

# Tantal-aeschnite, a new mineral of the aeschnite group from the Borborema region, north-eastern Brazil

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**SUMMARY.** Tantal-aeschnite occurs as idiomorphic metamict crystals in the Raposa pegmatite at São José do Sabugí, Paraíba State, NE. Brazil. Morphological data, microscopic properties, and differential thermal analysis results are given. Electron-microprobe analyses yielded a formula:  $\{Ca_{0.28}(Yt,Ln)_{0.425}(Th,U)_{0.11}\}(Ta_{0.75}Ti_{0.62}Nb_{0.595}Fe_{0.05})O_6$ . Yttrium is the predominant rare-earth element, with cerium and neodymium as most abundant lanthanides. The tantal-aeschnite unit cell has (after heating)  $a$  5.34,  $b$  10.97,  $c$  7.38 Å. An indexed X-ray powder pattern (similar to that of aeschnite) is presented.

SEVERAL metamict minerals have already been described from north-eastern Brazil by Rolff (1946) and Adusumilli and Rao (1962). The first author of the present paper is undertaking a general study of the metamict minerals from this region, which is known as the Borborema region. In connection with this work she received from Mr. Luizhélío Barreto (Escola de Agronomia, Areias, Paraíba State) a number of crystals from the Raposa pegmatite in the municipality of São José do Sabugí, Paraíba State. The crystals proved to be metamict. Combined X-ray diffraction (after heating) and electron-microprobe analysis made it possible to identify the material as a new mineral of the aeschnite group. The name tantal-aeschnite (for the composition) has been approved before publication by the Commission on New Minerals and Mineral Names of the International Mineralogical Association. It must be remarked that the name tantal-aeschnite has erroneously been applied by Kornetova *et al.* (1963) to an aeschnite with atomic ratios  $Ti:Ta:Nb = 0.89:0.565:0.525$ , which consequently should have been called tantalian aeschnite.

A first note on the Brazilian tantal-aeschnite has been published by the first author (Adusumilli, 1968). Type locality material is preserved at the Department of Geosciences, University of Brasilia, and at the Institute of Earth Sciences, Free University, Amsterdam. In both institutes the specimens are labelled NT-52.

*Occurrence.* The Raposa pegmatite has never been described or mentioned in the literature. According to the collector of the crystals of tantal-aeschnynite it is a homogeneous pegmatite of considerable length, but its width is only about 50 cm. The pegmatite is enclosed in the Seridó mica-schists. Mineralogically it consists of quartz, strongly red-coloured microcline, biotite, small crystals of titanomagnetite (?), columbite, beryl, and tantal-aeschnynite.

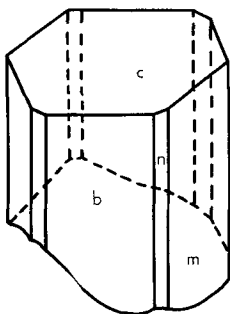


FIG. 1. Crystal drawing of tantal-aeschnynite NT-52, with forms  $c\{001\}$ ,  $b\{010\}$ ,  $m\{110\}$ , and  $n\{130\}$ ; about  $\times 1.5$ .

*Macroscopic properties.* Tantal-aeschnynite occurs as idiomorphic prismatic crystals showing a typical orthorhombic morphology. Specimen NT-52, which attained the dimensions  $56 \times 31 \times 20$  mm, was used for further study.

Study by reflection goniometer is difficult because of the size of the crystals and the weak lustre of the crystal faces, which, moreover, are corroded. In spite of the poor precision of the measured interfacial angles identification of the following forms was possible: pinacoids  $\{010\}$  and  $\{001\}$ , the last only represented by the face  $(001)$ , and the prisms  $\{110\}$  and  $\{130\}$  (fig. 1).

The mineral shows a brownish-black to black colour, conchoidal fracture, and resinous lustre; the streak is light yellowish-brown; Mohs hardness  $5\frac{1}{2}$  to 6.

