NOTULAE NATURAE

OF

THE ACADEMY OF NATURAL SCIENCES
OF PHILADELPHIA
(Founded 1812)

NUMBERS 1 TO 100
1939 — 1942

PHILADELPHIA
1943

NOTULAE NATURAE

NUMBER 92 OF SEPTEMBER 16, 1941

THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA

SARMIENTITE, A NEW MINERAL FROM ARGENTINA

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While studying the mineralization of the iron sulfate deposits of La Alcaparrosa,[3] a new mineral was discovered with the composition: $FeAsO_4.Fe(SO_4)OH.5H_2O$, monoclinic. To it the authors have given the name of a worthy Argentine national hero, Domingo Faustino Sarmiento,[4] who founded the Córdoba Academy of Science, and who stimulated the mining industry of the Argentine Republic.

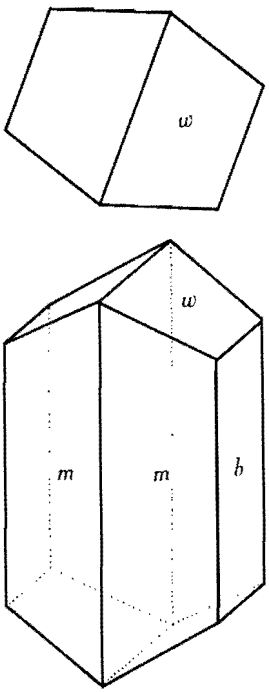

FIG. 1 Sarmientite.

The mineral was found in the iron-sulfate deposits (alcaparrosas) of the "Santa Elena" mine, situated on the right-hand slope of the Quebrada de La Alcaparrosa, almost in front of Km. 127 of the road from San Juan to Calingasta, in the Department of Barreal, and at an elevation of 1360 to 1520 meters above sea-level.

Three veins occur in the deposit, the middle one, or Alcaparrosa, being longest and thickest. These veins outcrop in diabase, possibly Triassic in age, run parallel along the upper part of the hill, and tend to diverge as they approach the Quebrada. The strike of the principal vein is chiefly N.E.-S.W., with a dip varying from vertical to about 45° S.E. Its length is about 1 km. from the Quebrada to the reddish Gotlandian shales in which it ends. The thickness of the veins, as seen in their outcrops and in the workings, varies: the principal vein ranges in width from 0.9 to 3.2 meters; the width of the other two averages from 0.4 to 0.5 meters.

The diabase, wall-rock of the veins, is usually altered in the immediate contact with the sulfates, especially in the higher levels, where it has a brownish color. It is often found as inclusions within the mass of sulfates.

The primary sulfide deposit, mesothermal in type, is probably related to the dacitic intrusion situated somewhat south of the mine.

The irregular distribution of the various minerals in the vein results in heterogeneous masses of striking color, especially in the zone of ferric sulfates. In the diversity of minerals it is one of the most interesting deposits in the country.

In the oxidized zone, the minerals developed include szomolnokite (ferropallidite), melanterite (the zinciferous variety calingastite,[5] with 16.67% FeO, 1.29% CuO, and 8.42% ZnO), copiapite, roemerite, slavikite,[6] butlerite and parabutlerite,[6] glockerite, fibroferrite, zinciferous botryogen, and amarantite. Epsomite, gypsum, and pickeringite were also found at both sides of the vein, as well as a small amount of goslarite which was associated with primary sphalerite. Alteration of these minerals has resulted in superficial coatings of yellow and brown vitriol-ochres, and some native sulfur.

The most abundant of these minerals in the principal vein are copiapite, fibroferrite, amarantite, and szomolnokite, and in lesser quantities, sarmientite, slavikite, and butlerite and parabutlerite.

Primary minerals were found with depth: pyrite, in small grains and pieces, scattered throughout the szomolnokite, sphalerite in quite pure, isolated fragments in goslarite; chalcopyrite in minute grains, and arsenopyrite in a thin offshoot, with scorodite, near the place where the sarmientite was found. In this zone was a somewhat altered fragment of ankerite, which, together with some quartz and inclusions of diabase, make up the gangue of the deepest zone recognized so far.

The sulfates owe their origin to oxidation of pyrite and associated sulfides by atmospheric agents, which began with the formation of the szomolnokite. By further oxidation and hydration, other ferric compounds developed. The concentrated sulphuric acid solutions formed attacked the gangue and wall-rock, extracting such elements as magnesium, calcium, and aluminium, which entered into the composition of many of the minerals.

