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Sweetite, a new mineral from Derbyshire

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ABSTRACT. Sweetite, naturally occurring $Zn(OH)_2$ with tetragonal symmetry, has been found at Milltown, near Ashover, Derbyshire. It occurs as colourless or whitish bipyramids up to 1 mm in size scattered over the surface of colourless fluorite cubes. The cell dimensions are a 8,222 and c 14.34 Å with $Z = 20$. The strongest lines of the X-ray powder pattern are (d, I, hkl): 4.53 37 (112); 3.572 60 (004,202,211); 2.922 100 (213,220); 2.708 18 (105,204); 2.257 17 (224,215,321); 1.840 11 (226,420,413); 1.764 24 (316). Sweetite is uniaxial negative, ω 1.635, ε 1.628. D_{meas} is close to 3.33 and D_{calc} 3.41. Chemical analysis gave 84.3% ZnO and 17.0% H_2O, while theoretical figures for $Zn(OH)_2$ are 81.9 and 18.1% respectively.

SWEETITE was first found in February 1982 by Mr S. A. Rust at a disused limestone quarry 200–300 m north-west of the village of Milltown near Ashover in Derbyshire. It occurred in an oxidized area of a vein exposure on the north-western face of the quarry, the unaltered material consisting of fluorite veined with calcite. The sweetite crystals were found in the first 30 cm of the oxidized area above the quarry floor, between two narrow veins of fluorite, sprinkled over the face of colourless fluorite cubes in cavities several centimetres in diameter. Other cavities carried altered galena with anglesite and cerussite while hydrocerussite and litharge have also been found in the oxidized area. Joints in the fluorite veins were covered in a white encrusting mineral identified as attapulgite. A description of the minerals, other than sweetite, found at this locality has been given by Rust (1983).

About twenty specimens of sweetite have been found, of which three are lodged in the British Museum (Natural History). The type specimen was initially submitted as an unknown mineral and chemical tests indicated that the crystals did not correspond with any previously reported mineral species.

Chemical properties. Initial electron probe examination of a crystal of sweetite yielded zinc as the only major element detectable by that technique. An energy-dispersive analysis gave close to 67 wt. % Zn (*c.* 83% ZnO) plus 0.2% Ca and 0.1% Si. Examination in a wavelength-dispersive instrument showed that the crystal had a core of higher zinc concentration (around 100% ZnO) with traces of Pb and Cd.

Atomic absorption analysis of a 0.1292 mg crystal gave 67.7% Zn (= 84.3% ZnO) while CHN elemental analyser determinations on 0.4698 and 0.1503 mg samples gave 17.0 and 18.1% H_2O respectively. No other elements were detected—the only other indication obtained was a very small carbon signal from the CHN analyser; this is probably due to either a small amount of organic contamination or a little adhering calcite. Fluorine was sought in the AAS solution but not found.

Theoretical compositions for $Zn(OH)_2$ are ZnO 81.9% and H_2O 18.1%. The somewhat high bulk ZnO determination appears to be due to the presence of the core of almost pure ZnO in some of the crystals. For the same reason the water determination may well be more precise on the smaller of the two crystals measured, as there is less likelihood of it containing such a core. There are no grounds, therefore, for supposing that the composition of

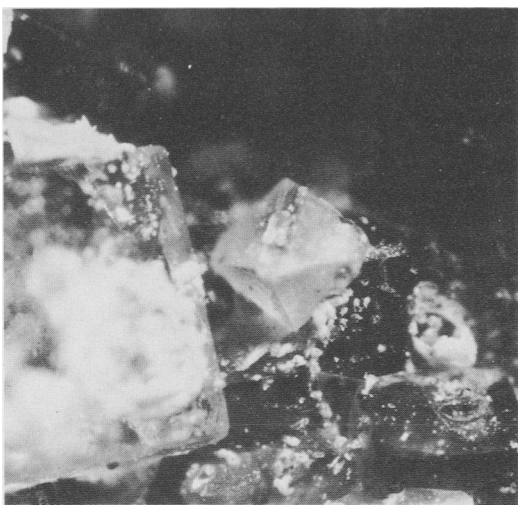

FIG. 1. Bipyramidal crystal of sweetite in a cavity in specimen BM 1982, 4 with a fluorite cube in the foreground (× 30).

sweetite departs appreciably from stoichiometric $Zn(OH)_2$.

An infrared spectrum was obtained but the quality was poor due to the small sample weight and possibly also to exchange reactions with KBr in the disc. The spectrum shows some similarity with published data for synthetic ε-$Zn(OH)_2$ (Srivastava and Secco, 1967) but they may be complicated by other anions and radicals and may also differ with different methods of synthesis.

Sweetite is soluble with slight effervescence in dilute hydrochloric acid.

