THE AMERICAN MINERALOGIST

JOURNAL OF THE MINERALOGICAL SOCIETY OF AMERICA

Vol. 53 JANUARY–FEBRUARY, 1968 Nos. 1 and 2

SANJUANITE, A NEW HYDRATED BASIC SULFATE-PHOSPHATE OF ALUMINUM

M. E. J. DE ABELEDO, V. ANGELELLI, M. A. R. DE BENYACAR, *Comisión Nacional de Energía Atómica*; *Buenos Aires*; AND C. GORDILLO, *Universidad National de Córdoba.*

ABSTRACT

Sanjuanite is a new mineral, $Al_2(PO_4)(SO_4)OH \cdot 9H_2O$, found in dark Carboniferous slates, on the eastern slope of Sierra Chica de Zonda, Department of Pocito, San Juan Province, Argentina. The mineral occurs as white, compact masses with luster dull to silky, fracture uneven or earthy; hardness: 3; specific gravity: 1.94. It forms aggregates of microscopic fibers, arranged in parallel or divergent bundles. Under high magnification, lath-like crystals are seen; these show oblique extinction, suggesting a symmetry no higher than monoclinic. ns at 20°C: α' ($\perp$ to fiber length) 1.484, γ' (parallel to fiber length) 1.499. The strongest lines of the X-ray powder diffraction pattern are: 10.77 (100), 4.13 (55), 5.28 (38), 4.32 (36), 3.45 (35), 8.66 (30), 4.27 (30), 3.59 (30). An infrared absorption spectrum, thermogravimetric and differential thermal analyses curves are given. The name sanjuanite is for the province of its occurrence.

INTRODUCTION

The object of the present paper is to describe a new mineral found in the Department of Pocito, San Juan province, Argentina. The chemical composition and X-ray powder data show that it is a new species; the mineral is named sanjuanite for the province of its occurrence.[1]

OCCURRENCE

The mineral was found at about 45 km SSW from San Juan City and 12 km to the NNW from the mouth of the La Flecha canyon, at an altitude of about 900 m. above sea level, in one of the several ridges of the eastern slope of Sierra Chica de Zonda (San Juan Precordillera).

The area is one of Tertiary, Carboniferous and Ordovician sediments. The mineral occurs at a short distance to the west from a small limestone ridge, in dark plant-bearing slates of carbonic age with a strike N 30°E and a dip of 35°E. In the mineralized area the slates are cut by two prin-

[1] The name sanjuanite was approved in advance of publication by the Commission on New Minerals and Mineral Names of the IMA.

cipal sets of diaclases. These diaclases are strongly impregnated by hydrated iron oxides, some of which include small lenses of natrojarosite, up to 2 cm thick.

In this area sanjuanite appeared in a trench about 3 m long as two veinlets 5 cm apart and from 2 to 5 cm thick, embedded in conformity within the slates.

The veinlets of sanjuanite are often bounded by thin gypsum layers. On the same ridge, and at about 15 m from the above mentioned trench, alunite, associated with gypsum, also occurs.

Concerning the origin of the minerals mentioned, it seems possible that they were formed by thermal acid solutions of changing composition that rose during the Quaternary.

Optical and Physical Properties

Sanjuanite occurs as white, chalk-like, compact masses, with dull to silky luster; fracture earthy or uneven; hardness 3.

The specific gravity of 1.94 is an average of three pycnometric determinations, with toluene as pycnometric liquid.

Sanjuanite forms aggregates of microscopic fibers, colorless in transmitted light, and arranged in parallel or divergent bundles. After disper-

Fig. 1. Electron micrograph obtained with sanjuanite crystals.