Vertically, these minerals have been exposed in depth as follows:

	Below outcrop
Vitriol-ochres	at 0.5 meters
Copiapite, fibroferrite, and szomolnokite	at 6.5 "
Szomolnokite, compact mass with pyrite, etc.	at 9.5 "

These measurements represent a cross-section at the deepest pitch of the vein.

Sarmientite has been found, so far, only in the open-cut working known as " Fibroferrite ", where the principal vein attains a thickness of 3.2 meters. Associated with it were fibroferrite, copiapite, botryogen, szomolnokite with calingastite, slavikite, gypsum, and epsomite. The first sample of sarmientite consisted of a nodule about 7.5 cm. in diameter and was found in a fresh mass of fibroferrite. Development of the mine showed the presence of sarmientite in more frequent occurrence as small irregular nodules of great purity.

The color of nodules of sarmientite is pale yellow-orange. The mineral has a specific gravity of 2.58.

Under the microscope, with considerable magnification, the nodules are seen to be made up of exceedingly minute, prismatic crystals which have a length of 2 to 25 microns.

A crystal only 25 microns long (about one-thousandth of an inch) was oriented under a binocular microscope, and transferred to a two-circle goniometer. Signals were obtained which served to identify the faces of the crystals. The crystallographic data are given in Table I.

The system is monoclinic. Crystals are prismatic in habit, and consist of but three forms: *b* (010), *m* (110), and *w* (011). (Fig. 1.)

Sarmientite is optically +. The indices of refraction, measured by immersion are:

$$\alpha = 1.628,\ X = a$$
$$\beta = 1.635,\ Y = b$$
$$\gamma = 1.689,\ Z \wedge c = 12°$$

The results of a chemical analysis of sarmientite are compared in Table II, with the theoretical composition of the compound $FeAsO_4.Fe(SO_4)OH.5H_2O$.

The formula is analogous to that of destinezite. But a single ferric arsenate-sulfate has been heretofore described, the amorphous pitticite. Sarmientite is compared with these minerals below:

Pitticite	$3Fe[(SO_4 . OH) . (AsO_4) . (OH)_3] . \pm H_2O$	Isotropic
Sarmientite	$FeAsO_4 . Fe(SO_4)OH . 5H_2O$	Monoclinic
Destinezite	$FePO_4 . Fe(SO_4)OH . 5H_2O$	"
Diadochite	$Fe[(PO_4) (SO_4 . OH)] 4 \pm H_2O$	Amorphous

TABLE I ANGLES OF SARMIENTITE

Monoclinic, $\frac{2}{m}$; a : b : c = 0.3415 : 1 : 0.5242; $\beta = 97°39'$

$p_o = 1.535$; $q_o = 0.5195$; $\mu = 82°21'$

	Measured angles		Average	
	ϕ	ρ	ϕ	ρ
1. b (010)	1°44′	87°40′		
2. b ($0\bar{1}0$)	0°35′	86 03′	1°10′	87 °51′
3. m (110)	70°56′	90°		
4. m ($1\bar{1}0$)	71°40′	"	72°18′	90°
5. w (011)	14°22′	28°24′		
6. w ($0\bar{1}1$)	14°23′	28°26′	14°22′	28°25′

TABLE II. ANALYSIS OF SARMIENTITE

	I	II
Fe_2O_3	36.57	36 4
CaO	0.27	
As_2O_5	22.68	22.6
SO_3	18.28	18.3
H_2O	22.86	22.7
	100.65	100 0

I. Analysis of sarmientite by Paul Collins.

II. Theoretical composition of $FeAsO_4 \cdot Fe(SO_4)(OH) \cdot 5H_2O$

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[1] Engineer, Dirección de Minas y Geologia, Republica Argentina

[2] Associate Curator, Mineralogy and Petrology, The Academy of Natural Sciences of Philadelphia.

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Angelelli, Victorio y A. Chaudet. Sobre dos sulfatos de hierro de la mina "Santa Elena", provincia de San Juan. Rivista Minera Geol. y Min.; Soc. Argentina Mineria y Geol., 8: 46-52, 1937.

[4] Domingo Faustino Sarmiento (1811-1888) was a great Argentinian educator and statesman and held the offices of Minister of Public Instruction, and Minister of the Interior, and President of the Argentine Republic, to which office he was elected while Minister to the United States in 1868

[5] Angelelli and Trelles, op. cit., p. 40.

[6] Gordon, Samuel G. Slavikite, butlerite and parabutlerite from Argentina; Notulae Naturae, no 89, 1941