ORDOÑEZITE, ZINC ANTIMONATE, A NEW MINERAL FROM GUANAJUATO, MEXICO[1]

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Abstract

Tin ores from the Santín mine, Guanajuato, Mexico, contain a new mineral having the chemical composition Zn Sb_2O_6. Chemical analysis gave ZnO 20.07, Sb_2O_5 80.49 SiO_2 and Al_2O_3 n.f.; sum 100.56 per cent. It occurs in small pale to dark brown tetragonal crystals showing the forms {001}, {011} and {110}, and usually twinned on {013}. Unit cell dimensions are $a=4.67$, $c=9.24$ Å, space group *P4/mnm*. The structure is the trirutile type, and the mineral is isostructural with tapiolite ($FeTa_2O_6$), bystromite ($MgSb_2O_6$), and many other artificial antimonates and tantalates. Its physical and optical properties are as follows: cleavage none, fracture conchoidal, hardness $6\frac{1}{2}$, specific gravity 6.635 (calculated 6.657), luster adamantine, uniaxial (+), $n>1.95$. Ordoñezite occurs in small veinlets in rhyolitic rocks associated with cassiterite, cristobalite, tridymite, hematite, sanidine, topaz, and fluorite.

Introduction

In 1941 a collection of cassiterite was acquired by the U. S. National Museum from the Santín mine, Cerro de las Fajas, Santa Caterina, Guanajuato, Mexico. Several specimens were analyzed spectrographically to determine the cause of a wide color range. Two had zinc and antimony as major constituents. Further investigation revealed that this material was a new mineral having the composition $ZnSb_2O_6$. It has been named ordoñezite (or-dohn′-yez-ite), in honor of the late Ezequiel Ordoñez, formerly head of the Instituto de Geologia de Mexico, and one of Mexico's greatest geologists.

The writers wish to thank the Lucius Pitkin Company, New York City, for making the first spectrographic analyses, K. J. Murata of the U. S. Geological Survey for additional spectrographic analyses, and J. J. Fahey, also of the Survey for a specific gravity determination.

Chemistry

A spectrographic analysis of ordoñezite is given in Table 1.

The results of a chemical analysis of the same sample are given in Table 2.

Ordoñezite is insoluble in acids and was put into solution by sintering with sodium peroxide in a platinum crucible at 480° C. The antimony was precipitated as the sulfide in sulfuric acid solution, the sulfide redissolved, and titrated with 0.1 N potassium permanganate. Zinc was precipitated as the sulfide in 0.01 N sulfuric acid and ignited at 900° C. to

[1] Publication authorized by the Secretary, Smithsonian Institution, Washington, D. C.

TABLE 1. SPECTROGRAPHIC ANALYSIS OF ORDOÑEZITE FROM THE SANTÍN MINE, GUANAJUATO, MEXICO (USNM R9127; K. J. MURATA, ANALYST)

Per Cent	Element
>1	Zn, Sb
0.X	Al, Si
0.0X	Mg, Sn, Fe, Na, Cu
0.00X	Ca, Mn, Ti, Li, In

Not found: As, Pb, Cd, Co, Ni, U, Cr, Bi, Ge, Mo, W, Tl, Ag, Ga, Ba, Sr, Be, B, Zr, P, Nb, Y, La.

TABLE 2. CHEMICAL ANALYSIS OF ORDOÑEZITE FROM THE SANTÍN MINE, GUANAJUATO, MEXICO

	1	2		3
ZnO	20.07	0.247	1	20.10
Sb_2O_5	80.49	0.249	1.01	79.90
SiO_2	n.f.			
Al_2O_3	n.f.			
	100.56			100.00

1. Ordoñezite. USNM R9127. G. Switzer, analyst.
2. Molecular ratios.
3. Theoretical composition of $ZnSb_2O_6$.

convert it to the oxide. Silicon and aluminum were sought for but not found.

X-RAY DATA

Ordoñezite gives an *x*-ray powder pattern identical with that of artificial $ZnSb_2O_6$, and is isostructural with bystromite ($MgSb_2O_6$) and tapiolite ($FeTa_2O_6$). The *d* spacings of these compounds are compared in Table 3.

The crystal structure of $ZnSb_2O_6$ has been determined by Byström, Hök and Mason (1942). It has a trirutile-type structure, with space group *P*4/*mnm*, and unit cell dimensions $a=4.66$ *k*X, $c=9.24$ *k*X.

