aux intempéries.

INTRODUCTION

A friable mass of minerals about 15 cm in diameter was discovered by Mr. Kim Robinson while sinking

a shaft on a weathered pegmatite near Mt. Holland in Western Australia (Lat. $32^\circ 10'S$, Long $119^\circ 44'E$) prior to mining for rubellite. This material was subsequently found to consist largely of cesttibtantite and the new mineral species *kimrobinsonite*.

The weathered pegmatite and adjoining wallrock consist largely of montmorillonitic clay, together with substantial amounts of quartz, K-feldspar, lithium-bearing muscovite and tourmaline. Minor minerals include anthophyllite, phlogopite, apatite, cassiterite, ferrocolumbite, beryl, zircon, thorite, microlite, bismoclite, barite, manganotantalite, hafnon, cesttibtantite and kimrobinsonite.

According to Mr. Kim Robinson, the mass containing the two minerals had an overall shape of a skeletal crystal, and was found at a depth of about 14 metres. On being removed, the mass crumbled into small pieces, and the material delivered into the hands of the authors consisted of small fragments with a maximum diameter of about 5 mm. In polished section, the fragments are seen to consist of an irregular intergrowth of black and white phases, in places intermixed to give shades of grey (Fig. 1). The black phase is cesttibtantite, and the white phase is kimrobinsonite. Minor amounts of manganotantalite and an antimonial microlite occur as inclusions in the two main phases.

DESCRIPTION OF KIMROBINSONITE

Kimrobinsonite is white with a dull chalky lustre, and has a white streak. It is cryptocrystalline, and too fine grained for individual crystallites to be discerned under the optical microscope. The mineral is soft and friable; hardness determinations with a pyramidal indenter loaded with 20 g gave VHN 70, with a standard deviation of 12, on ten determinations. The specific gravity could not be determined because the mineral is too dense for sink-float methods, and not enough pure material could be picked for a reliable pycnometric determination. However, the density calculated from unit-cell volume and composition, assuming $Z = 1$, is 6.865 g/cm^3 .

Kimrobinsonite appears to be isotropic, as is to be expected with a cubic substance (see later). The index of refraction is considerably in excess of 2; a Gladstone-Dale calculation gives a calculated value of 2.23.

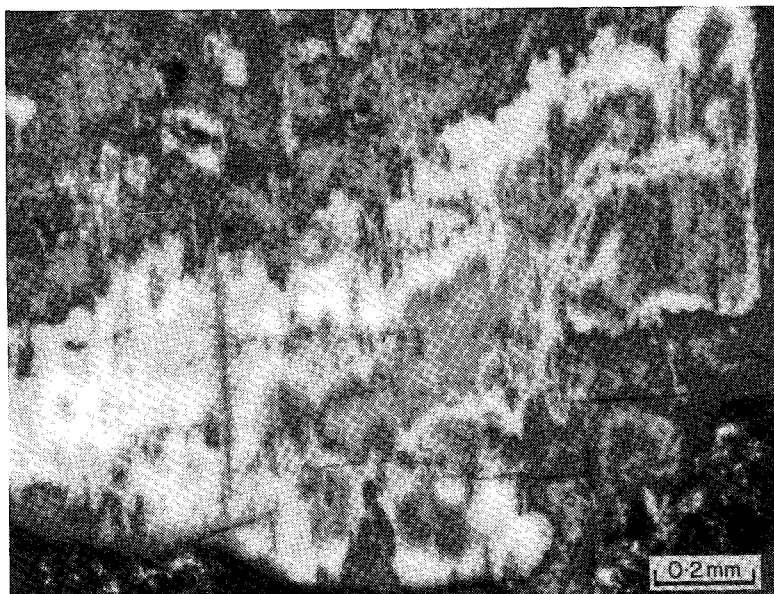


FIG. 1. Photomicrograph, in oblique illumination, of a cut surface of the kimrobinsonite-cesstibantite intergrowth. The kimrobinsonite is white, and the cesstibantite appears in various shades of grey.