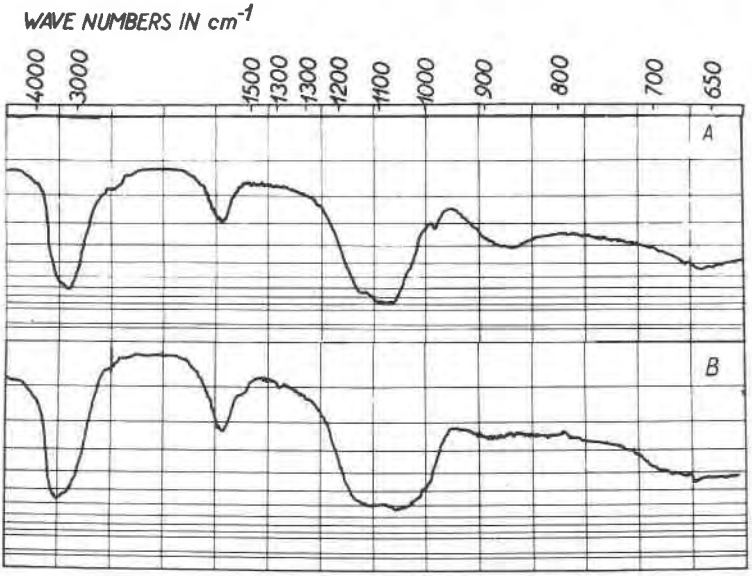

FIG. 2. Infrared absorption spectra. A: Sanjuanite. B: Kribergite.

sion of the bundles, lath-like crystals are observed under high magnification. Figure 1 shows a typical electron micrograph obtained from a specimen dispersed in water, in a Phillips EM 100 A instrument.

In the polarizing microscope the crystals show definite oblique extinction (up to 25–30°) suggesting a symmetry no higher than monoclinic. The elongation is positive and the birefringence medium. The fine grained character of the material precluded the measurement of the principal refractive indices. The indices determined were (20°C):

$$\gamma' \parallel \text{to fiber length} = 1.499$$

$$\alpha' \perp \text{to fiber length} = 1.484$$

An infrared absorption spectrum was obtained using the KBr disk method. A Beckmann IR5 instrument with a NaCl prism was used; the spectrum is shown in Figure 2a.

CHEMICAL PROPERTIES AND COMPOSITION

Sanjuanite is readily soluble in warm mineral acids. Heated in a closed tube, it gives off a high proportion of acid water.

A semiquantitative spectrographic analysis gave the results shown in Table 1. The results of the chemical analyses and the calculation of the formula are given in Table 2.

TABLE 1. SEMIQUANTITATIVE SPECTROGRAPHIC ANALYSIS OF SANJUANITE

	%		%
P	>10	Na	<0.01
Al	10	Li	<0.01
Fe	0.1–1	Si	<0.001
F	<0.1	Mg	<0.001
K	<0.1	Cu	0.0001
Rb	<0.1		

DEHYDRATION AND THERMAL ANALYSIS

Samples of sanjuanite kept at room temperature in a desiccator over P_2O_5 lost gradually up to 84 percent of the total water contents; no intermediate product could be detected. As the dehydration proceeded, the intensity of the reflections in the X-ray diffraction pattern gradually decreased; no shifting in the position of those reflections was observed. The product of dehydration was virtually amorphous to X rays; kept in a damp atmosphere it rehydrated to give a product with the original X-ray pattern.

A sample of sanjuanite kept in a vacuum of about 10^{-4} mm Hg for several hours dehydrated to give a product completely amorphous to X rays, which did not rehydrate when kept in a damp atmosphere.

A thermogravimetric curve (Fig. 3) was obtained in a thermobalance

TABLE 2. CHEMICAL ANALYSES OF SANJUANITE

	1	2		3	4
		a	b		
	%	%	%	%	
P_2O_5	16.74	16.32	16.10	16.39	1.000
SO_3	18.89	18.94	18.91	18.62	1.013
Al_2O_3	24.04	24.23	24.07	23.48	2.000
Fe_2O_3		1.43	1.43	1.72	0.095
H_2O	40.33	39.84	40.12	40.20	19.417
Totals	100.00	100.76	100.63	100.41	

1. Theoretical Composition for $Al_2(SO_4)(PO_4)OH \cdot 9H_2O$.
2. First sample collected by Aparicio in 1965; a) and b) are analyses of different portions of the sample.
3. Sample collected in 1966 by V. Angelelli.
4. Atomic ratios of column (3).

with photographic register, on a sample weighing 300 mg; the rate of heating was 2° per minute up to 550°C, and 5° per minute from 550 to 1100°C. Up to 1100°C the weight loss was 34.84 percent (approximately equivalent to 87 percent of the water contents of the mineral).

A differential thermal analysis curve (Fig. 3) shows endothermic breaks at 308°C (very large), 888°C (large), and 710°C (small).

Diffraction Data

Sanjuanite was examined by X-ray diffraction using a Philips PW 1050 diffractometer unit, Ni filtered Cu radiation and a scanning rate of 1/2° per minute. Observed spacings are given in Table 3.

