

MIARGYRITE SILVER ORE FROM THE RANDSBURG DISTRICT, CALIFORNIA

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INTRODUCTION

Miargyrite, one of the rarest of the sulphantimonites of silver crystallizing in the monoclinic system, has the formula $\text{Ag}_2\text{S}\cdot\text{Sb}_2\text{S}_3$. It has been found in the United States only in the Flint and Silver City districts in Owyhee County, Idaho,¹ and in the Randsburg district of California.² In the latter district it has been abundant in the bonanza silver ores lately worked by the California Rand Mining Co. Shortly after the discovery of the rich silver ores of these mines an excellent series of specimens was obtained for the National Museum by Frank L. Hess. These specimens form the basis for the following description.

Although the Randsburg district has been prospected since the sixties and has been an active mining region since 1893, the rich silver ores were not discovered until April 12, 1919.³ The original outcrop of the ore was on the Juanite claim, only about 30 feet from a well-traveled road about 2 miles southeast of the town of Randsburg. The ore at the surface was very rich and all of the material mined was shipped to the smelter, leaving the mine literally without a dump. The specimens received by the United States National Museum are labeled as from the Kelly mine, which is one of the compact group now included in the California Rand properties.

There are a number of veins belonging to two systems that are rather complex in their relationships. The country rock consists of mica-albite and amphibole schists of pre-Cambrian age. Only two of the numerous silver veins outcropped, and one of these two is too low grade to be worked at a profit. The original discovery was made on the Shaft vein at the only point at which it came to

¹ Earl V. Shannon. The Minerals of Idaho. Bull. U. S. Nat. Mus. 131, pp. 148-150, 1926; Miargyrite and Tetrahedrite from the Flint District, Idaho. Amer. Min., vol. 13, No. 1, pp. 18-21, January, 1928.

² Arthur S. Eakle. Minerals of California. Calif. State Mining Bureau Bull. 91, p. 70, 1923, and Carlton D. Hulin. Geology and Ore Deposits of the Randsburg Quadrangle of California. Calif. State Mining Bureau Bull. 95, 1925.

³ Hulin. Geology and Ore Deposits of the Randsburg Quadrangle of California, p. 103.

the surface and the surface ore was very rich, assaying 300 ounces of silver and 3 ounces of gold to the ton. Adjacent to the veins the schists are commonly rather highly altered and frequently silicified and cut by veinlets of silica and pyrite. The walls of the veins are more or less indefinite and gradational.⁴

ORES

The richest specimens at hand consist of massive silver minerals, somewhat fractured and traversed by thin fillings of quartz. These contain a few cavities lined by crystals of miargyrite over which there may or may not be a discontinuous coating of clayey substance. The massive material consists principally of massive miargyrite. Hulin writes that miargyrite is the most abundant and important silver mineral of the region, but that stylumite is only slightly less important. He says that the latter mineral is not apparent in the hand specimens, since it ordinarily occurs in minute irregular or rounded grains, commonly microscopic in size, which are usually entirely surrounded by miargyrite. The stylumite is further almost invariably associated with chalcopyrite and occasionally with argentiferous bornite. Hulin defines stylumite as a silver-bearing bournonite with the formula $3(\text{Cu}_2, \text{Ag}_2, \text{Fe})\text{S} \cdot \text{Sb}_2\text{S}_3$, which is the formula given for this mineral by Dana. It was identified by him in polished surfaces under reflected light and is described as brittle, metallic, dark gray in color, and with a black streak. Microchemical and blowpipe tests indicated the presence of silver, iron, antimony, and sulphur in the Randsburg mineral. On polished sections it is faintly gray and slightly lighter in color than the miargyrite.

Wherry and Foshag⁵ give as the formula for stylumite simply $3\text{Cu}_2\text{S} \cdot \text{Sb}_2\text{S}_3$. Since the composition of this mineral is so incompletely known it was hoped that enough of the Randsburg material could be obtained for analysis. The coarse-grained massive high-grade ore was sawed and polished and etched on the polished surface with nitric acid. It was found to consist almost entirely of miargyrite which was unattacked by the nitric acid. There was present, however, a little interstitial material which etched bronzy and probably is the mineral identified as stylumite by Hulin, but it was in such small amount and so intergrown with miargyrite as to render the separation of a portion for analysis impracticable.

