

ART. XXXIII.—*Contributions to Mineralogy*.—No. VII ; by
F. A. GENTH.

DURING the last year or two, I have been engaged with the investigation of several very rare minerals, the composition of which was but little known, or doubtful, principally from localities on the Pacific coast.

In some instances, the results which have been obtained, although sufficient to establish with great probability the true nature of the species, represented, on account of the great scarcity of material, the composition of mixtures of several minerals. As for instance with the California tellurids, of which I have for a long time in vain endeavored to procure larger quantities of pure material, but despairing to find any, I had already written out my results for publication, when about two months ago, through the kindness of several friends, I was so fortunate as to obtain of these interesting minerals, minute, but *perfectly pure* fragments, which enabled me to renew my examinations and in this manner partly to corroborate, partly to correct results, which had previously been obtained, and also to establish an interesting *new* species. I will now proceed with the results of my investigation.

1. *Whitneyite*.—About three years ago a specimen of this mineral was brought to the Hon. N. S. Higgins, then at the

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Cerro Colorado mine, Southern Arizona, under the impression that it contained a large amount of silver, and he was requested to ascertain the value of the ore. To the great disappointment of the owner he recognized it as an arsenid of copper, and found in a pure fragment of it, 11.59 per cent of arsenic, which proved that it was Whitneyite. He secured the specimen, which he kindly presented to me.

In its crystalline structure and color, it has exactly the appearance of specimens, furnished by the original locality, the Pewabic mine, Michigan. It is somewhat intermixed with a hornstone-like mineral. The analysis gave, after deducting 9.52 per cent of hornstone, etc. :

Copper,.....	88.54 per cent.
Silver,.....	<i>a trace</i>
Arsenic,	11.46 “

From La Lagoona, a rancho on the road to Libertad, about 35 miles from Saric, Sonora, where it is said to exist in considerable quantities.

2. *American Tellurium minerals.*—The first discovery of a tellurid in this country is due to Dr. C. T. Jackson (this Journ. [II], vi, 188), who from some preliminary examinations supposed that from the Whitehall mine, Spotsylvania Co., Va., which had been mistaken for molydenite, to be *foliated tellurium*.

A short time afterward a mineral was discovered at a gold mine in Fluvanna Co., Va., which much resembled that from the Whitehall mine. It was analyzed by Mr. Coleman Fisher, Jr. (this Journ. [II], vii, 282), who recognized it as a “*telluret of bismuth*,” containing a *large percentage of selenium*.

In a subsequent publication (this Journ. [II], x, 78), Dr. Jackson corrects his first statement and gives the result of an analysis, showing the Whitehall mineral to be *tetradymite* and *not foliated tellurium*.

In his paper he also observed the occurrence of *yellow oxyd of bismuth*, investing the nodules of the tellurium ore, which is *not* carbonate of bismuth, for it does not effervesce with acids.

In the year 1850, I discovered *tetradymite* in Davidson Co., N. C., of which I published a description and analysis (this Journ. [II], xvi, 81). I mention as associated with it a mineral, resulting from its oxydation, containing *telluric acid*.

In my Contributions to Mineralogy (this Journ. [II], xix, 15), I show that the mineral from Fluvanna Co., Va., analyzed by Mr. Coleman Fisher, Jr., contains *no* appreciable quantity of *selenium* but is a *pure tertellurid of bismuth*.

As new localities of tetradymite I mention the Phoenix mine and Boger mine, Cabarrus Co., N. C.

Several localities at which tetradymite was found, were given by Prof. C. U. Shepard, one in the Chestatee river near Dahlonega, Lumpkin Co., Ga., then the Pascoe mine, Cherokee Co., and another near Van Wort in Polk Co., Ga. (this Journ. [II], xxvii, 39).

The discovery of *bornite* at Field's gold mine, near Dahlonega, Ga., was announced by Dr. Jackson ([II], xxvii, 366). This I proved subsequently to be erroneous (Mining Magazine, [II], i, 358), showing the mineral, like that from Fluvanna Co., Va., to be *tertellurid of bismuth*, which opinion was fully corroborated by a reëxamination of the same mineral by Mr. David M. Balch, (this Journ. [II], xxxv, 99).

These are, as far as I can ascertain, all the localities at which tellurium minerals have been found in the Atlantic States, and they represent only the *one* species, tetradymite, but in its *two* well established varieties.*

The Pacific States have lately furnished a far greater variety and in fact, with the exception of *sylvanite*, all the known tellurium minerals have been found there, together with several *new* ones.