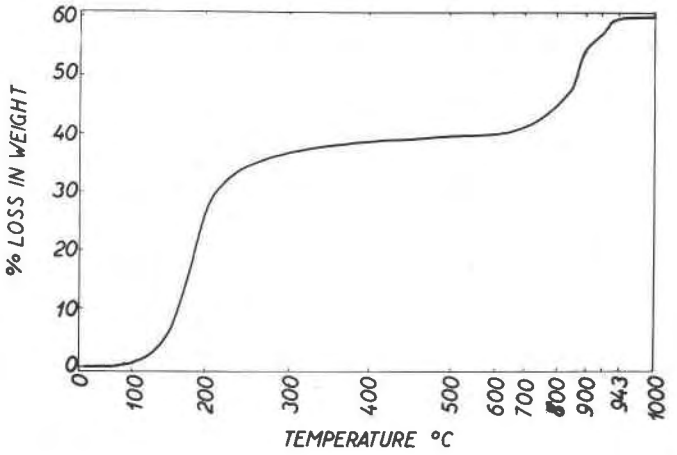

Fig. 3. Thermogravimetric curve of sanjuanite.

No single crystal study was possible on the fine grained material.

Attempts were made to obtain two parameters of the unit cell from electron diffraction data, but no electron diffraction pattern could be obtained. Considering the high vacuum in the electron microscope this is not surprising, as samples of sanjuanite kept in a vacuum of 10^{-4} mm Hg for several hours gave a product amorphous to X rays.

Relationship to Other Minerals

Torsten du Rietz (1945) described a new aluminum sulphate-phosphate mineral, kribergite, from Kristineberg mine (Västerbotten, Sweden). The reported specific gravity and optical properties of kribergite are very similar to those of sanjuanite. A small piece of the kribergite specimen RM 450003 from the Mineralogical Section of the Swedish

Museum of Natural History was made available to us through the kind cooperation of Mr. Eric Welin. From this sample X-ray powder diffraction data, an infrared spectrum (Fig. 2b) and electron micrographs (Fig. 5) were obtained at our laboratory. The small amount of sample available did not permit other determinations.

TABLE 3. X-RAY POWDER DATA COMPARED FOR SANJUANITE AND KRIBERGITE

Sanjuanite		Kribergite		Sanjuanite		Kribergite	
$d_{meas.}$[a] Å	I	$d_{meas.}$[a] Å	I	$d_{meas.}$[a] Å	I	$d_{meas.}$[a] Å	I
10.77	100	11.57	100	3.200	15	3.195	3
8.66	30	9.27	3	3.150	10		
7.31	5					3.090	2
6.92	7	6.62	20	3.030	4	3.020	1
6.40	15			3.000	4		
		5.85	10	2.905	10	2.930	5
		5.72	8	2.873	15	2.863	14
5.28	38	5.37	12	2.817	28	2.744	4
4.97	5	5.02	23	2.686	24	2.685	2
4.43	32			2.612	3		
4.32	36			2.482	3		
4.27	30			2.423	10		
4.13	55			2.380	7		
4.04	27			2.347	4		
3.95	5	3.92b	4	2.321	5		
3.82	10			2.158	6		
3.59	30			2.134	7		
3.450	35	3.495	3	1.920	20		
3.36b	13	3.320	4				

[a] Data obtained with a Philips wide angle diffractometer, using Ni filtered Cu radiation.

In spite of the similarity in physical properties, sanjuanite and kribergite seem to be different species. The X-ray powder patterns of both minerals are clearly different; the observed interplanar spacings are compared in Table 3. The chemical composition also shows dissimilarities; the analysis given by du Rietz for kribergite agrees approximately with the formula $Al_5(PO_4)_3(SO_4)(OH)_4 \cdot 4H_2O$, distinct from that of sanjuanite, $Al_2(PO_4)(SO_4)OH \cdot 9H_2O$.