The composition of kimrobinsonite was determined partly by electron microprobe and partly by CHN analyzer, the latter done by the Australian Microanalytical Service in Melbourne. The components with atomic number above 10 were determined on a MAC electron microprobe equipped with crystal spectrometers, and using the following standards: pure metals for Ta, Nb, Sb and Fe, and analyzed jadeite for Na. Corrections were made by means of the MAGIC IV computer program (Colby 1971). The analyses for C and H were done on several milligrams of hand-picked material by means of the CHN microanalysis procedure. Unfortunately, some contamination by cesstibantite could not be avoided in the sample submitted for CHN analysis, and so the H and C values obtained must be considered somewhat low.

TABLE 1. COMPOSITION OF KIMROBINSONITE

	Weight Percent			Atomic Proportions
	Detd.	Corr.*		
Na ₂ O	0.7	0.7	Na	0.05
FeO	0.4	0.4	Fe	0.01
Sb ₂ O ₃	0.7	0.7	Sb	0.01
Ta ₂ O ₅	78.5	78.5	Ta	0.82
Nb ₂ O ₅	6.6	6.6	Nb	0.11
H ₂ O	5.9	8.9	OH	2.27
CO ₂	2.8	4.2	CO ₃	0.22
	95.6	100.0	O	1.02

Results of microprobe analyses, except for H₂O and CO₂, which were determined by CHN microanalysis. Corrected composition assumes that the analytical shortfall is due entirely to H₂O CO₂ (see text).

The results of the analyses are shown in Table 1. The low summation is attributed to the low H and C values, and the analysis is therefore recalculated on this assumption. The calculated formula approximates (Ta, Nb)(OH)_{2.3}(CO₃)_{0.2}O, which can be written as (Ta,Nb)(OH)_{5-2x}(O,CO₃)_x, where *x* is about 1.2. If *x* can take the value of zero, then the ideal formula can be written as (Ta,Nb)(OH)₅, but it is not known whether that compound is stable without O²⁻ or CO₃²⁻.

Attempts were made to synthesize crystalline Ta(OH)₅, but without success. Tantalum hydroxide precipitates readily from aqueous solution (Cotton & Wilkinson 1966, p. 920), and we have been able to produce such a precipitate. However, the synthetic product is amorphous and does not give an X-ray-diffraction pattern; heating caused the synthetic product to decompose.

Single-crystal X-ray diffraction could not be done on kimrobinsonite because of the cryptocrystalline nature of the mineral. However, it gives a good X-ray powder-diffraction pattern corresponding to a primitive cubic lattice of the perovskite type. The measurements of the pattern, obtained from an 80-mm Guinier camera, using CuK α radiation and employing ThO₂ as an internal calibration standard, are given in Table 2. Except for a few very weak lines, one of which can be attributed to cesstibantite, the pattern is readily indexed on a cubic unit-cell with *a* 3.812 \pm 0.001Å.

TABLE 2. X-RAY POWDER DIFFRACTION PATTERN OF KIMROBINSONITE

Line No.	I est.	d meas.	d calc.	hkl
1	10	3.808	3.812	100
*2	<1	3.035	—	—
3	1	2.966	—	—
4	7	2.696	2.695	110
5	<1	2.409	—	—
6	2	2.202	2.201	111
7	<1	2.030	—	—
8	3	1.907	1.906	200
9	5	1.702	1.705	210
10	4	1.555	1.556	211
11	1	1.348	1.348	220
12	2	1.270	1.271	{221 {300
13	1	1.206	1.205	310
14	1	1.149	1.149	311
15	1	1.017	1.019	321
16	<1	0.952	0.953	400
17	1	0.923	0.924	410
18	1	0.897	0.898	330
19	<1	0.8736	0.8745	331
20	<1	0.8513	0.8524	420
21	1	0.8285	0.8318	421
22	<1	0.8113	0.8127	332

80-mm Guinier camera, TbO_3 internal standard, $CuK\alpha$ radiation. * This line corresponds to the strongest diffraction-line of cesstibtantite.

We have not been able to relate kimrobinsonite to any known mineral species, and a search of the literature failed to turn up a comparable artificial compound. There are data for various modifications of Ta_2O_5 , but none that are similar to kimrobinsonite. The only Ta compound that gives an apparently similar X-ray-diffraction pattern is one reported by Khitrova (1966) produced as a thin film on rock salt, and to which the composition $TaO_{0.82}$ was ascribed. The pattern, although not published in detail, is said to be cubic, of the perovskite type, and with an a of 3.87 Å.