Prof. W. P. Blake was the first who reported the occurrence of tellurium ores in California (Geological Reconnoissance in California, 302) (this Journ. [II], xxiii, 270), stating that a mineral containing tellurium and silver, probably hessite, had been washed out from a gold drift near Georgetown, Eldorado Co., Cal.

The next information which was published about California tellurium ores, is contained in a pamphlet on the "New Melones Gold and Silver Mines," in which appears a Report of Mr. Charles A. Stetefeldt on the Reduction of Telluric Gold and Silver Ores, an abstract of which was published in the Berg. und Hüttenmännische Zeitung, Oct. 30, 1865. Stetefeldt remarks that "*the samples of ore from the Stanislaus mine contain large quantities of sylvanite or graphite tellurium of steel-gray color and metallic luster, by far the richest tellurium ore, and smaller quantities of the tellurium of lead, recognizable by its tin-white color and great luster.*"

Mr. Guido Küstel describes in the Mining and Scientific Press of San Francisco, of May 20th, 1865, the principal ore of the Melones mine, "tellurite (1) of silver-gold as a new species, gives its specific gravity as from 9 to 9.4 and the compo-

* In Dana's System of Mineralogy, ii, 64, it is mentioned that minute crystals, which I had observed to occur with gold ores at Gold Hill, Rowan Co., N. C., were probably *sylvanite*; subsequent examination, however, proved them to be *bismuthine*.

sition, determined by blowpipe analysis as follows: Au=24·80, Ag=40·60, Te=35·40 (?). In a communication dated San Francisco, Jan. 4, 1866 (Berg. und Hüttenmännische Zeitung, 1866, 128), he states that he has neither observed sylvanite nor tellurid of lead, but besides the principal ore, of which he gives his previous results (misprinted 21·80 instead of 24·80), tellurid of silver, native tellurium, copper-nickel (1? Genth) pyrites and free gold.

Mr. Jas. Ross Browne in his Report on the Mineral Resources of the States and Territories West of the Rocky Mountains, Washington, 1867, published W. P. Blake's catalogue of March, 1866, in which the latter states that at the Stanislaus and Melones mines, "*very beautiful specimens of gold associated with tellurium were taken out of a vein from 6 to 18 inches thick, and at a depth of 200 feet from the surface. This telluret has a tin-white color and is not foliated like the tetradymite of the Field vein in Georgia. Its exact specific character is not yet determined.*"

At the meeting of the Academy of Nat. Sciences in Philadelphia, of August 6th, 1867, I have made some observations referring to the progress of my investigations, and announced the occurrence of a new mineral, tellurid of nickel, at the Melones mine.

In a private communication, dated Helena, Montana Territory, Nov. 25, 1867, Mr. J. L. Kleinschmidt informs me, that about two months previously, he had received from Prof. Swallow a mineral of the appearance of bismuth, which attracted his attention by its pale gray color and bright luster. A preliminary examination gave lead, silver, gold and tellurium. No further examination having been made, nothing can be said as to its true nature.

Prof. B. Silliman mentioned at the session of Dec. 2, 1867, of the California Acad. of Sciences, the occurrence of tellurium ores at *three new localities*—at the Golden Rule mine on the mother lode near Poverty Hill, Tuolumne Co., where ores similar to those of the Melones mine are found in thread-like quartz veins, crossing the cleavage of argillite, at the Raw Hide rancho mine and at the Reist mine on the mother lode at Whisky Hill, Tuolumne Co., where he discovered a very small crystal of hessite. In one of the mines at Angel's camp he observed foliated tellurium.

On the 5th of Dec. 1867, Mr. Kleinschmidt writes me from Helena, that he had discovered in placer gold from Highland, Montana Territory, gray metallic scales which he found to contain tellurium and bismuth. He very liberally placed the whole quantity which he had secured, into my hands for further investigation.

This brief review contains, I believe, all that has been communicated with reference to the occurrence and composition of tellurium minerals in this country, and it will be seen from it that very much doubt existed as to the real nature of the California minerals. I was very anxious therefore, to submit them to a thorough chemical examination.

To Dr. Theodore F. Moss, I am indebted for the first two pieces from the Stanislaus mine, Calaveras Co., Cal., which I have received, and which have furnished very important material for this investigation, one containing the tellurid of nickel (melonite), in the purest condition, in which I have seen it, only very little mixed with hessite, and the other, principally hessite, but mixed with more or less melonite.

The next and also very valuable specimen from the Stanislaus mine, was brought from California by the Hon. N. S. Higgins. It contained the tin-white altaite, in some portions so intimately mixed with hessite that, before I had obtained a pure specimen of altaite, I thought it might be a new species. It also contained foliated melonite, and minute specks of a mineral, which may be native tellurium.