The specific gravities of some fragments of NT-52 were determined by means of a Berman balance. Polished sections of the mineral showed that tantal-aeschnynite contains veinlets of an unidentified mineral, thus making any determinations subject to a certain degree of error. The values obtained ranged from 5.75 to 6.13. These values are appreciably below the specific gravity calculated from the chemical analysis and the unit cell (6.39), a discrepancy that may reasonably be attributed to the mineral forming the above-mentioned veinlets and to the metamict state of tantal-aeschnynite. The calculated specific gravity of tantalian aeschnynite from Siberia is 5.87 (Kornetova *et al.*, 1963), while that of aeschnynite ranges from 4.9 to 5.3 (Aleksandrov *et al.*, 1964).

*Microscopic properties.* In thin section tantal-aeschnynite is transparent showing a yellowish-orange colour. In polished section the mineral shows a dark grey colour in oil immersion with abundant internal reflections: white, yellowish-orange, dark red. The mineral is isotropic due to metamictization.

Micro-indentation hardness (VHN) was measured with a Leitz Durimet-Pol applying a load of 100 g during 15 sec;  $VHN_{100}$  of tantal-aeschnynite: 657–673 kg/mm<sup>2</sup> (mean minimum and maximum values of fifteen indentations). Kornetova *et al.* (1963) obtained a mean VHN of 764 kg/mm<sup>2</sup> on tantalian aeschnynite. The VHN-range for aeschnynite specimens from the Urals is 593–734 kg/mm<sup>2</sup> (Aleksandrov *et al.*, 1964).

The reflectance was measured with the Leitz MPV microscope photometer at the four standard wave-lengths, using as a standard carborundum NPL.N.2538.30. The reflectance of the mineral is 14.5 % (470 nm), 14.2 % (546 nm), 14.0 % (589 and 650 nm).

The differential thermal analysis curve of tantal-aeschnynite was established using

a portable Eberbach apparatus with a heating rate of 20 °C per minute. The curve shows a sharp exothermic peak at 740 °C, which is also characteristic for aeschynite (Kerr and Holland, 1951). The exothermic effect is due to crystallization of the mineral (Aleksandrov *et al.*, 1964).

TABLE I. *Chemical composition and atomic ratios of tantal-aeschynite and tantalian aeschynite, and composition of rare-earth elements*

	1	2		1a	2a		1b	2b
CaO	6.2	4.01	Ca	0.467	0.278	La	7.9	2.9
SrO	—	0.30	Sr	—	0.011	Ce	22.4	20.1
FeO	—	0.77	Fe <sup>2+</sup>	—	0.056	Pr	3.6	6.6
Fe <sub>2</sub> O <sub>3</sub>	0.9	0.28	Fe <sup>3+</sup>	0.048	—	Nd	11.2	19.6
Al <sub>2</sub> O <sub>3</sub>	—	1.03	Al	—	0.079	Pm	—	—
La <sub>2</sub> O <sub>3</sub>	1.3	0.68	La	0.034	0.016	Sm	3.4	10.8
Ce <sub>2</sub> O <sub>3</sub>	3.7	4.76	Ce	0.095	0.113	Eu	—	0.6
Pr <sub>2</sub> O <sub>3</sub>	0.6	1.56	Pr	0.015	0.037	Gd	3.3	8.5
Nd <sub>2</sub> O <sub>3</sub>	1.9	4.76	Nd	0.048	0.110	Tb	—	1.1
Sm <sub>2</sub> O <sub>3</sub>	0.6	2.72	Sm	0.014	0.061	Dy	2.1	3.9
Eu <sub>2</sub> O <sub>3</sub>	—	0.16	Eu	—	0.003	Ho	—	0.4
Gd <sub>2</sub> O <sub>3</sub>	0.6	2.22	Gd	0.014	0.048	Er	2.1	0.9
Tb <sub>2</sub> O <sub>3</sub>	—	0.29	Tb	—	0.006	Tm	—	—
Dy <sub>2</sub> O <sub>3</sub>	0.4	1.04	Dy	0.009	0.022	Yb	3.5	0.5
Ho <sub>2</sub> O <sub>3</sub>	—	0.11	Ho	—	0.002	Lu	—	0.1
Er <sub>2</sub> O <sub>3</sub>	0.4	0.25	Er	0.009	0.005	Yt	40.5	24.0
Yb <sub>2</sub> O <sub>3</sub>	0.7	0.14	Yb	0.015	0.003			
Lu <sub>2</sub> O <sub>3</sub>	—	0.05	Lu	—	0.001			
Yt <sub>2</sub> O <sub>3</sub>	4.6	3.92	Yt	0.172	0.135			
SiO <sub>2</sub>	—	0.25	Si	—	0.016			
TiO <sub>2</sub>	11.7	18.22	Ti	0.619	0.888			
ThO <sub>2</sub>	6.5	1.31	Th	0.104	0.019			
UO <sub>2</sub>	0.4	—	U	0.006	—			
Nb <sub>2</sub> O <sub>5</sub>	18.7	17.87	Nb	0.595	0.524			
Ta <sub>2</sub> O <sub>5</sub>	39.3	32.13	Ta	0.752	0.566			
H <sub>2</sub> O <sup>+</sup>	—	1.05	Σ	3.016	2.999			
H <sub>2</sub> O <sup>-</sup>	—	0.09	O	6.000	—			
Total	98.5	99.97	(O, OH)	—	6.349			

