STYLOTYPITE, A DISCREDITED SPECIES*

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Abstract

The evidence on which the validity of stylotypite as a mineral species rests is reviewed. Existing published data are shown to be unsatisfactory, and attempts to verify reported occurrences of the mineral had negative results. All reported specimens of stylotypite which it was possible to identify are tetrahedrite or other known minerals. In the absence of valid data justifying stylotypite as a species, it should be discredited.

Introduction

A previously accepted mineral species may become discredited in various ways, such as by proof that the type material was some other species, or that it was a mixture. Sometimes re-examination of the original material is not possible; but if the work done on the material is shown to be unsatisfactory and further, if no proven specimen of the alleged substance has ever been found—all alleged specimens being identified as other well-known species—then there are valid grounds for discrediting the supposed species. Such is the case with stylotypite, since 1865 accepted, with, it is true, occasional misgivings, as a mineral species. Since the original work by von Kobell almost a century ago, a score, more or less, of mineralogists have had to deal with this mineral and with few exceptions, have accepted without question the dubious statements of their predecessors. Not until 1931 was it shown by Schneiderhöhn and Ramdohr (1) that serious question existed as to stylotypite being a mineral species. However, stylotypite is still listed as such in several standard mineralogical text books.

History of the Mineral

The history of stylotypite is indicated in the chronological table shown on the following pages.

The name "stylotyp" given by von Kobell (2) is the Greek στˆλος = column, and τύπος = form. The Spanish term canutillo was found on the label of the original specimen from Copiapo, Chile, in the collection of the Duchy of Leuchtenberg, signifying a small tube or pipe and refers to the shape of the material. Even in this original account, it was noted that except for its four-sided, almost rectangular (92½°) prismatic shape, it completely resembled tetrahedrite, and von Kobell's detailed account of the chemical and physical properties ends with the statement that (only) the external form of the material distinguishes it from tetrahedrite. Ap-

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TABLE 1. HISTORY OF "STYLOTYPITE"
(Asterisk indicates first-hand study)

Year	Writer	Reference	Locality	Work
1865*	von Kobell, Franz	2	Copiapo, Chile	Proposed as species; made analyses
1892–1914	Dana, *System*, 5th and 6th Ed.	3		Listed as species
1898	Sommerblad, H.	4		Obtained synthetic $3Cu_2S\cdot Sb_2S_3$. Did not name it
1903*	Stevanovic, S.	5	Copiapo, Chile Costrovirroyna, Peru	Measured crystals; made analyses
1908	Groth, Paul	6		Accepted stylotypite as species; discussed relationships
1909	Dana, E. S., and Ford, W. E.	7		Indicated similarity to falkenhaynite
1912	Parravano, N., and de Cesaris, P.	8		Termed synthetic $3Cu_2S\cdot Sb_2S_3$ stylotypite (instead of tetrahedrite)
1916	Murdoch, J.	9		Listed as species
1920	Davy, W. M., and Farnham, C. M.	10		Listed as species (very rare)
1921	Wherry, E. T., and Foshag, W. F.	11		Listed as species
1925*	Hulin, C. D.	12	Randsburg, Calif.	Identified stylotypite
1926	Doelter, C., and Leitmeier, H.	14		Accepted as species requiring further work
1931*	Schneiderhöhn, H., and Ramdohr, P.	1	Chile, Peru	Showed Stevanovic's 1902 work was done on mixture
1939	Gaudin, A. M., and Dicke, G.	15		Synthesized tetrahedrite but found no stylotypite in system $Cu_2S—Sb_2S_3$
1941	Strunz, H.	16		Listed as "tetrahedrite probably pseudomorphous after pyrostilpnite (?)"
1944	Palache *et al.*	17		Listed as species
1948	Klockmann-Ramdohr	18		Status of Peruvian stylotypite (1902) questioned as probably tetrahedrite
1949*	Milton-Axelrod	This paper		California "stylotypite" (1925) found to be tetrahedrite
1949*	Milton-Axelrod	This paper		Bolivian "stylotypite" found to be jamesonite, tetrahedrite, etc.
1949*	Milton-Axelrod	This paper		Peruvian "stylotypite" found to be tetrahedrite

parently, however, this was considered sufficient to give it species rank, and von Kobell's original questionable decision later found support in the even more questionable work of Stevanovic, cited below.