Rotation and zero layer photographs of an ordoñezite crystal gave $a=4.67$ Å, $c=9.24$ Å (both values ± 0.01 Å). From this the axial ratio is $c=1.979$.

The unit cell contains $Zn_2Sb_4O_{12}$. The calculated density is 6.657 (measured 6.635).

TABLE 3. COMPARISON OF X-RAY *d* SPACINGS OF ORDOÑEZITE, ARTIFICIAL $ZnSb_2O_6$, BYSTROMITE AND TAPIOLITE

Ordoñezite[1]		$ZnSb_2O_6$[2]		Bystromite[3]		Tapiolite[4]		*hkl*[5]
I	*d*	*I*	*d*	*I*	*d*	*I*	*d*	
10	4.58			40	4.63	10	4.60	100
20	4.11			70	4.19	10	4.21	101
90	3.26	v. st.	3.30	100	3.32	90	3.34	110
10	2.65	w.	2.69	30	2.69	10	2.71	112
80	2.55	st.	2.58	90	2.57	80	2.58	103
40	2.31	m.	2.33	50	2.34	50	2.37	200
20	2.23	w.	2.24	20	2.25	20	2.26	113
20	2.07	w.	2.08					210, 202
20	2.02	w.	2.03	30	2.04	10	2.06	211
10	1.90	m.	1.89					114
100	1.72	v. st.	1.72	90	1.73	100	1.74	213
		v. w.	1.71					105
50	1.64	st.	1.64	40	1.65	70	1.68	220
		v. w.	1.63					204
		v. w.	1.55					222
30	1.54	st.	1.54	20	1.54	30	1.53	006
50	1.47	st.	1.52	40	1.48	60	1.50	310
40	1.39	st.	1.39					116
60	1.38	st.	1.38			50	1.39	303, 205
30	1.28	m.	1.28	10	1.28	30	1.29	206
10	1.24	—	1.24					314
60	1.19	st.	1.19	30	1.19	50	1.21	323

[1] Ordoñezite, Santín mine, Guanajuato, Mexico; USNM R9127; camera radius 114.59 mm; λCu = 1.5418 Å.

[2] Artificial $ZnSb_2O_6$. Data from Byström, Hök and Mason (1942), *d* converted from *k*X to Å.

[3] Bystromite, Sonora, Mexico. Data from Mason and Vitaliano (1952), *d* in Å.

[4] Tapiolite, Chanteloube, France. USNM 86267, camera radius 114.59 mm., λCu = 1.5418 Å.

[5] Values of *hkl* from Byström, Hök and Mason (1942).

MORPHOLOGY

Ordoñezite occurs as drusy or stalactitic masses of repeatedly twinned tetragonal crystals having a maximum size of 2 mm. Two twin crystals of excellent quality were measured. One with (100) as pole gave for two faces of {011}, $H = 26° 51'$ and $26° 46'$ respectively, corresponding to rho values of 63° 09′ and 63° 14′. From these, $c = 1.9797$, in excellent agreement with $c = 1.979$ obtained from *x*-ray measurements. The second crystal was mounted to rotate about the intersection of (100) and the twin plane. Measurements made with the crystal in this position were plotted on a stereographic net and rotated about [100] to place [001] vertical. This identified the twin plane as (013), the same as that reported for tapiolite. Only {110} and {011} were observed on the twin crystals.

A few very small single crystals of ordoñezite were found, one of which was used to determine unit cell dimensions by the Weissenberg method. Only faces of {110} and {011} gave measurable signals. {001} is present but etched.

The appearance of typical ordoñezite crystals is shown in Fig. 1.

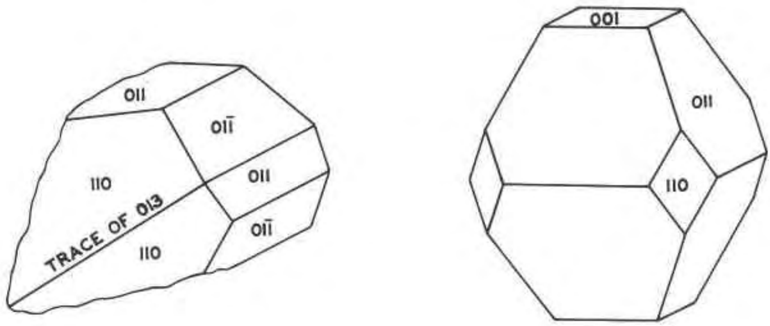

FIG. 1. Twin and single crystals of ordoñezite from the Santín mine, Guanajuato, Mexico.