1. Tantal-aeschynite NT-52, Brazil. Electron-microprobe analysis by C. Kieft.

2. Tantalian aeschynite, Siberia. Wet chemical analysis by M. E. Kazakova.

1a, 2a. Atomic ratios to 6 oxygen and 3 cations respectively.

1b, 2b. Composition of rare-earth elements, atoms %.

*Chemical composition.* Analyses have been carried out by the second author with a Cambridge Geoscan electron-microprobe; the electron excitation potential was 20 kV. The standards used were: wollastonite for Ca, lueshite for Nb, uraninite for U, synthetic TiO for Ti, synthetic CeO for Ce, synthetic ThF<sub>4</sub> for Th, and pure elements for Fe, Ta, La, Pr, Nd, Sm, Gd, Dy, Er, Yb, and Yt.

After the usual corrections for background and dead time the rough percentages were corrected with a computer programme by Springer (1967). This programme has been slightly modified; deviations from the Springer programme are mass absorption

coefficients from Heinrich (1966) and  $J/Z$  factors in the stopping power correction from Duncumb and Reed (1968).

The corrected weight percentages (average of five analyses) are given in Table I, along with the wet chemical analysis of tantalian aeschynite from Siberia by Kor-netova *et al.* (1963). The crystallochemical formula of tantal-aeschynite was calculated on the basis of six oxygen atoms in one-fourth of the orthorhombic unit cell:  $\{Ca_{0.47}(Yt,Ln)_{0.425}(Th,U)_{0.11}\}_{1.005}(Ta_{0.75}Ti_{0.62}Nb_{0.595}Fe_{0.05})_{2.015}O_6$ . Kor-netova *et al.* (1963) derived two formulae from their analysis; one of them is on the basis of  $A = 1$  and  $B = 2$ , with Al and all Fe in the  $A$  position:  $\{Ca_{0.28}(Yt,Ln)_{0.56}Sr_{0.01}Fe_{0.055}Th_{0.02}Al_{0.08}\}_{1.005}(Ti_{0.89}Ta_{0.565}Nb_{0.525}Si_{0.015})_{1.995}\{O_{5.89}(OH)_{0.46}\}_{6.35}$ .

It is evident that the Siberian material, having atomic ratios  $Ti:Ta:Nb = 0.89:$

$0.565:0.525$ , should have been called tantalian aeschynite as titanium is the predominant element in the  $B$  position. The Brazilian specimen NT-52 is the first material having an aeschynite-structure with tantalum as pre-dominant element in the  $B$  position ( $Ti:Ta:Nb = 0.62:0.75:0.595$ ). Instead of proposing an entirely new name it was decided to use the now accepted name *tantal-aeschynite* for the mineral.