The mineral is named after Mr. Kim Robinson of Perth who discovered the assemblage in which the mineral occurs. Both mineral and name have been approved by the I.M.A. Commission on New Minerals and Mineral Names. Type specimens have been deposited with the Government Chemical Laboratories of Western Australia, the National Museum of Victoria in Melbourne, the British Museum of Natural History, the Smithsonian Institution, and the Musée de Minéralogie de l'École des Mines in Paris.

NEW DATA ON CESSITBANTITE

Cesstibtantite was first described by Voloshin *et al.* (1981) from a granitic pegmatite in the Kola peninsula of the U.S.S.R. It was given the formula $(Cs,Na)SbTa_4O_{12}$ and was designated a member of the pyrochlore-microlite group. Crystallographic study of type material by Ercit and coworkers (in prep.) showed that the formula is more correctly expressed as $Cs_{0.3}(Sb,Na)(Ta,Nb)_2(O,OH)_6$. A second occurrence of cesstibtantite has been reported

TABLE 3. CHEMICAL COMPOSITION OF CESSITBANTITE FROM WESTERN AUSTRALIA AND U.S.S.R.

	Western Australia	U.S.S.R.*	Western Australia	U.S.S.R.	
K_2O wt. %	2.2	1.28	Ba	0.36	0.24
Ca_2O	6.5	6.95	Cu	0.24	0.28
CaO	—	0.04	Ca	—	0.01
PbO	—	1.08	Pb ²⁺	—	0.03
FeO	0.1	—	Fe ²⁺	0.01	—
Sb_2O_3	17.0	13.78	Sb ³⁺	0.60	0.54
Bi_2O_3	—	0.75	Bi ³⁺	—	0.02
Ta_2O_5	65.9	72.81	Ta	1.51	1.89
Nb_2O_5	5.1	2.54	Nb	0.20	0.11
** H_2O	1.9	0.45	OH	1.06	0.29
	99.1	99.38	O	4.94	6.00

Electron-microprobe data. * From Voloshin *et al.* 1981. ** H_2O calculated from OH required for electrostatic neutrality.

from the Tanco pegmatite in Manitoba (Ercit & Černý 1982).

The chemical composition of the cesstibtantite associated with the kimrobinsonite is shown in Table 3, together with one of the compositions given by Voloshin *et al.* (1981). Our analysis was made by electron microprobe using the same procedure outlined for kimrobinsonite, except for Cs, which was determined by an energy-dispersion spectrum-stripping procedure (Ware 1982), since no suitable Cs standards were available. The compositions of the cesstibtantite from the two occurrences are quite similar, the major difference being in the higher Sb_2O_3 and lower Ta_2O_5 values obtained for the sample from Western Australia.

The samples from the two localities also give essentially the same X-ray-diffraction patterns, both being cubic, the one from the U.S.S.R. having a 10.526 ± 0.005 Å, and the one from Western Australia, 10.525 ± 0.002 Å.

In appearance, however, the two specimens of cesstibtantite are entirely dissimilar. The U.S.S.R. material is reported to be transparent and ranges between colorless and grey. By contrast, the Western Australian mineral is black and opaque, except in the very thinnest particles. This different appearance may be due to differences in the manner in which the minerals were formed. The U.S.S.R. cesstibtantite is attributed to a mineralizing episode related to albitization of the pegmatite (Voloshin *et al.* 1981), whereas the Australian mineral is apparently the product of weathering.

DISCUSSION

The kimrobinsonite and cesstibtantite are evidently decomposition products resulting from the weathering of a large crystal of an unknown mineral or minerals. A mineral that might have served as a primary precursor of this mixture is stibiotantalite $SbTaO_4$, which occurs in Ta-Sb-bearing pegmatites, but its replacement by the present assemblage requires a substantial increase of the Ta:Sb ratio, which implies a loss of Sb from the original crystal. At present there is insufficient evidence to prove or

disprove this suggestion, and the possibility of some other precursor cannot therefore be excluded. Perhaps the resolution of this problem will have to await deeper excavation of the weathered pegmatite and exposure of the unaltered equivalent of this mineral assemblage.

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