For its chemical composition sanjuanite appears to be a close analogue to schoderite (Hausen, 1962). The formula for schoderite may be given as $Al_2(PO_4)(VO_4) \cdot 8H_2O$ which resembles the formula for sanjuanite, the group (VO_4) substituting for (SO_4). A similarity can also be found be-

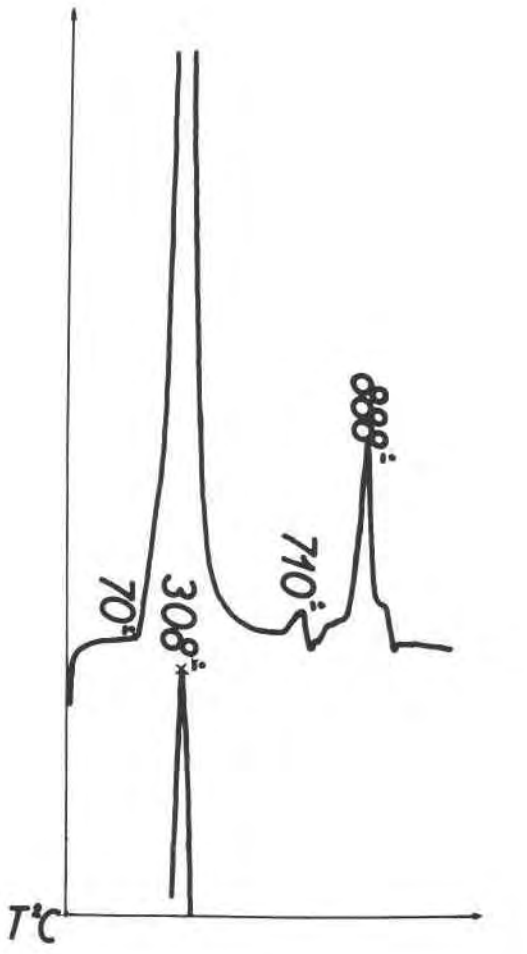

FIG. 4. Differential thermal analysis curve of sanjuanite.

tween the formula for sarmientite (Angelelli and Gordon, 1941), $Fe_2(SO_4)(AsO_4)OH \cdot 5H_2O$, and that for sanjuanite. The X-ray powder patterns of schoderite by Hausen (1962) and of sarmientite by two of us (MEJA and MARB) are different from that of sanjuanite.

ACKNOWLEDGMENTS

The thanks of the authors are due to Mr. Emiliano Aparicio for the samples and information given, to Mr. Carlos B. Amaya who was responsible for the spectrographic determinations, to Mr. Luis C. de la Fuente for the differential thermal analysis and to Mr. Juan Orecchia for the infrared spectrum.

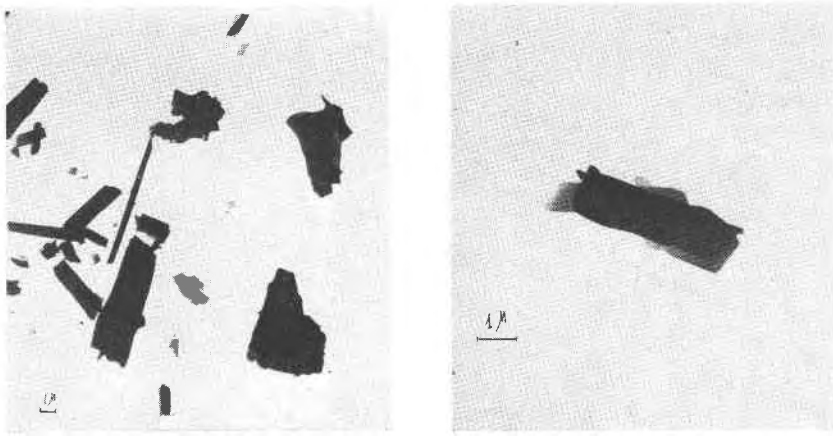

FIG. 5. Electron micrographs of kribergite.

Dr. Michael Fleischer, of the U. S. Geological Survey, has been kind enough to offer valuable suggestions and advice.

REFERENCES

ANGELELLI, V, AND GORDON (1941) Sarmientite, a new mineral from Argentina. *Acad. Sci. Philadelphia, Not. Nat.*, no. 92.

DU REITZ, T. (1945) Kribergite, ett nyt mineral från Kristinebergs gruva i Västerbottens lan. *Geol. För. Förh.* **67**, 78–79.

HAUSEN, D. M. (1962) Schoderite, a new phosphoranadate mineral from Nevada. *Amer. Mineral.* **47**, 637–648.

Manuscript received, November 22, 1966; accepted for publication September 18, 1967.