My analyses had to be made with the cleanest that could be selected from the very much mixed material of these three pieces, but they were at once, as far as possible, repeated, when I received through the kindness of Dr. I. Adelberg and Messrs. Louis Beckers and Jas. B. Hodgkin of New York, and E. Balbach, Sr., of Newark, N. J., specimens from the Stanislaus mine, which gave me minute quantities of perfectly pure altaite, the highly auriferous hessite (petzite), and of the new and interesting mineral calaverite.

The tellurium ores of the Stanislaus mine occur in talcose and chloritic slates, associated with quartz, dolomite, ? apatite, a uranium mineral, titaniferous iron, pyrites, chalcopyrite, small quantities of galena, blende, and free gold. In the specimens which I have seen, neither of these mineral forms in the quartz or dolomite larger patches; they are generally present in small particles only, and so much mixed together, that but two pieces furnished the pure material, which I could obtain for examination.

I had just finished my investigation of the tellurids from the Stanislaus mine, when I received for examination, through the kindness of Professors B. Silliman, Dana and Brush, a specimen of petzite from the Golden Rule mine, Tuolumne Co., Cal. It is associated with minute quantities of altaite, gold and pyrites, with quartz and dolomite in argillaceous slate. The specimen furnished perfectly pure material for analysis.

a. Petzite and Hessite.—Of all the tellurium minerals, which have been observed in California, that variety of tellurid of

silver, in which a large portion of silver is replaced by gold, the so-called petzite, appears to be the most common.

The specimens which I have examined, both from the Stanislaus mine and from the Golden Rule mine, were without crystalline structure, showed a distinct conchoidal fracture, metallic luster and a color between dark steel gray and iron black, sometimes tarnished with pavonine colors. Brittle, soft, hardness about 2.5, sp. gr. according to Küstel 9—9.4. Streak, iron black.

B.B. with soda gives a bluish green flame and yields a silver globule of a yellowish white color. If a fragment is placed upon a hot coin, or is very cautiously heated with the blowpipe, the dark steel-gray color changes into a dull yellow, from the separation of gold globules, as observed by Küstel. Nitric acid turns it black at once, and dissolves it slowly with the separation of metallic gold; aqua regia dissolves it with the separation of chlorid of silver.

The material for the analyses, highly magnified, was found to be free from admixtures with the exception of a minute quantity of quartz, which was deducted as follows: from analysis I, 2.60 p. c., from II, 0.99 p. c., from IV, 0.48 p. c., and from V, 0.59 p. c.

	Stanislaus Mine.			Golden Rule Mine.	
	I.	II.	III. (Küstel).	IV.	V.
Gold,	25.55	25.70	24.80	25.60	24.97
Silver,	41.93	42.36	40.60	41.86	40.87
Tellurium,	32.52*	31.94*	35.40?	32.68	34.16*
	100.00	100.00	100.80	100.14	100.00

These analyses correspond closely with the composition, expressed by the formula: $AuTe + 3AgTe$, which requires:

Au,	197	25.35
3Ag,	324	41.70
4Te,	256	32.95
	<u>777</u>	<u>100.00</u>

This variety of auriferous tellurid of silver is closely allied to that from Nagy-Ag, analyzed by Petz, but it contains a considerably higher percentage of gold. The analysis of Petz agrees nearly with the formula $2AuTe + 9AgTe$, the ratio between Au : Ag being 1 : 4.7, whilst that of the California mineral is 1 : 3.

Notwithstanding this difference in composition, they should not be considered as different species, gold being capable of replacing silver in variable quantities, I adopt therefore, Haidinger's name "Petzite," for *all varieties* of telluric silver, in which a large portion of silver is replaced by gold.

* From the loss.

Not all the tellurid of silver from the Stanislaus mine, however, is petzite; there occurs also the other variety, which does not contain any, or only a very small percentage of gold, as already observed by Küstel.

The *true* hessite, or the variety more approaching to it, is of a darker color and seems not to form larger particles, but to be more finely disseminated through the matrix, often between the cleavage planes of dolomite.

I have not been able to obtain it for my analyses in a state of purity. It was mixed with other tellurids, with quartz, dolomite and free gold. For the purpose of analyzing it, the mixed material, coarsely powdered, was treated with warm dilute chlorhydric acid to remove the dolomite, then picked out again, after having been thoroughly washed, but it was impossible to obtain it free from quartz, tellurid of nickel and free gold.