Physical and optical properties. Sweetite is uniaxial negative, ω 1.635, ε 1.628. Crystals have the appearance of small (up to 1 mm) tetragonal bipyramids (fig. 1); owing to poor reflections from

TABLE I. *X-ray powder diffraction data for sweetite*

hkl	d_{calc}	d_{obs}	I_{obs}	*hkl*	d_{calc}	d_{obs}	I_{obs}
101	7.13	7.14	10	336	1.505	1.506	3
112	4.515	4.53	37	318	1.476	1.472	10
103	4.132	4.12	5	514	1.470		
200	4.110			426	1.457		
004	3.585			523	1.454	1.456	4
202	3.566	3.572	60	440	1.453		
211	3.560			417	1.429		
114	3.050	3.043	4	435	1.426	1.428	11
213	2.914	2.922	100	505	1.424		
220	2.906			442	1.424		
105	2.708			530	1.410	1.403	2
204	2.702	2.708	18	1.1.10	1.392	1.385	4
222	2.693			532	1.383		
301	2.691			2.0.10	1.354	1.358	5
312	2.444	2.454b	2b	408	1.351		
215	2.261			525	1.347		
224	2.258	2.257	17	444	1.347	1.350b	6
321	2.251			602	1.346		
314	2.104	2.109	9	611	1.345		
206	2.066			338	1.316	1.320	2
323	2.058	2.058	2	534	1.312		
400	2.055			613	1.306	1.301	5
107	1.988			620	1.300		
305	1.981	1.981b	10			1.282	5
402	1.975					1.242	2
411	1.975					1.225	5
330	1.937	1.936	< 1			1.203	4
332	1.870	1.877	2			1.188	2
226	1.846					1.174	3
413	1.840	1.840	11			1.148	2
420	1.838					1.130	2
008	1.793	1.792	6			1.119	< 1
217	1.789					1.092	3
325	1.785					1.073	2
316	1.759	1.764	24			1.050	3
118	1.713	1.711b	4			1.035	2
334	1.704					1.023	1
208	1.643					1.007	2
307	1.641					0.9984	2
415	1.637	1.641	8			0.9895	2
424	1.636					0.9647	2
431	1.633						
501	1.633						
512	1.573	1.579	4				
433	1.555	1.560	14				
503	1.555						

a goniometric study, indexing of these faces is uncertain, possible {112}. Some crystals show evidence of a basal plane and a few are tabular. They are whitish translucent, sometimes transparent, occurring on the faces of colourless fluorite crystals associated with calcite and baryite. The measured specific gravity of sweetite is close to 3.33 (a fragment 'swims' in methylene iodide); the value calculated from the theoretical formula and unit cell is 3.41 and from the theoretical formula and refractive indices, using the Gladstone–Dale relation, 3.32.

X-ray study. (*h*0*l*), (*h*1*l*) and (*h*2*l*) Weissenberg photographs and an *a*-axis rotation photograph show sweetite to be tetragonal with *a* 8.222 ± 0.005, *c* 14.34 ± 0.01 Å, with $Z = 20$. The only systematic absences are *h*00 ($h \neq 4n$), leading to the enantiomorphic primitive space groups $P4_12_12$ or $P4_32_12$. Since all reflections with $(h+k+l)$ odd are weak, the powder pattern could be indexed on a body-centred cell of the same dimensions, or on a primitive cell with *a* 5.815 Å ($8.222/\sqrt{2}$). These cells do not lead to satisfactory Weissenberg indexing and the smaller primitive cell with $Z = 10$ is incompatible with the derived space groups. The indexed powder pattern given in Table I was obtained using Philips 11.46 cm diameter camera with Cu-$K\alpha$ radiation. All lines could be indexed on the body-centred cell, but reflections not observed on the Weissenberg photographs were omitted.

X-ray data are available for six orthorhombic or hexagonal modifications of zinc hydroxide but we have not found any report of an artificial preparation corresponding to sweetite. Attempts to synthesise the phase have so far only produced the well-known orthorhombic phase ε-$Zn(OH)_2$, which has subsequently been found in small amounts associated with sweetite.

Name and type specimen. Sweetite is named for the late Jessie M. Sweet (1901–79), for many years curator of the mineral collection at the British Museum (Natural History). The name and description have been ratified prior to publication by the IMA Commission on New Minerals and Mineral Names. The holotype specimen (BM 1982, 4) was collected by Mr S. A. Rust of Hemel Hempstead and is now deposited at the British Museum (Natural History).

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REFERENCES

Rust, S. A. (1983) *Mineral Realm*, **2** (4), 15–23.
Srivastava, O. K., and Secco, E. A. (1967) *Can. J. Chem.* **45**, 585–8.

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