The compositions of the rare-earth elements, expressed in atoms per 100 (Yt,Ln), are included in Table I. Since yttrium is the predominant rare-earth element in both tantal-aeschynite and tantalian aeschynite, the species names for the two minerals, following Levin-

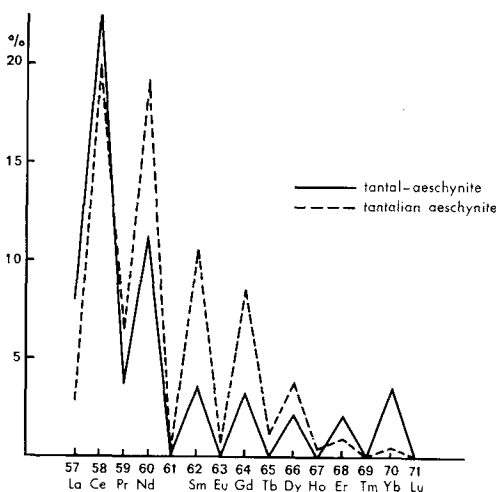


FIG. 2. Composition of lanthanide elements in tantal-aeschynite and tantalian aeschynite.

son (1966), are tantal-aeschynite-(Y) and tantalian aeschynite-(Y). Fig. 2 gives the composition of the lanthanide elements (atomic number 57 to 71); the distribution of these elements in the two minerals is similar, and conforms to Oddo and Harkins's rule, the alternation of high and low abundances of the even- and odd-numbered elements.

*X-ray data.* Although the mineral exhibits an idiomorphic shape, tantal-aeschynite proved to be completely amorphous to X-rays. The powdered sample was heated in air and nitrogen at 700 °C for 3 hours, at 1000 °C for one hour, and finally at 1300 °C for one hour.

X-ray powder diffraction diagrams were obtained by the first author at the Labora-tória de Técnicas Físico-Químicas in Lisbon. A Straumanis-type 114.83 mm diameter Debye-Scherrer camera was used with Ni-filtered Cu-radiation and one hour exposure. The powder patterns of the mineral heated at the different temperatures are essen-tially the same, and are similar to the pattern of aeschynite (Powder Diffraction File

TABLE II. X-ray powder diffraction data for tantal-aeschnynite NT-52. *I* estimated. Mineral heated at 1300 °C in air

<i>hkl</i>	<i>I</i>	<i>d</i> <sub>obs</sub>	<i>d</i> <sub>calc</sub>	<i>hkl</i>	<i>I</i>	<i>d</i> <sub>obs</sub>	<i>d</i> <sub>calc</sub>	
020	< 1	5.45 Å	5.49 Å	230	1	2.15 Å	2.16 Å	
—	2	4.75	—	231	< 1	2.06	2.07	
021	2	4.40	4.40	222	2	2.00	2.01	
111	1	4.01	4.03	151	2	1.96	1.96	
120	< 1	3.82	3.83	133	3	1.91	1.91	
002	3	3.71	3.69	004	4	1.86	1.84	
022	2	3.09	3.06	—	1	1.81	—	
130	10	3.00	3.02	061	< 1	1.78	1.77	
112	10	2.94	2.93	301	< 1	1.73	1.73	
131	2	2.80	2.79	242	5	1.70	1.70	
—	1	2.75	—	062	1	1.64	1.64	
200	5	2.65	2.67	330	7	1.581	1.602	
041	2	2.57	2.57	312				1.588
140	1	2.44	2.44	134				1.574
221	2	2.33	2.28	252	3	1.52	1.540	
103	1	2.26	2.23	322				1.540
042	3	2.21	2.20	plus 24 additional weak peaks to 0.921 Å				