The majority of the specimens of the lot consists of a breccia of fragments of dark gray fine-grained siliceous material the open interstices of which are lined with a layer of white quartz covered with a druse of minute transparent quartz crystals. It is resting upon the

⁴ Hulin. *Geology and Ore Deposits of the Randsburg Quadrangle of California*, p. 112.

⁵ Edgar T. Wherry and W. F. Foshag. *A New Classification of the Sulphosalt Minerals*. *Journ. Wash. Acad. Sci.*, vol. 11, No. 1, pp. 1-8, January, 1921.

quartz crystals in these vugs that the best crystals of miargyrite are found, although other less perfect crystals line the vugs in massive miargyrite. Hulin notes that small amounts of arsenopyrite, pyrite, pyrargyrite, proustite, chalcopyrite, argentiferous bornite, and stibnite also occur in the ore, but in the specimens at hand these minerals are not conspicuous and do not present any features worthy of special note. Green chromiferous mica is reported to occur rarely in altered wall rock in the outcrop of the Footwall vein.

The paragenesis of the minerals has been discussed in detail by Hulin. The stylumite (?) is in part contemporaneous with quartz and is older than miargyrite, which sometimes replaces it. The order of genesis of the several minerals is given as:

A. Primary:

1. Silica (chalcedony and quartz).
2. Pyrite.
3. Arsenopyrite.
4. Stylumite.
5. Chalcopyrite.
6. Argentiferous bornite.
7. Miargyrite.
8. Pyrargyrite.
9. Proustite.
10. Stibnite.
11. Calcite.

B. Secondary:

12. Secondary sulphides.
13. Cerargyrite.
14. Melanterite.

The following metallographic properties and reactions which are obtained on polished sections of the miargyrite are the characteristic ones for the species:

Color in section: Gray with red internal reflections in places.

Anisotropism: Strong.

Color in powder: Dark ruby red, distinctly darker than pyrargyrite.

1:1 HNO₃: Negative.

1:1 HCl: Fumes tarnish; in places negative.

20 per cent KCN: Slowly stains brown.

20 per cent FeCl₃: Negative.

40 per cent KOH: Stains iridescent.

5 per cent HgCl₂: Negative.

Since it was not desired to sacrifice the well-crystallized specimens by removing crystals enough to analyze, the analyzed material was taken from a coarse-grained massive specimen. (Cat. U.S.N.M. No. 95334.) By boring shallow pits in the centers of large and pure grains of miargyrite on polished surfaces 0.2 gram of pure sample was obtained. This was analyzed in the Museum laboratory with the following results:

Analysis of miargyrite from Randsburg, Calif.

Earl V. Shannon, analyst

	Found	Theory
Insoluble.....	0. 80	-----
Silver.....	36. 20	36. 90
Copper.....	. 02	-----
Iron.....	. 56	-----
Lead.....	. 95	-----
Antimony.....	42. 46	41. 20
Arsenic.....	Trace.	-----
Sulphur.....	19. 27	21. 90
	100. 26	100. 00

This analysis shows that the mineral is normal miargyrite, free from unusual constituents. It is a mineral of relatively low silver content as compared with the other silver minerals, with red streak which are commonly called ruby silver, and include proustite, pyrargyrite, and polybasite.

The crystals of miargyrite occur either lining cavities in the massive mineral or implanted on the drusy quartz of the vugs in the breccia ore. They are very brilliant black in color but tend to tarnish and become iridescent in the air. None of those in the specimens at hand are large, the most of them being between 1 and 3 millimeters in diameter. They occur singly or in small clusters grown together in haphazard fashion. No recognizable twins were found.

This mineral is monoclinic in crystallization and crystals from all localities are characterized by a rather peculiar general habit, being thick tabular parallel to the base c (001) with a predominance of faces lying in the zone between the front pinacoid a (100) and the side dome (011). This is especially true of the Randsburg material. This habit