It was necessary, therefore, for the purpose of ascertaining the condition in which the gold was present, whether as tellurid or free gold, to make a careful analysis of the free gold associated with the Stanislaus mine tellurids, and from the amount of silver remaining with the gold, after treating the mineral with nitric acid, both the amount of free gold and that of tellurid of gold was determined. The free gold contains:

Gold,	88.63 per cent.
Silver,	11.37 "

	100.00

The purest hessite (I), after deducting 7.21 p. c. of admixtures, of which 4.22 p. c. were of free gold and the balance quartz, and a less pure specimen (II), which contained 28.60 p. c. of admixtures, of which 6 p. c. were of free gold, gave:

	I.	Requires Te.	II.	Requires Te.	
Gold,	3.28	1.06	3.22	1.05	for AuTe
Silver,	46.34	27.45	55.60	32.95	" AgTe
Lead,	1.65	1.02	----	----	" PbTe
Nickel,	4.71	15.32	1.54	5.01	" Ni ₂ Te ₃
Tellurium,	44.45		39.64*		
	-----	-----	-----	-----	
	100.43	44.85	100.00	39.01	

This would be equal to:

	I.	II.
Hessite,	78.11	92.82
Altaite,	2.67	----
Melonite,	20.03	6.55

Ratio of Au : Ag in the hessite in I = 1 : 25; in II = 1 : 31.

There certainly exists also the variety of hessite, which is *entirely free* from gold; that which was mixed with the impure

altaite, III, and with the melonite (see below), did not contain any, and the material for analysis when dissolved in nitric acid, did not separate any brown gold, it contained, therefore, the *true* hessite.

b. Altaite.—This very rare mineral also occurs at the Stanislaus mine as already observed by Charles A. Stetefeldt, and it appears to be the mineral to which W. P. Blake refers in his catalogue. I noticed it in minute quantities with the petzite from the Golden Rule mine.

It is easily distinguished from the other tellurids by its tin-white color, which has a slight but distinct greenish yellow hue. Tarnishes with a bronze yellow color. Cleavage distinctly, in some pieces eminently cubical. Exceedingly brilliant metallic luster. Hardness below 3. Streak gray.

Analysis I was made with an almost pure piece; after deducting 1.03 p. c. of quartz, and 1.96 p. c. for II, which was less pure, I obtained:

	I.	Requires Te.	II.	Requires Te.
Lead,.....	60.71	37.54	47.84	29.58
Silver,.....	1.17	0.69	11.30	6.70
Gold,.....	0.26	0.08	3.86	1.25
Tellurium,.....	37.31		37.00*	
	<hr/> 99.45	<hr/> 38.31	<hr/> 100.00	<hr/> 37.53

These analyses would represent the composition of the two specimens as:

Altaite,.....	99.25	77.42
Hessite,.....	2.20	23.11

Before I had the purer varieties of altaite, from which the two last analyses were made, I analyzed some from the piece presented by Mr. Higgins. It gave results which were, in several points of view, of interest. After, from the purest that could be found, the carbonates had been removed by dilute chlorhydric acid and it had been completely washed, it was pulverized and the lighter portion washed off. The heavier portion gave after deducting 8.00 p. c. of free gold and 3.45 p. c. of quartz:

(Mixture of altaite and hessite) III.

Silver,.....	44.49	requiring Te	26.36
Lead,.....	18.37	“	“ 10.89
Tellurium,.....	37.14*		

37.25

This mixture contains, therefore, 70.85 p. c. of *true* hessite and 29.26 p. c. of altaite.

This result was quite surprising, since the material appeared to be comparatively pure, at any rate seemed to contain a far larger percentage of altaite.

Future investigations will be necessary to ascertain whether there really exists a tellurid of silver, or tellurid of silver and lead, which has the white color and cubical cleavage of the altaite.

c. ? *Native tellurium*.—I have above already mentioned, that the specimen brought by Mr. Higgins contained minute specks of a mineral which may be native tellurium. The quantity which I have observed is microscopic. They have a grayish-white color.

According to Küstel, native tellurium occurs at the Stanislaus mine. That these greyish-white specks might be native tellurium has been suggested by the results of the analysis of the light washings from the last mentioned analysis. They contained 94.23 p. c. of quartz and other insoluble substances, but no gold, and 5.77 p. c. of tellurium minerals, showing the following composition:

Ag,	30.75	requiring Te	18.23	=	48.98	p. c. true	hessite
Pb,	26.94		16.66	=	43.60	"	altaite.
Te,	42.31				7.42	"	tellurium.
	100.00				34.89		

This leaves an excess of 7.42 p. c. of tellurium, which may be present in the native state. This becomes the more probable, if we take into consideration the far lower specific gravity of this substance. The analysis of melonite also gives a slight excess of tellurium, which may be due to an admixture of the native metal.

