THE MINERALOGICAL MAGAZINE

AND

JOURNAL

OF THE

MINERALOGICAL SOCIETY.

No. 54. JUNE, 1898. Vol. XII.

Augelite from a New Locality in Bolivia.

By L. J. Spencer, M.A., F.G.S.,

Assistant in the Mineral Department of the British Museum.

[Read November 16th, 1897.]

In a recent number of this Magazine (Vol. XI, 1895, p. 16) augelite was shown to be a definite mineral species, having the chemical composition $AlPO_4.Al(OH)_3$, and crystallising in the monosymmetric system. Owing to its rarity, or perhaps to its similarity in appearance to barytes, it has previously only been described[1] three times in mineralogical literature, and has been found at only two localities, namely, Westanå in Sweden and Machacamarca in Bolivia. It is therefore of interest to be able to record the mineral from a new locality.

The new occurrence is in the veta [=vein] Carmen of the silver mines at Tatasi and Portugalete,[2] in the province Sud-Chichas of the department Potosi. The specimen on which the augelite was found is one of a

[1] Des Cloizeaux (*Manuel de Min.* II, 1893, p. 454) examined cleavage flakes of the Swedish mineral; he gives a cleavage angle and some of the optical characters, but not enough to determine the system of crystallisation.

[2] Tatasi and Portugalete are mining villages which are connected by a level driven through the intervening mountain. H. Reck has described the Portugalete mines, *Berg.-und Hüttenm. Zeitung*, 1884, p. 125.

large suite of Bolivian specimens recently presented to the British Museum by my friend Mr. Malcolm Roberts, A.R.S.M., Administrator of Mines to the Compañia Guadalupe de Bolivia.

The specimen consists of an altered, acid volcanic tuff, with massive pyrites, and in cavities a considerable quantity of "feather ore," which is often aggregated in balls around indistinct crystals of black blende. In the cavities are also crystals of pyrites, chalybite, gypsum and calcite, together with white, powdery kaolin. The pyrites is cubical in habit, but sometimes aggregates of small cubes build up indistinct octahedra, as in fluorite. The gypsum is present as a few colourless needles with the forms $b\{010\}$, $m\{110\}$, $l\{111\}$ and $n\{\bar{1}11\}$. Calcite occurs as very minute thick-tabular crystals, with smooth, bright prism planes, and dull, rounded basal planes; they incrust the pyrites, or are penetrated and supported by the needles of "feather ore." In the kaolin a trace of phosphoric acid was found. The "feather ore," which is locally known as "paja quemada" (= burnt straw), consists of radiated or confused masses of very fine needles or hairs, which possess a certain degree of flexibility, and are of a dull iron-black colour. It was found to contain lead, antimony and sulphur. An analysis of "paja quemada" from Portugalete has been made by L. Kiepenheuer, and from this vom Rath[1] deduces the formula $2(Pb\frac{3}{5},Fe\frac{2}{5})S+Sb_2S_3$, calling the mineral jamesonite. Some of Mr. Roberts' specimens are, however, so intimately mixed with numerous minute octahedra of pyrites, as to suggest that the iron shown in Kiepenheuer's analysis may be due to the presence of this mineral.

The augelite, which is present in only small amount, is usually embedded in the massive pyrites, and sometimes encloses specks of this mineral. It is colourless and transparent, and shows the usual perfect cleavages. It so closely resembles barytes in general appearance, that it is only to be distinguished from this species by the measurement of the cleavage angles, and by the optical examination of cleavage flakes, namely, the determination of the extinction angles and the position of the optic axes. In a cavity, two small crystals showing faces and a third crystal very deeply etched were found; these measured about 1 mm. across.

One of these crystals shows three large bright planes, namely, $m(110)$, $m'''(1\bar{1}0)$, and a vicinal face near $c(001)$ in the zone $[001, 1\bar{1}0]$. The presence of this vicinal face, which is striated parallel to its intersection with $(1\bar{1}0)$, quite masks the symmetry of the crystal. Replacing the three edges formed by the above planes are narrow, striated, and some-

[1] *Sitz.-ber. niederrhein. Ges. Bonn*, 1879, XXXVI, p. 80.

what ill-defined planes of the forms $a\{100\}$, $n\{112\}$, and $d\{334\}$. The last of these has been previously given only as doubtful. The measured angles were:—

		Calculated.	Measured.
$mm'''=110:1\bar{1}0$	...	113°14′	113°16′
cm $=001:110$	...	77 52½	78 55
cm''' $=001:1\bar{1}0$	...	77 52½	76 16
dm $=334:110$	...	37 41	37 23
$n'm'''=1\bar{1}2:1\bar{1}0$	...	46 45	47 1