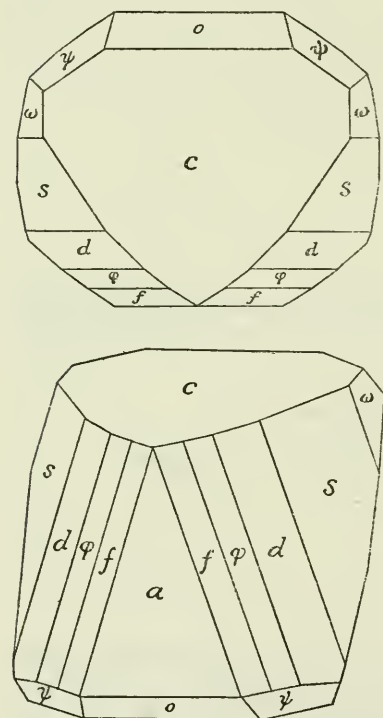


FIG. 1.—CRYSTAL OF MIARGYRITE THICK TABULAR ON c (001)

makes the crystals very hard to orient. Although the basal pinacoid is usually present, this is inclined to the pole. The a (100) pinacoid is the only face developed in the prismatic zone and this is usually

so striated as to give very poor signals. Even when the correct orientation is known, this habit makes very precise adjustment on the goniometer almost impossible. Moreover, most of the crystals appear to have been fractured through the center, and the halves, although firmly recemented, are displaced a degree or more with reference to each other.

The crystal illustrated in Figure 1 (crystal 1993) is from the specimen (Cat. No. 95334) of massive miargyrite which furnished the material for analysis. It is typical of those occurring in the vugs in massive ore, although the larger of these are deeply striated and grooved and, being crowded and grown flat against the walls of the cavity, are seldom completely developed. These are somewhat simpler in habit and show a less number of forms than those resting upon quartz druses. This crystal gave the following measurements:

Measurements of miargyrite crystal, Figure 1

Form		Symbol		Quality description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
1	<i>c</i>	0	001	Fair.....	91 51	8 32	90 00	8 37
2	<i>a</i>	$\infty 0$	100	Good.....	90 00	90 00	90 00	90 00
3	<i>O</i>	-10	$\bar{1}01$	Fair.....	90 03	39 31	90 00	39 43
4	<i>A</i>	+1	111	-----do-----	22 03	71 43	21 18	72 15
5	<i>A</i>	+1	111	-----do-----	22 05	72 13	21 18	72 15
6	<i>S</i>	+21	211	Good.....	36 01	74 26	36 03	74 28
7	<i>S</i>	+21	211	P. blurred.....	35 28	73 53	36 03	74 28
8	<i>d</i>	+31	311	Good, dim.....	45 48	77 07	46 49	76 46
9	<i>f</i>	$+\frac{9}{2}1$	922	-----do-----	59 12	77 30	57 32	79 33
10	φ	+41	411	V. dim, end of zone.	50 57	78 32	54 31	78 43
11	ψ	$-\frac{41}{33}$	413	Poor, dim.....	49 39	56 11	50 03	56 30
12	ψ	$-\frac{41}{33}$	413	-----do-----	50 48	56 11	50 03	56 30

All of the crystals are strongly striated in two zones. The most prominent set of striations is parallel to the intersections of the faces in the zone 100:011 and the faces of this zone are often rounded by oscillation between the various forms in this zone with many vicinal forms. The striation is more marked in the end of the zone toward the front pinacoid and diminishes toward the opposite end, the form (011) being usually brilliant. Another less prominent series of striae occurs in the zone (100):(001). These two sets of striations are both present on the a (100) face and this together with the triangular or inverted keystone shape of the face serves to identify it and to orient the crystal.

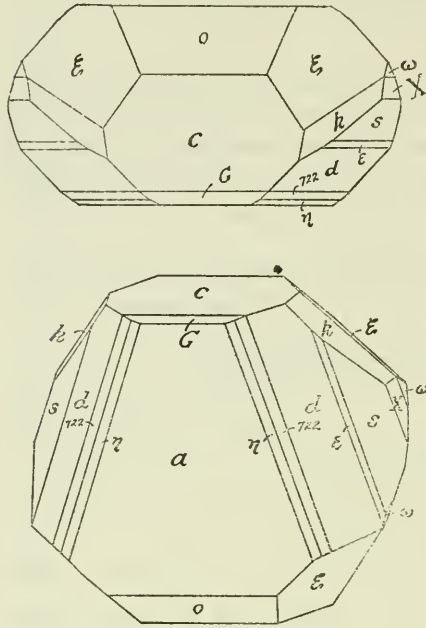


FIG. 2.—CRYSTAL OF MIARGYRITE THICK TABULAR ON a (100)

tabular parallel to the base. Every gradation exists between these two types. The former is illustrated in Figure 2. This crystal gave the following measurements:

Measurements of miargyrite crystal, Figure 2

Form		Symbol		Quality description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
1	c	0	001	Striated, blurred	90 01	8 00	90 00	8 37
2	a	$\infty 0$	100	Good	90 01	90 00	90 00	90 00
3	a	$\infty 0$	100	Excellent	89 41	90 01	90 00	90 00
4	ω	01	011	Good, minute	3 42	70 48	2 59	71 06
5	o	-10	$\bar{1}01$	Excellent	$\bar{8}9$ 55	39 56	$\bar{9}0$ 00	39 43

Measurements of miargyrite crystal, Figure 2—Continued

Form		Symbol		Quality description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
6	X	$+\frac{1}{2}1$	122	Excellent.....	21 32	71 53	19 48	72 05
7	X	$+\frac{1}{2}1$	122	do.....	21 18	72 06	19 48	72 05
8	s	+21	211	do.....	38 05	74 39	36 03	74 28
9	s	+21	211	Medium.....	36 00	74 04	36 03	74 28
10	new?	$+\frac{7}{2}1$	722	Excellent.....	49 05	76 43	50 59	77 48
11	d	+31	311	do.....	47 16	76 42	46 49	76 46
12	d	+31	311	do.....	47 45	76 43	46 49	76 46
13	ϵ	$+\frac{5}{2}1$	522	Good.....	42 17	75 32	41 53	75 39
14	η	+61	611	do.....	63 42	80 56	64 18	81 32
15	η	+61	611	Poor.....	65 23	82 00	64 18	81 32
16	k	$+\frac{11}{42}$	124	Very poor.....	16 29	56 32	15 19	56 27
17	G	$+\frac{1}{5}0$	105	V. p. stri.....	90 09	16 37	90 00	19 13
18	ξ	$\frac{21}{33}$	$\bar{2}13$	P. blurred.....	$\bar{30}$ 35	48 19	$\bar{27}$ 25	47 32
19	ξ	$\frac{21}{33}$	$\bar{2}13$	do.....	$\bar{30}$ 17	48 19	$\bar{27}$ 25	$\bar{47}$ 32

The only face which can not be reasonably referred to an established form is:

No. 10. Measured.....	$\varphi=49$ 05	$\rho=76$ 43
722 calculated.....	50 59	77 48
Difference.....	$\Delta=1$ 54	$\Delta=1$ 05

These crystals vary gradually to the general type shown in Figure 3, in which the front pinacoid is reduced to a small face and the crystal is distinctly tabular parallel to the basal pinacoid c (001). The crystal of this type measured gave the angles:

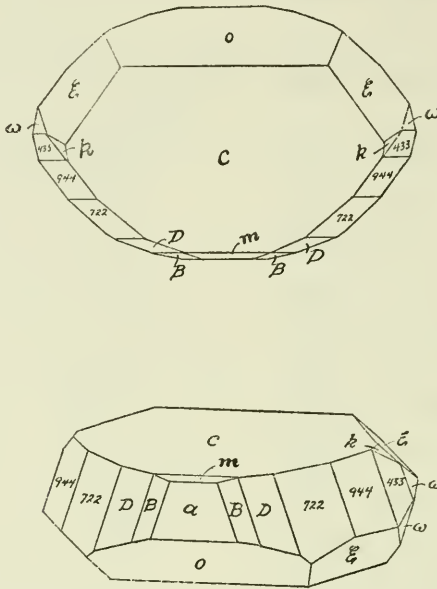


FIG. 3.—CRYSTAL OF MIARGYRITE TABULAR ON c (001)

Measurements of miargyrite crystal, Figure 3. (Lab. No. 1992)

Form		Symbol		Quality description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
1	c	0	001	Stri., double.....	89 55	90 53	90 00	8 37
2	a	$\infty 0$	100	P. blurr.....	90 40	91 00	90 00	90 00
3	m	+10	101	V. v. p. line.....	91 23	48 36	90 00	48 37
4	o	-10	$\bar{1}01$	Med. blurred.....	$\bar{9}1$ 00	38 09	$\bar{9}0$ 00	39 43
5	ω	01	011	Good.....	2 48	70 30	2 59	71 06
6	ω	01	011	Med. blurred.....	2 49	70 20	2 59	71 06
7	D	+71	711	Narrow line.....	68 34	82 21	67 31	82 31
8	New?	$+\frac{7}{2}1$	722	P. end of zone.....	48 09	77 46	50 59	77 48
9	New?	$+\frac{7}{2}1$	722	Excellent.....	50 18	77 16	50 59	77 48