d. *Melonite*.—A new mineral, Ni_2Te_3 (?), hexagonal. I observed one microscopic, but perfect six-sided plate; generally in indistinct granular and foliated particles, with eminent basal cleavage. Luster metallic, color reddish-white, similar to that of bismuth, tarnishes rarely, with a brownish color. Streak, dark gray. B.B. in a tube gives a sublimate fusible into colorless drops, leaving a gray mass; on charcoal, it burns with a bluish flame giving very little white volatile incrustations and leaving a grayish-green residue, which in the inner flame with soda yields a gray magnetic powder of metallic nickel. Dissolves in nitric acid with a green color, yields on evaporation a white crystalline powder of tellurous acid; addition of ammonia gives a clear blue solution.

This appears to be one of the rarest of the tellurids of the Stanislaus mine. Only one of the specimens which I have received contained enough of the mineral to make an analysis of it, and this was mixed with quartz, and small quantities of hessite, altaite and possibly of native tellurium. After deducting 22.22 p. c. of quartz and 3.26 p. c. of free gold, I obtained:

		Requires Te.	
Silver-----	4.08	2.42	6.50 p. c. of <i>true</i> hessite.
Lead-----	0.72	0.45	1.17 “ altaite.
Nickel-----	20.98	68.27	89.25 “ melonite.
Tellurium----	73.43	2.29	“ nat. tellurium.(?)
	99.21	71.14	

The nickel from all my analyses contained just enough cobalt to color a borax bead very slightly blue.

From this analysis as well as from the two analyses of hessite given above, the formula of the melonite appears to be Ni_3Te_3 . Although the hexagonal form would better agree with the formula $NiTe$ and bring the melonite into the same group with millerite, pyrrhotine, greenockite, etc., it is not very probable that it is a mixture of native tellurium and $NiTe$, because it would have contained about one third of native tellurium. The material for analysis, however, strongly magnified showed distinctly a small quantity of the dark colored hessite, and every other particle showed the reddish hue, but *not the slightest* admixture of a greyish white mineral could be observed.

The composition of melonite, corresponding with Ni_3Te_3 would be :

2Ni-----	59	=	23.51
3Te-----	192		76.49
	251		100.00

e. Calaverite, a new mineral, AuTe₄.—I have only observed it once, associated with petzite, on a specimen from the Stanislaus Mine.

Massive, without crystalline structure. Soft. H. below 3. Brittle. Luster metallic. Color bronze yellow. Streak yellowish gray. Fracture uneven, inclining to subconchoidal.

B.B. on charcoal burns with a bluish green flame and yields globules of gold of a *high* yellow color. Nitric acid darkens it and separates metallic gold; aqua regia dissolves it with the separation of a minute quantity of chlorid of silver. The material for the analyses when strongly magnified appeared to be perfectly pure. In II, 1.45 pr. ct. of quartz were deducted.

	I.	II.
Gold-----	40.70	40.92
Silver-----	3.52	3.08
Tellurium----	55.89	56.00*
	100.11	100.00

Associated and frequently mixed with the calaverite is petzite. Although the material for analyses appeared perfectly

pure, from an admixture of petzite probably results the greater portion of the silver, but a minute quantity is certainly replacing a portion of the gold, because, if the whole amount of silver with the corresponding quantity of gold (41.70 : 25.35) is taken as petzite, both analyses would give only about 97 pr. ct. The ratio between gold and tellurium (after deducting the silver as petzite) is 1 : 4.2 or nearly 1 : 4, the most probable formula for calaverite is therefore $AuTe_4$, which in its pure state would have the composition :

Au	197	44.47
4Te	256	55.53

A comparison between the analyses of the calaverite and those of the Transylvania sylvanite leads to very interesting suggestions. Under the name sylvanite, *two* distinct minerals are generally treated; one, the so-called "graphic tellurium," for which the name "sylvanite" may remain, and the "weisstellur" and "gelberz."

The most recent and reliable analyses of these minerals were made by Petz, who found in the graphic tellurium from Offenbanya :

	I.	II.
Tellurium	59.97*	58.81*
Antimony	0.58	0.66
Gold	26.97	26.47
Silver	11.47	11.31
Copper	0.76	----
Lead	0.25	2.75

Of the varieties weisstellur and gelberz from Nagy-Ag, he analyzed : I, long crystals of a white color; II, thick crystals; III, short yellowish crystals; IV and V, massive bronze-yellow mineral :

	I.	II.	III.	IV.	V.
Tellurium	55.39	48.40	51.52	44.54	49.96
Antimony	2.50	8.42	5.75	8.54	3.82
Gold	24.89	28.98	27.10	25.31	29.62
Silver	14.68	10.69	7.47	10.40	2.78
Lead	2.54	3.51	8.16	11.21	13.82

From these analyses it will be observed that in the graphic tellurium the amount of silver varies but very little, and that the analyses of Petz give exactly, what Berzelius, and a trifle more, than what Klaproth had already found. On the contrary the analyses of the weisstellur and gelberz show the greatest possible variation in all their constituents. Including Klaproth's analysis, the antimony varies from *none* to 8.54 p. c., the silver from 2.78 to 14.68 p. c., and the lead from 2.54 to 19.50 p. c.