Von Kobell analyzed a specimen of his type material (Analysis *A*, Table 2). His work was repeated on similar material also from Copiapo, Chile, by Stevanovic (5) (Analysis *B*, Table 2). Further analytical work, also by Stevanovic, on "Stylotypite" from Peru, is given in Analyses *C*, *D*, *E*, and *F*, Table 2. This seems to be the total of all reported analyses of this substance.

Stevanovic noted that his Analyses *C*, *D*, and *E* of the Peruvian material are not in good agreement, especially *E*, and recognized this as proof of the heterogeneity of the analyzed material, notwithstanding its seeming homogeneity. Discussing the composition of the material, he ruled out tetrahedrite, which it indeed resembled, because of its darker color and easier solubility in acids—criteria of dubious significance—and also because of its crystallographic characters, of which more below.

He compared the Peruvian "stylotypite" with von Kobell's originally so-named material from Copiapo in Chile. It appeared identical with the Peruvian specimens, and, like these, gave discordant results on repeated analyses (*A* and *B*). He also analyzed a substance of somewhat similar composition, termed falkenhaynite by Scharizer, (20) which, after variously ascribed relationships, is now listed in the new Dana (17) as a discredited or doubtful species referred to the tetrahedrite series.

TABLE 2. ANALYSES OF "STYLOTYPITE"

	A	*B*	*C*	*D*	*E*	*F*
S	24.30	23.12	23.20	23.20	25.75	24.55
Sb	30.53	28.58	22.15	26.31	16.86	18.99
As	—	—	6.20	4.32	6.28	7.07
Bi	—	—	1.12	1.12	.73	.54
Cu	28.00	30.87	41.50	36.05	43.60	45.84
Ag	8.30	10.43	1.40	1.34	1.44	1.62
Fe	7.00	6.27	2.24	2.76	3.98	—
Zn	tr.	tr.	1.54	3.43	.80	.90
Insol.	—	—	.34	1.41	.41	—
	98.13	99.27	99.69	99.94	99.85	99.51

A Copiapo, Chile, von Kobell, analyst.
B Copiapo, Chile, Stevanovic, analyst.
C, *D*, *E* Caudalosa, Costrovirroyna, Peru, Stevanovic, analyst.
F *C* with 10.84% $CuFeS_2$ deducted.

Stevanovic found that the bulk of the Copiapo, Chile, "stylotypite" which he analyzed was not measurable goniometrically, because alteration had roughened the exterior of the nearly rectangular prismatic crystals. However, he found with this material a few crystals of different habit, two of which were "mechanically freed from their rough surface, and *polished with emery and buckskin*." A set of measurements (to seconds of arc! was obtained, and combined with measurements (not given) on "stylotypite from Caudalosa." However, he mentions that all the crystal faces were strongly striated, giving poor reflections. From such data Stevanovic computed axial ratios, etc., and deduced an isomorphous relationship between:

Xanthokon	Ag_3AsS_3
Feuerblende (pyrostilpnite)	Ag_3SbS_3
Stylotyp	$(Cu, Ag, Fe/2, Zn/2)_3(Sb, As, Bi)S_3$

In summary, both the chemical analyses and the goniometric measurements of von Kobell and Stevanovic are unsatisfactory and give no sound basis for considering the material studied to be a valid mineral species. Subsequent workers, with the few exceptions noted, appear to have accepted the original data; e.g., the latest edition of Dana (17) shows stylotypite listed as a species of composition $(Cu, Ag, Fe)_3SbS_3$.

The older literature and data therein cited include crystallographic measurements by Stevanovic on material from the Caudalosa mine, Costrovirroyna, Peru; this was later shown by Schneiderhöhn and Ramdohr (1) to be a mixture of a mineral in all respects like tetrahedrite, together with pyrite, enargite, and possible wittichenite, etc.

