

*Lewisite and Zirkelite, two new Brazilian Minerals.*

By Dr. E. HUSSAK,  
Of the Geological Survey of S. Paulo,

AND

G. T. PRIOR, M.A., F.G.S.  
Assistant in the Mineral Department of the British Museum.

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I. LEWISITE.

THIS new antimonate was found in the cinnabar mine of Tripuhy, near Ouro Preto, Minas Geraes, Brazil.

The occurrence of cinnabar at this locality has been known since 1810, and a short notice of it is given by Eschwege in his *Pluto Brasilensis*, p. 456, which was published in 1833.

Some three years ago work of a prospecting character was undertaken by the Companhia Mineralogica under the direction of the mining engineer, F. P. de Oliverra, and, by his invitation, one of us had an opportunity of examining the locality and making a collection of its minerals. The cinnabar, which had previously only been known to occur in rolled fragments up to the size of a pea, was found in small quartz veins, in a metamorphic mica-schist.

The small hill, to which the cinnabar is confined, consists of argillaceous mica-schist passing into hæmatite-mica-schist (itabirite): in places the rock contains much iron-pyrites altered to limonite, and is cut by a dyke a few metres wide of diabase-porphyrity. The slope of the hill is covered with a thick bed of gravel containing numerous fragments of cinnabar up to the size of a fist. This gravel, on washing with the batea, affords a residue of fine heavy sand consisting mainly of cinnabar and specular iron, but containing also a variety of other interesting minerals.

Lewisite is one of the minerals found in this heavy sand.

*Physical Characters.*

The mineral is cubic, and occurs in small (seldom exceeding a millimetre in greatest diameter) perfect octahedra without modification. A measurement of the octahedral angle gave  $109^{\circ} 22'$ . Twinning according to (111) is rare. The mineral is isotropic, and has a fairly perfect octahedral cleavage.

Colour, honey-yellow to colophony brown; streak, light yellowish-brown; translucent; lustre, vitreous to resinous.

Hardness, 5.5; not brittle.

Density (weight of 1 cc.), 4.950 at  $18^{\circ} \text{C.}$ , as determined on 0.9784 gr.

Under the microscope some of the crystals were seen to be filled with small, colourless, doubly-refracting grains and scales of mica, extending in part beyond the crystal faces, and also with exceedingly fine yellow needles (rutile?) and isolated gas pores.

Occasionally the crystals show a thin, sulphur yellow, pulverulent decomposition crust, and the same alteration product may be seen on the cleavage surfaces and in cavities in the centre of the crystals.

*Chemical Characters.*

In the Bunsen flame the mineral fuses somewhat readily on the edges, and gives a greenish-blue colour to the flame. The microcosmic bead in the reducing flame is yellow while hot, violet when cold. The mineral is insoluble in acids, is decomposed by fusion with sodium carbonate, and is easily reduced by heating to low redness in hydrogen.

*Method of Analysis.*

The analysis was made on material freed as far as possible by careful selection under the lens from crystals showing alteration or inclusions.

The finely-powdered mineral, dried at  $110^{\circ}$ , was reduced in a current of hydrogen. No fluorine could be detected in the sodium carbonate plug which was placed at the end of the combustion tube. The material after reduction was digested in aqua regia, to which tartaric acid was added, and the solution was filtered off from some insoluble siliceous impurity (6.37 per cent.), the weight of which in the calculation of the analysis was deducted from the weight of material taken. The antimony was precipitated by sulphuretted hydrogen, and weighed as black sulphide after heating in carbonic acid. After weighing, the precipitate was fused with sodium carbonate and sulphur, and a little titanate acid was separated. No lead could be detected. The filtrate from the sulphide of antimony was made alkaline with ammonia, and a portion of the calcium which came down as tartrate was collected, ignited, re-dissolved, and finally

precipitated by ammonium oxalate. The iron and manganese were precipitated by ammonium sulphide, and the titanium, after the destruction of the tartaric acid, by a double precipitation with ammonia. In the filtrate the calcium and alkalis were determined in the usual way. 0.0982 gr. of the mineral was tested for fluorine by fusing with sodium carbonate and finally precipitating with calcium chloride. The precipitate dissolved to a clear solution in water acidified with acetic acid; and although a very slight residue, insoluble in water, was obtained on evaporating to dryness and treating with water, no fluorine could be detected in it by the microchemical barium silico-fluoride test.