Physical and Optical Properties

Ordoñezite has the following physical properties: cleavage none, fracture conchoidal, hardness $6\frac{1}{2}$, specific gravity 6.635 (4° C.), luster adamantine, color very light to very dark brown, variable from colorless to pearl gray, olive buff to dark olive, light yellowish olive, bone brown (Ridgeway), transparent.

The optical properties of ordoñezite are: uniaxial (+); indices of refraction much higher than the highest liquid available (1.95), and probably considerably higher than 2.0.

Occurrence

Rhyolitic rocks with veinlets or fractures carrying cassiterite and associated minerals are found in many parts of Mexico. In almost every rhyolitic area in the country, from Sonora and Chihuahua on the north to Chiapas on the south, some cassiterite can be found. A small tin mining industry is based upon these cassiterite occurrences, operated by *gambusinos* or pocket-hunters. One of the characteristic features of these occurrences is the association of the high temperature forms of silica, cristobalite and tridymite, with the cassiterite. Quartz, chalcedony, or opal may also be present, but their association with the cassiterite is less intimate. Hematite is a very common associate of the tin mineral; magnetite is rarer. Also present in the ores are sanidine, topaz, fluorite, and rarely zeolites.

Genth (1887) reported the analyses of some of these Mexican cassiterite ores in which were found appreciable to large amounts of lead, zinc, bismuth, antimony, and arsenic. Ingalls (1895) quotes two analyses of pig tin from Mexican ores which show appreciable quantities of lead and bismuth, and large quantities of antimony. These impurities in the tin ores and the smelted metal suggest the presence of unrecognized accessory minerals. Arsenic and lead may be ascribed to mimetite (Diablo mine, Durango; Cabires mine, Michoacan, Zimapan, Hidalgo); antimony and zinc minerals have not been reported previously.

The Santín mine is one of these small tin occurrences in rhyolitic rocks. It can be reached most easily from San Luis de la Paz to Victoria to Santa Catarina (42 miles) by car, and Santa Catarina to Rancho Ruscia ($4\frac{3}{4}$ miles) by trail. Rancho Ruscia lies at the western foot of Cerro de las Fajas, a high hill of bedded lava flows, whose banded appearance gives the hill its name. The Santín mine lies on the lower south slope of the Cerro de las Fajas, only a short distance from the ranch-house. The mine has been described briefly by Foshag and Fries (1942).

The rock of the Santín mine is broken by a system of small fractures that appear to be confined, principally, to a narrow east-west zone. These fractures carry a little clay and the ore mineral cassiterite. According to Sr. Martin Sutti, owner of the mine, pockets of ore occur along these fractures but the individual pockets seldom yielded more than 75–100 kilograms of cassiterite. Much of the ore from the Santín mine consisted of beautiful branching groups of seal brown cassiterite crystals. According to Sutti, the cassiterite in the upper portions of this small mine was botryoidal, becoming more crystallized with depth.

Ordoñezite occurs sparingly with the cassiterite. An analysis of a 15 ton lot shipped from the mine showed 2.16 per cent of Sb_2O_3, indicating an ordoñezite content of about three per cent. Associated minerals, in addition to the cassiterite, are hematite, quartz, cristobalite, hyalite, and montmorillonite. Cassiterite and hematite were the earliest minerals to form, followed by ordoñezite. The ordoñezite may rest directly upon the rock, or upon an earlier crust of red cassiterite, or cassiterite and hematite. Small prismatic crystals of quartz perch directly upon cassiterite or ordoñezite, and are distinctly later. Cristobalite, as small white drusy balls, was found on a few groups of cassiterite crystals, but not in direct association with ordoñezite. Hyalite is rare upon quartz. The sequence of mineral deposition in these fractures was (1) cassiterite and hematite,

(2) ordoñezite, (3) cristobalite, (4) quartz, (5) hyalite and (6) montmorillonite.

These cassiterite occurrences in rhyolitic rocks are believed to be deposited from aqueous vapor solutions resulting from the congelation of lava flows, as a late stage in their crystallization. Morey and Hesselgesser (1951) have demonstrated the appreciable solubility of silica in superheated steam, and Foshag (1926) has shown how such vapors can yield cristobalite and tridymite. Hematite shows an appreciable solubility in such vapors, but the solubility of cassiterite is quite low.

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Manuscript received Jan. 11, 1954