The most rational conclusion under these circumstances is to consider these minerals mechanical mixtures of different species, such as native antimony, altaite and hessite, with a peculiar tellurid of gold.

Starting from this supposition, I found, after deducting the admixtures, the ratio of gold and the remaining tellurium as follows :

In	I,	=	1 : 4.95
"	II,	"	1 : 4.24
"	III,	"	1 : 4.78
"	IV,	"	1 : 3.82
"	V,	"	1 : 4.13

The two last analyses, those of the *massive bronze yellow* mineral, seem to prove that "gelberz" is nothing else than an *impure* calaverite.

The analyses of the graphic tellurium, for which the formula $\text{AgTe}_3 + \text{AuTe}_3$ has been given, correspond better with the formula $\text{AgTe}_4 + \text{AuTe}_4$, especially, if the *exact* ratio between gold and silver, which has been *found*, is taken as the basis of the calculation. Ratio of Au : Ag in I=1 : 0.84, in II=1 : 0.8. The latter would give the following composition, which agrees very well with the analysis :

Au.....	197.0	26.47
0.8Ag.....	86.4	11.61
7.2Te.....	460.8	61.92
	<hr/>	<hr/>
	744.2	100.00

The white color of the weisstellur, together with the higher percentage of tellurium show that they are intermediate varieties, in which more or less silver is present as AgTe_4 replacing a portion of the gold.

The relation existing between sylvanite and calaverite is similar to that between petzite and hessite.

In connection with the tellurids of the Stanislaus mine and the new localities discovered by Prof. B. Silliman, I will mention that a specimen of gold in quartz from the Grass Valley, Cal., for which I am indebted to Dr. Lewis Feuchtwanger, contains minute quantities of a lead colored mineral, which contains tellurium, silver and a small quantity of lead, surrounding the gold. The quantity was too small for further examination.

f. Tetradyomite.—I have examined two varieties of tetradyomite, one found in placer gold at Highland, Montana Terr., by Mr. Kleinschmidt (I), and the other from the Phoenix Mine, Cabarrus Co., N. C. (II). I. The Montana mineral

occurs in scales. The largest of those which I received was about $\frac{1}{8}$ of an inch in diameter and about $\frac{1}{16}$ of an inch in thickness. Some of the scales showed the lateral planes of a six-sided prism. Color between lead and steel grey. It was partly oxydized into a substance, which proved to be a new mineral, a tellurate of bismuth, for which I propose the name "*Montanite*."

For the analysis, both of the tetradymite and montanite, a weighed quantity of the mixed minerals was treated with dilute warm chlorhydric acid, which leaves the tetradymite unacted upon, whilst the montanite is easily dissolved by it. The specimen was found to contain :

Tetradymite.....	49.23
Montanite.....	50.77
	100.00

II. The tetradymite from the Phœnix mine, of which I never have seen more than the one specimen in my collection, occurs in very minute scales, the largest not being over $\frac{1}{32}$ of an inch in width, of a color between lead-grey and iron-black implanted and disseminated in quartz and associated with free gold and pyrites. From the analysis was deducted 86.71 p. c. of quartz and free gold.

The following results were obtained :

	I (Montana.)	II (Phœnix Mine).
Quartz,	0.78	Copper, 0.41 p. c.
Ferric oxyd,	0.90	Iron, 0.54 requires 0.61 sulphur.
Bismuth,	50.43	57.70
Tellurium,	47.90	36.28
Sulphur,	none	5.01
	100.01	99.94

The ratio between bismuth and tellurium in I. is very near =1 : 3, which places this tetradymite alongside of those from Fluvanna Co., Va., and Field's mine, Georgia.

In analysis II. is a slight admixture of pyrites. The requisite quantity of sulphur for the amount of iron found, is=0.61, leaving 4.40 p. c. of sulphur as a constituent of the tetradymite. The ratio between sulphur, tellurium and bismuth is =1 : 2.03 : 1, giving exactly the formula $\text{BiS}_3 + 2\text{BiTe}_3$.