*Result of Analysis.*

	I.	II.	Calculated for 5CaO, 3Sb <sub>2</sub> O <sub>5</sub> , 2TiO <sub>2</sub> III.
Sb <sub>2</sub> O <sub>5</sub>	67.52	65.52	68.42
TiO <sub>2</sub>	11.85	11.70	11.70
CaO	15.98	15.47	19.88
FeO	4.55	6.79	—
MnO	0.38	—	—
Na <sub>2</sub> O	0.99	1.06	—
	<hr/> 100.72	<hr/> 100.54	<hr/> 100.00

Analysis I. was made on 0.5429 gr. of material dried at 110°.

Under II. is given the result of a preliminary analysis made on 0.2259 gr. of a different sample of material, which had been ignited.

The numbers under I. correspond approximately to the formula 5RO, 3Sb<sub>2</sub>O<sub>5</sub>, 2TiO<sub>2</sub>, or 3(RO, Sb<sub>2</sub>O<sub>5</sub>), 2(RO, TiO<sub>2</sub>), the calculated percentages for which are given under III.

The mineral is thus a titano-antimonate of calcium and iron, related on the one side to the calcium titanate perovskite, and on the other to the calcium antimonates atopite and romeite; it may also be said to be connected with the pyrochlore group of minerals, with antimonie acid replacing niobic acid.

At the time when the above analyses were made, no mineral of similar composition had been described, but in the last number of the Journal of the Geological Society of Stockholm (*Geol. Fören. Förhand. Stockholm*, XVII. (1895), pp. 313-18) there appears an account by Prof. H. Sjögren of what proves to be a very closely allied mineral, a new titano-antimonate from Jakobsberg, to which he has given the name Mauzeliite. It is iso-

metric, of brown colour, with specific gravity 5.11, and has the following chemical composition :—

Sb <sub>2</sub> O <sub>3</sub>	...	...	59.25
TiO <sub>2</sub>	...	...	7.93
PbO	...	...	6.79
FeO	...	...	0.79
MnO	...	...	1.27
CaO	...	...	17.97
MgO	...	...	0.11
K <sub>2</sub> O	...	...	0.22
Na <sub>2</sub> O	...	...	2.70
H <sub>2</sub> O	...	..	0.87
F	...	...	[8.63]
			101.53
— O for F			1.53
			100

The composition of the two minerals is thus very similar, but the larger amount of iron and the absence of lead and fluorine serve to distinguish the Brazilian mineral from the Mauzeliite.

We have given the name of Lewisite to this new titano-antimonate from Brazil in honour of Prof. W. J. Lewis, during whose tenure of office the study of Mineralogy in the University of Cambridge has been so much encouraged.

Besides the Lewisite, in the heavy sand derived from the washing of the gravel from the small hill at Tripuhy were found the following minerals :—

(1.) Xenotime occurring sparingly in elongated prismatic crystals from 2 to 3 mm. in length, showing the combination {110} and {111}, and more rarely extremely small and narrow faces {331} and {311}. The crystals are translucent and of wine-yellow colour, and have a very distinct prismatic cleavage. A measurement on one of the crystals of the pyramid angle (111 :  $\bar{1}\bar{1}1$ ) gave 82° 12'.

In form and appearance the xenotime crystals strongly resemble those of the diamond sand of Dattas, near Diamantina.

(2.) Monazite is fairly abundant in light sulphur-yellow and yellowish-brown crystals, from 1 to 2 mm. in length. Two types of crystalline

form were distinguished: (a) tabular parallel to  $a(100)$ , resembling turnerite, of yellowish brown colour, completely transparent, and free from inclusions; (b) prismatic by extension of  $v(\bar{1}11)$ , like the crystals from Alexander Co., N.C., of sulphur-yellow colour, and rich in inclusions of magnetite grains.

The following angles were measured on these crystals:—

	(a.) TURNERITE TYPE.		(b.) ALEXANDER CO. TYPE.
	Measured.	Calculated (Des Cloizeaux). <sup>1</sup>	
$al$	25° 4'	25° 14'	...
$an$	61° 38'	62° 4'	...
$bn$	28° 36'	27° 56'	...
$bv$	54° 2'	53° 22'	...
$bu$	30° 6'	29° 11'	...
$be$	48° 31'	48° 10'	...
$ar$	49° 16'	48° 3'	...
$ae$	80° 58'	79° 47'	...
$av$	61° 34'	61° 41'	61° 30'
$ac$	80° 24'	79° 47'	...
$aw$	39° 22'	39° 17'	39° 17½'
$rv$	...	73° 16'	73° 11'

The letters are those used in *Dana's Mineralogy* (6th ed.), p. 750, figs. 3-7.