The second crystal is also bounded by three large planes, namely, $m'(\bar{1}10)$, $m''(\bar{1}\bar{1}0)$, and a vicinal face quite close to $c(001)$, but in this case perpendicular to the plane of symmetry, and striated parallel to the axis of symmetry. The prism planes, as on the first crystal, are striated parallel to their mutual intersection, that is, parallel to the vertical axis. The new form $y\{910\}$ is represented by three narrow indistinct planes; $x\{\bar{1}01\}$ is present as a mere point, and there are small doubtful planes near the positions of $(\bar{1}16)$ and $(\bar{8}01)$. The angles measured on this crystal were:—

		Calculated.	Measured.
$m'm''=\bar{1}10:\bar{1}\bar{1}0$	...	113°14′	113°24′
cm' $=001:\bar{1}10$	...	102 7½	101 57
cm'' $=001:\bar{1}\bar{1}0$	...	102 7½	101 55½
gm $=910:110$	...	47 3	47°, 47°, 47¼°

With this crystal the indices of refraction, as measured through the natural prism, were 1·5752 and 1·5893 for sodium light; and the optic axial angle[1] in air as seen through the basal plane $c(001)$, was determined with a microscope-stage goniometer devised by Prof. Miers to be 82½°.

Cleavage fragments, which had been goniometrically and optically determined, were found to have the chemical characters of augelite. The specific gravity of the crystals was determined to be 2·69, by the method previously mentioned in this Magazine (Vol. XI. p. 186).

In the previous paper on the augelite from Machacamarca, Bolivia, it was stated that there are three places called Machacamarca in Bolivia,

[1] The acute bisectrix makes an angle of 11½° with the normal to $c(001)$. In the previous paper (*loc. cit.* p. 20) there is a slight ambiguity as to the position of the acute bisectrix. It lies "in the acute angle β," when β is taken as defined by Maskelyne (*Crystallography*, 1895, p. 436), but according to other authors this should read "in the obtuse axial angle β." According to Dana's notation (*System of Mineralogy*, 6th ed. 1892, p. xxxvi) it is $\mathrm{Bx_a} \wedge c = +34°$.

and at the time it was not possible to decide from which of these the specimens came. According to information supplied by Mr. Roberts, it can now be stated to be the Machacamarca[1] which is "a few leagues to the north of the town of Potosi, and in the 'cercado' of that town." I have, however, been unable to find any published mention of this place. The Machacamarca about half-way between the towns of Oruro and Poopó, in the department Oruro, is not a mineral territory; it is here that the Oruro ores are amalgamated. A third Machacamarca, south-west of Palca, in the department Cochabamba, is given in the descriptions of the French Expeditions to South America of d'Orbigny (1826-1833) and Castelnau (1843-1847).

Mr. Roberts has been in correspondence with a mining friend of his at the Potosi Machacamarca, and has been able to send me a specimen from this place. In the quartzose matrix, the crystals of bournonite, bright octahedra of pyrites, and zinckenite (?), this specimen exactly resembles those previously examined; but it was only after searching at various times during a period of twelve months that a small crystal of augelite was at last found. This crystal, which is about 1 mm. in length, differs from those previously described in being more decidedly prismatic in habit, being elongated in the direction of the vertical axis. The forms present are $m\{110\}$ and $c\{001\}$, with narrow, indistinct $a\{100\}$ and negative pyramids $\{hhl\}$.

These occurrences of aluminium phosphate in the mineral veins of Bolivia are of interest in connection with the presence of cassiterite, but usual absence of apatite, as described by Stelzner.[2] It may perhaps be suggested that some of the occurrences of barytes mentioned by Stelzner (*loc. cit.* 1897, p. 111) may really be of augelite, though of course not all. I have myself, in the hopes of finding augelite, made optical and goniometric measurements of *barytes* from:—

(1). Mina Guernica at San Vicente (prov. Sud-Chichas, dept. Potosi), with bright crystals of tetrahedrite; also from San Vicente with cubo-octahedra of galena.

(2). Aullagas (prov. Chayanta, dept. Potosi), with pyrargyrite and stanniferous argyrodite (this vol. p. 6).

(3). Pulacayo mine, near Huanchaca (prov. Porco, dept. Potosi), with blende.

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[1] This is about 200 kilometers N.N.E. of the new locality now described for augelite.

[2] *Zeits. deutsch. geol. Ges.* 1892, XLIV, 531; 1897, XLIX, 51; see *Min. Mag.* X, 261, and this vol. pp. 46, 7.