Admitting with Gustav Rose that tellurium sometimes replaces bismuth, as in the native bismuth from the Sorato, the bismuthine from Riddarhyttan, and the mineral from Cumberland, England, analyzed by Rammelsberg, which contains 6.43 p. c. of sulphur, equal to 28.13 p. c. of BiS_3 , showing it to be a mixture of bismuthine and native bismuth, the tetradymites

certainly should not be placed under native bismuth and considered as varieties of this mineral. It is far more rational to suppose that both sulphur and tellurium first satisfy their chemical affinities, if coming in contact with bismuth. If we reject Jackson's analysis, which is deficient in sulphur, and Wehrle's of the so-called "Molybdän-silver" from Deutsch-Pilsen, which shows a loss of nearly 5 p. c. and an admixture of over 2 p. c. of silver, all the other analyses prove that tetradymites form beyond doubt *two distinct and definite* compounds, those from Fluvanna Co., Va., and the Field's mine, Ga., like that from Montana Territory, being BiTe_3 , whilst those from Schubkau in Hungary, Davidson Co., N. C., and the Phoenix mine, Cabarrus Co., N. C., are unquestionably $\text{BiS}_3 + 2\text{BiTe}_3$.

The bornite from San José, Brazil, requires reëxamination, before its true nature can be established.

g. Montanite, a new mineral, $\text{BiO}_3\text{TeO}_3\text{HO}$ (or 2HO).—Results from the oxydation of tetradymite. I first distinguished it as a *new* mineral in the examination of the Montana tetradymite and named it after the territory. Having found it to be a new mineral and a very interesting one, on account of being the *first tellurate* observed in nature, I looked over my paper on the Davidson Co., N. C. tetradymite (this Journ. [II], xvi, 81), where I found that I stated that the oxydized portion "*evolved chlorine, when treated with chlorhydric acid and that therefore some of the tellurium was oxydized into telluric acid.*" Deeming a fuller investigation of much interest, I analyzed it and found beyond doubt, although my material was not quite pure, that the North Carolina mineral is *identical* with montanite. There was no tellurous acid present.

It is very probable that the "*yellow oxyd of bismuth*" from the Whitehall mine, Va., observed by Dr. Jackson (this Journ., [II], x, 78), is the same mineral.

Not crystallized, but some portions still retaining the scaly structure of the original tetradymite, and being in reality pseudomorphous after it (N. C.). Earthy incrustations. Color yellowish, greenish and reddish white; luster waxy to dull. H. about 3. Brittle.

B. B. reactions of bismuth and tellurium. Yields water, when heated in a tube. Gives off chlorine, when heated with strong chlorhydric acid, dissolves easily in dilute chlorhydric acid. Sulphydic acid precipitates from this solution only bismuth, lead and copper, but *no* tellurium, after neutralizing the filtrate by ammonia and the addition of a sufficient quantity of sulphid of ammonium, the whole quantity of tellurium can be precipitated by dilute chlorhydric or sulphuric acid as black tersulphid. The analysis gave:

	I.		II.		III.	
	From Montana.		From Davidson Co., N. C.			
		O.		O.		O.
Ferric oxyd,	0·56	----	1·26	----	0·32	----
Plumbic “	0·39	----	----	----	----	----
Cupric “	----	----	1·04	----	1·08	----
Bismuthic oxyd,	66·78	6·85	68·78	6·92	71·90	7·37
Telluric acid.	26·83	7·30	25·45	7·05	23·90	6·51
Water,*	5·94		3·47		2·80	
	<hr/>		<hr/>		<hr/>	
	100·00		100·00		100·00	

The oxygen ratio between tetroxyd of bismuth and telluric acid is very near equal to 1 : 1. Some doubt remains, however, to the amount of water, and future investigations have to ascertain whether it contains one or two equivalents. The composition of the pure mineral would be either of the following :

	BiO ₃ , TeO ₃ +HO			BiO ₃ , TeO ₃ +2HO	
BiO ₃	234	70·69	BiO ₃	234	68·82
TeO ₃	88	26·60	TeO ₃	88	25·88
HO	9	2·71	2HO	18	5·30
	<hr/>			<hr/>	
	331	100·00		340	100·00

3. *Barnhardtite* from Arizona.—I have observed this mineral amongst the copper ores of Bill Williams Fork, Arizona, associated with metallic copper, cuprite, copper glance, chalcopyrite, pyrites, chrysocolla, malachite and brochantite.

An analysis made by Mr. N. S. Higgins gave :

Copper.....	50·41 p. c.
Iron.....	20·44
Sulphur.....	28·96
	<hr/>
	99·81

It showed a slight admixture of copperglance.