Sommerblad (4) obtained a compound of formula Cu_3SbS_3 by fusion of copper chloride with antimony sulfide; its density was 5.182. That of a similar compound made from copper sulfide and antimony sulfide was 5.113. He noted that a cuprosulfantimonite of formula Cu_3SbS_3 ($=3Cu_2S \cdot Sb_2S_3$) corresponding to (trigonal) pyrargyrite Ag_3SbS_3, does not occur in nature. Groth (6) discussing the orthosulfarsenic and orthosulfantimonic salts of univalent metals, noted that they form isodimorphous groups, the so-called ruby silvers of trigonal and a less common monoclinic symmetry; the latter is represented by stylotypite, essentially Cu_3SbS_3, with antimony partly replaced by arsenic, and copper by silver. It is, according to Groth, isomorphous with xanthoconite and pyrostilpnite.

Numerous other investigators have studied the system Cu_2S—Sb_2S_3, in particular Parravano and de Cesaris (8). They found two maxima on the fusion curve, one at 542° corresponding to $Cu_2S \cdot Sb_2S_3$ or $CuSbS_2$ (chalcostibite), the other at 607° corresponding to $3Cu_2S \cdot Sb_2S_3$ or

Cu_3SbS_3 ("stylotypite"). This may have been properly tetrahedrite, for all evidence to the contrary. Murdoch (9) listed stylotypite as a species; he gave the properties of a "fairly reliable" specimen from an unstated locality. He noted that the color in polished section was "practically the same" as (associated) tetrahedrite.

Davy and Farnham (10) in their textbook listed stylotypite as a "very rare" species.

In 1921, Wherry and Foshag (11) also accepted "stylotypite" as a species, with monoclinic symmetry.

Doelter and Leitmeier (14) cited the analyses already given, with Stevanovic's crystallographic data, and remarked that further examination of the mineral was in order.

Gaudin and Dicke (15) synthesized chalcostibite and teterhedrite, also famitinite ($3Cu_2S \cdot Sb_2S_5$) as well as the simple sulfides from melts containing copper, sulfur, and antimony. They referred briefly to stylotypite, mentioning both von Kobell's discovery and that Schneiderhöhn considered the mineral to be a variety of tetrahedrite. They found that the only compound of composition Cu_3SbS_3 formed in their synthesis was always isotropic, and it was termed by them tetrahedrite without question.

A recent textbook (18) referred to the stylotypite from the Caudalosa mine, Peru (page 347), as probably pseudomorphs, now tetrahedrite; and (on page 371) as possibly pseudomorphs after pyrostilpnite.

Some years ago we became interested in this questionable substance, and wrote letters of inquiry to various mineralogists who might have some available for study. Also, through the kindness of Dr. Walter F. Hunt, a notice (19) of our interest was published, with no response. Only three mineralogists to whom we wrote had any, or knew where it might be obtained. Only three specimens labelled stylotypite turned up: in the collections of the National Museum, Washington, D. C., from the University of California, and one—the type Peruvian material—from the University of Freiburg in Breisgau, Germany. All of these have been studied by us, with results as follows:

"Stylotypite" from Bolivia

The first (C776) from the Canfield Collection now in the U. S. National Museum was labelled stylotypite, Machacamata (Machacamarca?), Bolivia. We have studied this, and find that the specimen consists of stubby prismatic crystals, and a massive mineral of similar lead gray color, showing a good conchoidal fracture. The two minerals have been respectively identified by x-ray study as jamesonite and tetrahedrite. Other ore minerals in subordinate quality can be seen microscopically.

The optical characteristics of this jamesonite differ somewhat from those stated in the literature, the mineral having lower birefringence than normal, and showing a slight development of twinning lamellae. Cleavage is not evident, and there is no "feathery" structure. The mineral is soft, with a brilliant "galena-white" reflection. J. M. Axelrod has identified the *x*-ray diffraction pattern as that of jamesonite. Further, Cyrus Feldman has analyzed the mineral spectroscopically, finding.