TABLE III. Unit cell dimensions of minerals of the aeschnynite-group

	<i>a</i>	<i>b</i>	<i>c</i>	<i>a:b:c</i>
Tantal-aeschnynite NT-52, Brazil	5.34 Å	10.97	7.38	0.487:1:0.673
Tantalian aeschnynite, Siberia	5.308	10.983	7.463	0.4833:1:0.6795
Non-metamict aeschnynite, Urals	5.38	11.08	7.56	0.486:1:0.682

card 11-627). The pattern of tantal-aeschnynite heated at 1300 °C in air is given in Table II. The same pattern has been used to calculate the dimensions of the orthorhombic unit cell by the least squares method. The unit cell dimensions (accuracy  $\pm 0.02$  Å) are given in Table III along with the dimensions of tantalian aeschnynite (Kornetova *et al.*, 1963) and non-metamict aeschnynite from the Urals (Zhabin *et al.* 1962).

*Acknowledgements.* The authors wish to thank Dr. J. Lima de Faria, Lisbon, for guidance and assistance during the X-ray work; Dr. P. Zwaan, National Geology and Mineralogy Museum, Leiden, The Netherlands, for determination of the specific gravity; Mr. Luizhélío Barreto, Areias, Paraíba State, for providing the specimens; Dr. M. Fleischer, U.S. Geological Survey, Washington, for information on tantalian aeschnynite. The work by the first author in Lisbon took place under the auspices of the Calouste Gulbenkian Foundation; a visit to Amsterdam was made possible by the National Research Council of Brazil.

## REFERENCES

- ADUSUMILLI (M. S.), 1968. *Jorn. Min. (Recife)*, **6**, 11-25.  
 — and RAO (A. B.), 1962. *Arquiv. Geol. Univ. Recife*, **2**, 1-9.

- [ALEKSANDROV (V. B.), ESKOVA (E. M.), and ZHABIN (A. G.)] Александров (В. Б.), Ескова (Е. М.) и Жабин (А. Г.), 1964. In: [VLASOV (K. A.)] Власов (К. А.), Геохимия, минералогия и генетические типы месторождения редких элементов. Том. II. Минералогия редких элементов. Москва. Translated 1966 as *Geochemistry and mineralogy of rare elements and genetic types of their deposits*. Vol. II. *Mineralogy of rare elements*. Jerusalem (Israel Program for Scientific Translations).
- DUNCUMB (P.) and REED (S. J. B.), 1968. *N.B.S. Spec. Publ.* No. 298, 133-54.
- HEINRICH (K. F. J.), 1966. In *The Electron Microprobe*, 296-378.
- KERR (P. F.) and HOLLAND (H. D.), 1951. *Amer. Min.* **36**, 563-72.
- [KORNETOVA (V. A.), ALEKSANDROV (V. B.), and KAZAKOVA (M. E.)] Корнетова (В. А.), Александров (В. Б.) и Казакова (М. Е.), 1963. Труды мин. муз. Акад. наук СССР (*Proc. Min. Mus. Acad. Sci. USSR*), **14**, 108-21. Refer. in: *Handb. Min.*, C. HINTZE, *Ergänzungsband III*, 1968, 317-18.
- LEVINSON (A. A.), 1966. *Amer. Min.* **51**, 152-8.
- ROLFF (P. A. M. A.), 1946. *Boletim DFPM*, **78**, 23-78.
- SPRINGER (G.), 1967. *Fortschr. Min.* **45**, 103-24.
- [ZHABIN (A. G.), ALEKSANDROV (V. B.), KAZAKOVA (M. E.), and FEKLIЧEV (V. G.)] Жабин (А. Г.), Александров (В. Б.), Казакова (М. Е.), и Фекличев (В. Г.), 1962. Докл. Акад. наук СССР (*Compt. Rend. Acad. Sci. URSS*), **143**, 686-9 (English trans. *Dokl. Acad. Sci. USSR (Earth Sci. Sect.)*, 1964, **143**, 86-9).

[Manuscript received 9 February 1973]