4. *Cosalite*, a new mineral, 2PbS+BiS₃.—A small specimen of this very interesting mineral was presented to me by Dr. Theo. L. Moss, who obtained it from a silver mine at Cosala, Province of Sinaloa, Mexico. It occurs disseminated through the whole mass of a pure, white quartz. Only one fragment showed a very indistinct crystalline, apparently rhombic form, slender and longitudinally striated. Fracture uneven. Luster metallic. Color lead-gray, soft, brittle. B.B. gives the reactions of sulphur, lead and bismuth, and with soda yields a minute globule of silver.

The only other mineral besides quartz, which I have observed with the cosalite was cobaltine, as ascertained by an arsenic and cobalt-determination of a small fragment. In the analysis

the requisite amount of arsenic was therefore calculated for the cobalt found, and after deducting in analysis I, 2.09 p. c. of quartz and in II, 26.83 p. c., the following results were obtained:

	I.	II.
Lead	37.72	33.99
Silver	2.48	2.81
Bismuth	39.06	37.48
Cobalt	2.41	4.22
Arsenic	3.07	5.37
Sulphur	15.59	15.64
	<u>100.83</u>	<u>99.51</u>

The analysis I shows an admixture of 6.79 p. c. of cobaltine, and II of 11.88 p. c. Deducting these quantities the composition is:

	I.	II.
Lead	40.32	38.79
Silver	2.65	3.21
Bismuth	41.76	42.77
Sulphur	15.27	15.23
	<u>100.00</u>	<u>100.00</u>

corresponding closely with the formula $2\text{Pb}(\text{Ag})\text{S} + \text{BiS}_2$, giving the following per centage:

2Pb	207	41.65
Bi	210	42.25
5S	80	16.10
	<u>497</u>	<u>100.00</u>

Cosalite is a Jamesonite, in which the tersulphid of antimony is substituted by tersulphid of bismuth, a small quantity of silver replacing lead.

5. *Boulangerite* from Nevada.—This mineral occurs in the Echo District, Union Co., Nevada, in indistinct long acicular crystals in white quartz. One of the crystals showed prismatic planes similar to those of aragonite. Longitudinally striated. The analysis gave:

Lead	54.82
Silver	trace
Iron	0.42
Antimony	26.85
Sulphur	17.91
	<u>100.00</u>

6. *Tetrahedrite* from Arizona.—An analysis of a "fahlerz"-like mineral from the Goodwin mine near Prescott, Arizona,

which I have made, gave, after deducting 4.22 p. c. of quartz, the following result:

Copper,	38.16	requires S for Cu_2S		9.63	} 13.78 = 1.31
Silver,	3.21	" "	AgS	0.48	
Zinc,	6.23	" "	ZnS	3.07	
Iron,	1.05	" "	FeS	0.60	
Arsenic,	trace				
Antimony,	24.67	" "	SbS_3	9.84	= 1
Sulphur,	26.97	" "			
	100.29			23.62	

The material for analysis appeared to be free from other impurities than quartz, and it is difficult to account for the large excess (3.35 p. c.) of sulphur. The other constituents agree very well with the tetrahedrite formula $4\text{RS} + \text{SbS}_3$.

Want of material prevented a reexamination.

7. *Brochantite* from Arizona.—This mineral occurs in minute crystals, on which I could observe the planes I , $\bar{i}\bar{i}$ and $1\bar{z}$, of a beautiful emerald green color, also in foliated masses at Bill Williams' Fork, Arizona. I analyzed a foliated piece, which, however, was somewhat mixed with chrysocolla and cuprite, and found:

	I.	II.
Water	14.46	----
Chlorine	0.31	0.33
Ferric oxyd	0.33	0.52
Cupric "	67.75	67.69
Sulphuric acid	13.55	13.27
Silicic "	3.60	3.59
	100.00	

This would give:

Brochantite,	$\text{CuO}, \text{SO}_3 + 3\text{CuOHO}$	76.49 p. c.
Atacamite,	$\text{CuCl} + 3\text{CuOHO} + 3\text{HO}$	2.10
Chrysocolla, (?)	$\text{CuO}, \text{SiO}_2 + 4\text{HO}$	12.68
Limonite,	$2\text{Fe}_2\text{O}_3 + 3\text{HO}$	0.38
Cuprite,	Cu_2O	7.96
Water,		0.47
		100.08

This is of course to be considered only as an approximation to the composition of this mixture. A more correct calculation could only be made after the composition of the atacamite and chrysocolla from Bill Williams' Fork had been established.

Philadelphia, March 1st, 1868.

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