Of the crystals of the turnerite type, only one very rich in faces was found suitable for measurement, and this, in spite of its favourable appearance, gave, on account of the imperfect development of the faces, great variations in the angles. This crystal showed the combination:  $a(100)$  predominant,  $b(010)$  tolerably broad faces,  $n(120)$ ,  $l(210)$ ,  $v(\bar{1}11)$ ,  $r(111)$ ,  $e(011)$ ,  $u(021)$ ,  $w(101)$ ,  $x(\bar{1}01)$ . The sulphur-yellow crystals of the Alexander Co. type were very poor in faces, appearing for the most part as monosymmetric prisms with end-faces of the combination  $v(\bar{1}11)$  and  $a(100)$ . Other combinations observed were:  $v, a, w$ ;  $v, a, w, x$ ;  $v, a, w, x, b$ .

(3.) Zircon: very rare, in small prismatic crystals of a wine-yellow colour.

(4.) Kyanite: very abundant, in transparent colourless to dark grey tabular crystals of the thickness of a sheet of paper. The crystals often become opaque from included grains. Of especial interest is the not in-

frequent occurrence of geniculated contact- and penetration-twins, precisely agreeing with those first described by Kenngott, and later by M. Bauer, with the face  $y(\bar{1}\bar{2}1)$  as twinning plane. Measurements of the angle  $M:M$  on three crystals gave  $62^\circ 46'$  to  $62^\circ 56'$ , agreeing very closely with the value calculated by Bauer. (Compare also Hintze, *Mineralogie*, p. 160, fig. 63.)

(5.) Tourmaline: rare, in microscopic dark brown prisms, mostly broken.

(6.) Rutile: tolerably abundant, in prismatic crystals from 1-3 mm. in length, for the most part tabular parallel to one of the prism faces, and then also often with two faces of the pyramid  $s(111)$  prominently developed, so as to give an apparently monosymmetric character. The minute crystals are very rich in faces; the observed forms were:  $a(100)$ ,  $m(110)$ ,  $l(310)$ ,  $s(111)$ ,  $e(101)$ ,  $t(313)$ ; twinning, according to  $e(101)$  and  $v(301)$ , very frequent.

(7.) Hämatite: with quartz and muscovite forms the principal part of the heavy residue of the gravel. Well formed crystals of the combinations  $c$ ,  $r$ ,  $n$ , and  $c$ ,  $m$ ,  $a$  occur, and show a distinct polysynthetic twinning striation according to  $r$ , along which the crystals part readily.

(8.) Iron-pyrites: tolerably abundant, in crystals rarely exceeding a millimetre in greatest diameter, and always altered to dark brown limonite. The crystals show the combination  $e(210)$ ,  $a(100)$ ,  $o(111)$ .

(9.) Magnetite: very abundant, in very small octahedral crystals, rarely altered to martite.

(10.) Gold: very rare, in thin compressed flakes.

(11.) Finally, from this locality we have a new titanio-antimonate of iron, the composition of which has not yet been accurately determined owing to lack of material.

The mineral occurs in extremely slender and very fragile hexagonal prisms, about 2 mm. long, of a resinous black colour, on which as terminal faces only the base has thus far been observed, since the slender needles are almost invariably broken and show a conchoidal fracture.

The crystals appear to be rhombic, the mean of several measurements of the remarkably lustrous prism faces over (010) being  $91^\circ 58\frac{1}{2}'$ . In combination with the prism is almost always the macropinacoid  $\{100\}$ , parallel to which the crystals are often tabularly developed. The rare basal face is arched and rough, so that no measurements could be made.

On account of the friability of the mineral, no optically orientated sections could be prepared, so that the reference to the rhombic system is not beyond doubt. In thin splinters the mineral is translucent, with a

dark brown colour; it is optically biaxial, with strong double refraction. It has a well developed conchoidal fracture without distinct cleavage. A rare twinning intergrowth according to a brachydome face, by which two prisms flattened along  $a(100)$  cross at an angle of  $60\frac{1}{2}^\circ$  (measured under the microscope), is noteworthy. The density (weight of 1 cc.) was 4.529 at  $22^\circ$  C. as determined on 0.1121 gr.