Major	Pb, Sb
Minor	Cu, Ag, Fe
Trace	Bi, As, B, Ni, V

The tetrahedrite was likewise identified by *x*-ray and spectroscopic studies showing:

Major	Cu, Sb, Ag
Minor	Zn, Fe
Trace	Bi, As, B, Ni

Optically, the tetrahedrite is normal—isotropic without cleavage. However, there are two varieties of two distinct shades of olive brown, the lighter more abundant, the darker occurring as inclusions in the first. Tetrahedrite often shows such variability.

Numerous tiny inclusions of chalcopyrite are present in the tetrahedrite, nearly always associated with equally tiny particles of a highly birefringent unidentified mineral.

Thus the Bolivian "stylotypite" is found to be a mixture, essentially of columnar jamesonite and massive tetrahedrite.

"Stylotypite" from California

The second specimen labelled stylotypite was obtained through the courtesy of Professor Carlton D. Hulin, who found it in the Rand silver mine, Randsburg, California (12). In a letter (13) to C. Milton, Professor Hulin stressed the tentative character of his identification, as necessarily resting on the mineralogical tables then available. The following quotations from his letter describe the occurrence, and supplement the published account:

"The determination (of stylotypite) was made about 1922–1923 at a time when the only mineral identification tables available for polished sections were those of Murdoch and Davy & Farnham. While the properties of the California Rand mineral reasonably satisfied the data given for stylotypite, considerable doubt naturally exists as to its true nature.

"In the California Rand ore the stylotypite lies between chalcopyrite and miargyrite-pyrargyrite-proustite in time—therefore forming at a time when copper-iron-silver-antimony-sulphur might reasonably have been concurrently present in the mineralizing solutions. Remnants of chalcopyrite being replaced by stylotypite occur in moth-eaten patches resulting from replacement by miargyrite and pyrargyrite. The stylotypite characteristically was deposited in drusy cavities lined with quartz crystals, and overlapping the deposition of the quartz is itself usually filled with scattered tiny quartz crystals. These usually are torn out on polishing, leaving the "stylotypite" with a pitted surface.

"The stylotypite reacts with HNO_3, but is negative to other reagents used by Davy & Farnham. Hardness about 3 and apparently a little softer than tetrahedrite or chalcopyrite. Streak black. Color in polished section a faint pinkish-white or flesh color not unlike enargite or famatinite, but differing from those minerals in being apparently isotropic.

"I obtained definite qualitative microchemical tests for copper, silver, and iron on fragments gouged from the polished surface with a needle.

"I have a number of specimens of ore from the California Rand, but except in the polished surface the stylotypite is never apparent due to the varying degree of replacement by miargyrite, pyrargyrite, and locally other silver minerals, which is always shown."

X-ray study by J. M. Axelrod of the isotropic mineral gave the pattern of tetrahedrite. Spectrographic study of the same material by K. J. Murata showed:

Major elements	(>1%)	Sb, Cu, Ag, Fe, Si, Al, Pb
Minor elements	(.X%)	Mg, Ti
	(.0X%)	Zn, Ni, As, Sn, Mn, Ba, V
	(0.01%)	Au?
Not found		B, P, Sr, Mo, Be, Cb, Ta, Re, Y, La, Co, Bi, Ge, In, Se, Te, Hg, Pt, W, Zr

Evidently, then, Hulin's stylotypite is tetrahedrite.

Finally, Professor Hans Schneiderhöhn has generously permitted us to study the type "stylotypite" from the Caudalosa mine, Costrovirroyna, Peru (Specimen No. 208, Mineralog. Inst., Freiburg) (1). *X*-ray study of this showed a pattern identical with that of tetrahedrite from various localities.

We are indebted to those mentioned above for having given us material for study or data concerning stylotypite. We are also indebted to F. A. Bannister, of the British Museum, C. Frondel, of Harvard University, F. H. Pough, of the American Museum of Natural History (New York), E. W. Nuffield, University of Toronto, Horace Winchell, Yale University, Vicente Juarez-Hoyos, Director of the Servicio Geologico Nacional, Bogota, Colombia, Robert Herzenberg, Oruro, Bolivia, Mark C. Bandy, Economic Cooperation Administration, Alfredo Garcia Stens, Banco

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