Measurements of miargyrite crystal, Figure 3—Continued

Form		Symbol		Quality description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
10	New?	$+\frac{7}{3}1$	733	Excellent.....	$37^{\circ} 53'$	$75^{\circ} 16'$	$40^{\circ} 02'$	$75^{\circ} 15'$
11	New?	$+\frac{7}{3}1$	733	Good.....	$39^{\circ} 25'$	$74^{\circ} 38'$	$40^{\circ} 02'$	$75^{\circ} 15'$
12	New?	$+\frac{4}{3}1$	433	Excellent.....	$24^{\circ} 45'$	$72^{\circ} 15'$	$26^{\circ} 41'$	$72^{\circ} 56'$
13	New?	$+\frac{4}{3}1$	433	do.....	$24^{\circ} 59'$	$72^{\circ} 15'$	$26^{\circ} 41'$	$72^{\circ} 56'$
14	B	+15.1	15.1.1	Poor, rounded.....	$78^{\circ} 18'$	$86^{\circ} 00'$	$78^{\circ} 57'$	$86^{\circ} 14'$
15	k	$+\frac{11}{42}$	124	Good.....	$19^{\circ} 30'$	$56^{\circ} 34'$	$15^{\circ} 19'$	$56^{\circ} 27'$
16	k	$+\frac{11}{42}$	124	do.....	$18^{\circ} 07'$	$57^{\circ} 05'$	$15^{\circ} 19'$	$56^{\circ} 27'$
17	ξ	$-\frac{21}{33}$	$\bar{2}13$	Medium.....	$28^{\circ} 44'$	$47^{\circ} 34'$	$27^{\circ} 25'$	$47^{\circ} 32'$
18	ξ	$-\frac{21}{33}$	$\bar{2}13$	Poor, mult.....	$25^{\circ} 16'$	$47^{\circ} 34'$	$27^{\circ} 25'$	$47^{\circ} 32'$

Of the faces measured on this crystal three forms, represented by two faces each, are apparently new, although the quality of the faces is such that it can not be positively asserted the indices derived for these are correct. They are:

No. 8.....	$\varphi=48^{\circ} 09'$	$\rho=77^{\circ} 46'$
No. 9.....	$50^{\circ} 18'$	$77^{\circ} 16'$
Average.....	$49^{\circ} 14'$	$77^{\circ} 31'$
722 calculated.....	$50^{\circ} 59'$	$77^{\circ} 48'$
Difference.....	$\Delta=1^{\circ} 45'$	$\Delta=0^{\circ} 17'$
No. 10.....	$\varphi=37^{\circ} 53'$	$\rho=75^{\circ} 16'$
No. 11.....	$39^{\circ} 25'$	$74^{\circ} 38'$
Average.....	$38^{\circ} 39'$	$74^{\circ} 57'$
733 calculated.....	$40^{\circ} 02'$	$75^{\circ} 15'$
Difference.....	$\Delta=1^{\circ} 23'$	$\Delta=0^{\circ} 18'$
No. 12.....	$\varphi=24^{\circ} 45'$	$\rho=72^{\circ} 15'$
No. 13.....	$24^{\circ} 59'$	$72^{\circ} 15'$
Average.....	$24^{\circ} 52'$	$72^{\circ} 15'$
433 calculated.....	$26^{\circ} 41'$	$72^{\circ} 56'$
Difference.....	$\Delta=1^{\circ} 49'$	$\Delta=0^{\circ} 41'$

The recognition of the crystal form of a "ruby silver" mineral may be of importance in identifying the mineral and consequently in estimating the probable silver content of the ore. The crystals of miargyrite (36.9 per cent silver) are readily distinguished from those of pyrargyrite (59.9 per cent silver), proustite (65.4 per cent silver), and polybasite (75.6 per cent silver). All of these have a red streak and pass under the name ruby silver.

