

SVEITE, A NEW MINERAL FROM AUTANA CAVE, TERRITORIO FEDERAL AMAZONAS, VENEZUELA

by

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ABSTRACT

A new mineral, sveite, occurs as white crusts and efflorescences on the walls of Autana Cave, Venezuela, excavated in the Roraima Group quartzite. It has been deposited from seepage water. Under the microscope it consists of aggregates of contorted flakes. Its formula is $\text{KA}_{17}(\text{NO}_3)_4\text{Cl}_2(\text{OH})_{16} \cdot 8\text{H}_2\text{O}$. The X.R.D. pattern can be indexed with the monoclinic cell $a = 10,89$; $b = 13,04$; $c = 30,71 \text{ \AA}$; $\beta = 92,10^\circ$; $Z = 6$, based on calculated density 2,185 (observed 2,0). The extreme refractive indices are 1,503 and 1,535, the extinction is parallel to the perfect cleavage {001} and 2V is positive, small.

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I. INTRODUCTION

An unidentified mineral collected in a cave by the members of the "Sociedad Venezolana de Espeleología" has been described by Urbani (1977) who gave a short account of it including X-ray powder patterns, a partial analysis (cations only) and scanning electron microscope photographs. He submitted material to the author for further investigation which led to the identification of the new mineral described in this paper. Both the mineral and the name have been approved by the I.M.A. Commission on New Minerals and Mineral Names. The name is derived after Sociedad Venezolana de Espeleología. Type material is deposited at the Mineralogy Section of the School of Geology, Universidad Central de Venezuela, Caracas and at the Departamento de Espeleología Física, Sociedad Venezolana de Espeleología, Caracas.

II. OCCURRENCE

The Cave in which the mineral occurs is located in the precipitous cliff face of a 850 metres high pinnacle, the Cerro Autana, in southern Venezuela. Its entrances are situated at three quarters from the base of the cliff and was reached for the first time in 1971 from the top of the Cerro, where the exploration team landed by helicopter (Colvée, 1973). The pinnacle is an outlier of Precambrian pink quartzite of the Roraima Group, forming very thick horizontal strata resting disconformably on a granitic basement. The cave itself is composed of several entrances interconnected by passages and large chambers. It has probably formed by (i) initial weathering of quartzite producing soft material along joints and bedding planes, followed by (ii) mechanical removal of sand by running water (Colvée, 1973).

On the walls of a vast chamber, sveite forms white crusts and efflorescences which have been obviously deposited by solutions trickling from a bedding plane close to the ceiling (Urbani, 1977, Fig. 1).

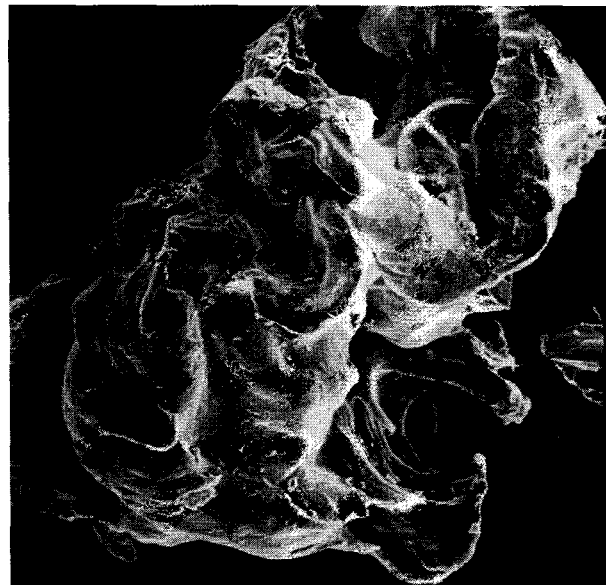


Figure 1

Electron scanning microscope photograph of sveite. Magnification 100 times. Note the contorted nature of the flakes.