The result of a qualitative and partially quantitative analysis, made on 0.0761 gr. of material, showed the presence of oxide of antimony with FeO (about 40 per cent.) and  $TiO_2$  (about 17 per cent.).

Of the above minerals, the three first, xenotime, monazite and zircon, presumably come from rocks of a granitic character, for O. A. Derby (*Am. Jour. Sci.* XXXVII. p. 109 and XLI., p. 308) has shown that these minerals, particularly xenotime and monazite, are very characteristic of certain types of granite.

A search for exposures of granite in the vicinity, however, proved fruitless.

The other minerals are undoubtedly derived from the argillaceous mica-schist which passes into itabirite.

The state of preservation of the above minerals from the gravel warrants the conclusion that they have not suffered long transportation, but have been deposited close to their place of origin as the gravel, derived from the weathering of the schist and the included quartz veins, was formed. The crystalline form of all is well preserved, even the cinnabar fragments presenting sharp angles. The Lewisite probably comes, like the cinnabar and gold, from the quartz veins.

The occurrence of antimonates with gold has already been observed by Dr. J. C. da Costa Sena at Sao Bartholomeu, near Ouro Preto, only a few miles distant from Tripuhy.

## II. ZIRKELITE.

A new calcium zirconate and titanate.

This mineral was found with baddeleyite, perovskite, etc., in the decomposed magnetite-pyroxenite of Jacupiranga, S. Paulo, Brazil.

A brief preliminary notice of it has already been given by one of us in a paper describing the new zirconia mineral baddeleyite and its associated minerals (*Tschermak's Min. u. Pet. Mitth.* XIV. pp. 408-10).

### *Physical Characters.*

Crystal system, cubic, the only observed form being  $o(111)$ . The crystals are always flattened parallel to an octahedral face, and are

deeply striated parallel to the same face in virtue of polysynthetic twinning. Twinning according to  $o(111)$  is very common, the forms being simple spinel-like types and complicated fourlings.

The cubic faces show by their striation the intergrown octahedra, and are truncated by brilliant octahedral faces. Cleavage, none; fracture, distinctly conchoidal; lustre, resinous; colour, black; opaque, except in very thin splinters, which are translucent with a dark brown colour, and isotropic; colour of powdered mineral, dark brownish-black, non-magnetic except when containing included grains of magnetite.

Density (weight of 1 cc.) = 4.706 at 18°, as determined on 0.5287 gr. hardness, 5.5; brittle.

#### *Chemical Characters.*

Heated in closed tube, unaltered; before the blowpipe fuses with difficulty on the edges; insoluble in acids; decomposed by fusion with acid sulphate of potassium.

#### *Method of Analysis.*

The finely powdered mineral was fused with acid sulphate of potassium, and the melt dissolved in cold water. Owing to the peculiar behaviour of titanous acid when mixed with zirconia, the former was not precipitated by boiling the dilute solution. The titanous acid, zirconia, and iron were therefore precipitated together by ammonia, the precipitate re-dissolved, and re-precipitated. In the filtrate the calcium and magnesium were determined by the usual methods. The zirconia and titanous acid were separated from the iron by precipitation with sodium thiosulphate. The separation of the zirconia and titanous acid was attempted by a combination of the hydrogen peroxide method of G. H. Bailey (*Jour. Chem. Soc. 1886, Trans. XLIX. pp. 149, 481*) and the acetic acid process of G. Streit and B. Franz (*Select Methods of Chemical Analysis, Crookes, 2nd ed. p. 98*). The greater part of the zirconia was first precipitated by hydrogen peroxide, and the titanous acid precipitated by long continued boiling of the filtrate strongly acidified with acetic acid. Owing to the imperfect method of separation and to the small amount of material used in the analysis, the individual numbers for the zirconia and titanous acid can only be considered as approximate.

*Result of Analysis.*

ZrO <sub>2</sub>	}	...	...	79.79	$\left\langle \begin{array}{l} 48.90 \\ 30.89 \end{array} \right.$
TiO <sub>2</sub>					
FeO	...	...	...	6.64	
CaO	...	...	...	11.61	
MgO	...	...	...	0.49	
Loss on ignition	...	...	...	1.02	
				99.55	

Weight of material used in analysis, 0.2256 gr.

We have dedicated this new zirconia-mineral to Professor Ferdinand Zirkel, of Leipzig (under whom one of us had the privilege to study), in commemoration of his great services in the microscopic investigation of minerals and rocks.

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