III. X-RAY DIFFRACTION ANALYSIS

The X-ray pattern (Table I) has been obtained with a Philips diffractometer in the Geological Survey Laboratory, using quartz as internal standard. In the pattern published by Urbani (1977) there are two minor lines, at 12.1 and 4.82 Å, which does not appear in the present diagram. They are possibly due to impurities absent in the sample now studied. They may also indicate the presence of an unstable, more hydrated phase decomposing into sveite by loss of water, a phase which would have been present in the material X-rayed by Urbani. As no X-ray single crystal study could be conducted due to the small size of sveite particles, the mineral could not be indexed unambiguously. However, among the several cells

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TABLE I
X-ray Powder Diffraction Data

No.	I/I_{100}	Obs	Calc	hkl	No.	I/I_{100}	Obs	Calc	hkl
1	100	10,20	10,23	003	30	10	2,540	2,539	318
2	15	8,04	8,05	013				2,537	150
3	5	7,445	7,427	112	31	5	2,506	2,506	152
4	20	6,174	6,165	104				2,496	421
5	35	5,995	6,002	022	32	11	2,487	2,489	414
6	1	5,588	5,594	120				2,485	048
		5,574	5,574	114	33	55	2,443	2,440	309
7	1	5,386	5,392	201				2,439	406
8	10	5,090	5,115	006	34	10	2,407	2,410	148
			5,070	202				3,406	328
9	5	4,381	4,384	007				2,405	342
			4,364	204	35	5	2,235	2,237	345
10	5	4,325	4,309	116				2,235	433
			4,305	031	36	5	2,190	2,190	434
11	20	4,209	4,183	032				2,188	157, 339
12	1	4,084	4,096	125	37	10	2,104	2,104	352
13	1	4,000	4,003	222	38	5	2,055	2,055	521, 429
			4,002	033				2,053	354
			4,000	205	39	1	2,032	2,030	444, 506
14	10	3,935	3,928	117	40	5	1,989	1,990	429
15	1	3,793	3,797	206				1,989	355
			3,783	034	41	10	1,964	1,963	166
16	40	3,692	3,680	018	42	1	1,926	1,926	265
17	10	3,580	3,587	301				1,924	508, 533
			3,577	108	43	5	1,901	1,902	534
18	1	3,483	3,486	311				1,901	517, 533
			3,483	127	44	1	1,881	1,882	451
			3,477	207	45	1	1,864	1,865	360
19	10	3,316	3,313	036				1,864	508, 361
20	15	3,269	3,272	313				1,863	452
			3,261	040	46	5	1,837	1,838	535, 358
21	1	3,138	3,139	314				1,837	170
			3,136	128	47	1	1,795	1,794	602, 529, 365
22	10	3,095	3,100	218	48	1	1,756	1,757	175, 605
			3,087	037	49	1	1,735	1,735	614
23	5	3,004	3,001	323, 044, 235				1,734	273
24	5	2,973	2,979	143	50	1	1,707	1,708	615, 458
25	5	2,913	2,909	306	51	1	1,693	1,694	461
26	10	2,882	2,883	144				1,692	462
			2,880	045	52	5	1,656	1,657	371, 553, 548
			2,887	038				1,656	552, 547
27	20	2,752	2,754	332				1,655	607
			2,750	046	53	1	1,629	1,629	277
28	5	2,717	2,719	401				1,628	081
29	5	2,600	2,600	413	54	1	1,600	1,601	466, 635, 555
			2,599	051					
			2,595	334					

Philips diffractometer, cobalt radiation, quartz as standard.

which have been calculated in orthorhombic, monoclinic and triclinic systems, a monoclinic cell was found to fit the best, taking into account the properties described further: $a = 10,89$; $b = 13,04$; $c = 30,71 \text{ \AA}$; $\beta = 92,10^\circ$ and $Z = 6$.

IV. CHEMICAL COMPOSITION

Before analysis the material was dried in a silicagel desiccator and split into two parts. One part was used for carbon, nitrogen, hydrogen and sulphur determination by gas chromatography in the National Chemical Research Laboratory (analyst Mr H.H. Lachmann). The remainder of the sample was analysed by the author in the laboratory of the Geological Survey by gravimetry (Al_2O_3 and Cl), with a flame photometer (K_2O), by colorimetry (P_2O_5) and by distillation method ($(\text{NH}_4)_2\text{O}$). No distinction between H_2O^+ and H_2O^- was made. The results are as follows:

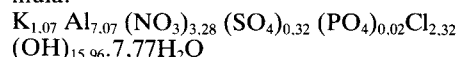
Al_2O_3	37,12 %	SO_3	2,65 %
K_2O	5,18 %	Cl	8,50 %
$(\text{NH}_4)_2\text{O}$	<0,02 %	C	<0,30 %
H_2O	29,25 %	Insol.	0,10 %
N_2O_5	18,26 %	-O = Cl ₂	1,92 %
P_2O_5	0,17 %	Sum	99,31 %

The residual material (Insol) left after HCl attack consists only of pink grains of detrital quartz. Microprobe work confirmed the homogeneity in composition as well

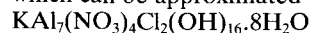
as the absence of any other elements with an atomic number greater than eleven. The sample analysed by Urbani (1977) contained 3,53 per cent Fe_2O_3 . This may be due to impurities like haematite from the country rock or due to ferric iron replacing aluminium in the mineral in quantities varying from place to place. Moreover, that author analysed minor elements not determined in the present study, namely

CaO	0,18 %
Na_2O	0,07 %
MgO	0,02 %
MnO	0,00 %
SiO_2	0,00 %

On the basis of a valency of -4 for the sum $\text{NO}_3 + \text{SO}_4 + \text{PO}_4$, the analyses yield the empirical formula:



which can be approximated to the ideal formula:



V. OPTICAL AND PHYSICAL PROPERTIES

Electron scanning micrographs (Fig. 1 and Urbani, 1977, Fig. 4) reveal that the mineral forms aggregates of strangely contorted flakes. The texture is obviously micaceous and the perfect cleavage is presumably {001}. Under the optical microscope svelte is colourless, the ex-

tion is parallel or nearly parallel to the perfect cleavage and the sign is negative. Poor images in convergent light were obtained, indicating that the mineral is biaxial positive having a small 2V. Only the extreme refractive indices could be measured: $\alpha = 1.503(2)$ and $\gamma = 1.535(2)$. Under the microscope it was observed that grains of sveite swelled in water more than ten times their initial volume and that the birefringence decreased progressively to zero when the grains are transformed into gelatinous matter. This phenomenon can be interpreted as being due to incongruent dissolution of sveite, leaving a residue of presumably aluminium hydroxide.

The specific gravity determined by the sink-float method in tetrabromoethane diluted with acetone, is 2.0. The calculated density, after the ideal formula, is 2.185. T.G.A. and D.T.A. experiments were conducted on 25 mg of matter, giving the following results: a strong endothermic peak at 240 °C, including a shoulder at 200 °C, corresponding to 49 per cent loss in mass; weak endothermic reactions at 400 °C, representing about 6 per cent loss (poorly distinct from previous loss), weak and broad at 1 000 °C (3 per cent loss), and weak at 1 150 °C (1 per cent loss), respectively.

Sveite is very soft, being comparable to talc. It is completely soluble in HCl and H₂SO₄ but dissolves with difficulty in HNO₃. Heated in a test tube it produces red-brown fumes.

VI. GENESIS

It is classically believed that nitrate minerals in caves form from animal excreta like bat guano. In the case of sveite, however, the origin from animal excreta meets some difficulty as it has been reported already that the mineral has obviously been deposited by solutions trickling directly from the ceiling of the cave. As it is very probable that there is no other cave at a higher level, it

seems, therefore, that nitrate and chloride must have been provided by rain water and by the organic matter contained in the soil of the top of the Cerro Autana. The solutions, presumably very acidic and poorly mineralized, as it must be the case in such a siliceous environment (Urbani, 1977), dissolve aluminium and potassium from feldspar and mica contained in minor amount in the quartzite. As the solutions are very diluted, the deposition of sveite can be achieved only after evaporation of many times its initial volume. Such an origin of nitrates, i.e. from seepage water, has been advocated for limestone caves (Hill, 1976).

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REFERENCES

- Colvée, P. (1973). Cueva en cuarcitas en el Cerro Autana, Territorio Federal Amazonas. *Bol. Soc. Venezolana Espel.*, **4**, 5-13. H.
- Hill, C. (1976). *Cave Minerals*. Speleopress, Austin, Texas, 137 pp.
- Urbani, F. (1977). Novedades sobre estudios realizados en las formas carsicas y pseudocarsicas del Escudo de Guayana. *Bol. Soc. Venezolana Espel.*, **8**, 175-197.

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