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THE

AMERICAN JOURNAL

OF

SCIENCE AND ARTS.

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THIRD SERIES.

VOL. VI.—[WHOLE NUMBER, CVI.]

Nos. 31—36.

JULY TO DECEMBER, 1873.

WITH THREE PLATES.

NEW HAVEN: EDITORS.

1873.

PRINTED BY TUTTLE, MOREHOUSE & TAYLOR, 221 STATE ST.

but I have as yet made no experiments in this direction. Finally Künzel* described, many years since, a hyposulphate, to which he gave the formula $Co_2O_3+4NH_3+2S_2O_5$ (old style). This formula becomes in my view, $Co_2(NH_3)_8S_2O_{13}$ and the salt then belongs to the octamin series, but I am unable to assign to it any plausible atomistic expression, and it is possible that its empirical constitution has not yet been correctly given.

In treating of the salts of my new series it appeared to me more in accordance with the theoretical views which I have adopted to abstain from trivial names. All the members of this series may however be regarded as containing the complex atom $Co_2(NH_3)_8(NO_2)_4$, which alone is constant and which from one point of view may be regarded as a diatomic radical or residue, and those who justify the use of trivial names by their convenience may find the name "Croceocobalt" expressive and appropriate.

(To be continued.)

Cambridge, June 16th, 1873.

ART. XVI.—*Mineralogical Notes on Utah, California and Nevada, with a description of Priceite, a new Borate of Lime;* by B. SILLIMAN.

1. *Enargite*, $3CuS+As^2Sb^3$.—This hitherto rare mineral exists in two or three localities in a district of Southern Utah, known as the Tintic District, about eighty miles south of Salt Lake City. The localities are, (1) the Shoebridge Mine, (2) the Mammoth vein, Eureka Hill, East Tintic, and, (3) the Dragon Mine, East Tintic. All these localities occur in metamorphic crystalline rocks of the granitic family.

The Shoebridge locality furnishes finely crystallized specimens, associated with octahedral pyrite. The vein in which it is found fills a fissure about four feet wide in granitic rocks. This vertical fissure is filled to the depth of about 80 feet from surface with enargite mixed with pyrite. The whole mass is regarded as a silver ore. A sample of the ore made up from such stock as I had in hand yielded to fire assay 269·25 oz. troy of silver, or $847.34 to the ton of 2000 lbs.; this is equal to 0·841 per cent of silver, which is considerably above the average value of the vein. Below the depth of 80 feet, the character of the vein changes, as I am informed by one of the owners, Mr. Samuel T. Hatch, of Salt Lake City, to a vein of argentiferous galena, carrying some antimony. In examining many hundred

* Journal für prakt. Chemie, lxxii, 218.

pounds of the ore taken from above the galena zone, I found only enargite and pyrite with quartz and some heavy spar as a gangue—and not a trace of galena, as the analysis proves.

The enargite from Shoebridge mine cannot be distinguished by the eye from that which was first mentioned by the late Prof. Root, from the "Morning Star Mine" in Alpine County, California (this Journal, II, xlvi, 201).* It occurs both massive of a brilliant luster and fracture, resembling in color gray copper; and also in brilliant orthorhombic crystals striated on the terminal plans parallel to the longer diagonal. The crystals are sometimes 5 or 6mm. long, but more commonly are not over 2mm. in length. The forms are more simple than the crystals figured from Peru. Dr. Gideon E. Moore, who has studied those from the Morning Star Mine, informs me that their form is identical with the Shoebridge mineral, and is expressed by the crystallographic formula $\infty P . 0P . \infty \bar{P} \infty . \infty \breve{P} \infty$.

Its pyrognostic characters conform to those of the Peruvian mineral, but it contains much less antimony then the California variety. Its specific gravity is 4·861 in fragments to 5·111 solid—almost that of pyrite, and somewhat higher than the Peruvian variety. Mr. E. S. Dana kindly furnished me some time ago the following approximate analysis of the Shoebridge mineral made by the chlorine method upon carefully selected crystals. He obtained—

Sulphur	34·35	Iron	1·06
Antimony	·95	Zinc	*trace*
Arsenic	17·20	Residue (undissolved),	*trace*
Copper	46·94		100·50

The silver was not determined. The iron is probably due to the pyrite, with which the species enargite is intimately associated; this occasions also the excess of sulphur, in the analysis, which corresponds, however, sufficiently well with the formula given above.

At the "Mammoth Vein," in Eureka Hill, the enargite occurs in broad laminated masses somewhat resembling black hornblende, and stained green in the joints by the oxidation of a portion of the copper. It is associated with calcite and is quite free from pyrite. The blowpipe shows it to be free, or nearly so, from antimony. This locality has not furnished the enargite otherwise than in columnar and cleavable masses.

The mineral from Dragon Mine resembles the last named variety, but is more massive. Neither of the two latter varieties have been analyzed.

2. *Bismuthinite*, B^2S^3.—This species is found rather abundantly in three associated mineral veins in Granite Min-

* Wrongly quoted in Dana (5th ed.), p. 797, as in vol. xlv.

ing District, Beaver County, Utah, about ten miles west of Beaver City. The main vein, which is said to be about six feet in thickness, contains also bismuth ocher or *bismite*, Bi, staining the surface greenish yellow (a sign by which the vein has been traced at intervals, it is said, for about 2000 feet), and *bismutite* (hydrous carbonate of bismuth), $Bi^4C^2H^4$, in yellowish-gray masses inclining to siskin-green. These last two species are due, no doubt, to the oxidation of the bismuthinite.

These three species sometimes form masses of considerable size, but more commonly the sulphid occurs alone in a gangue of almadin garnet of a hair-brown color, with black hornblende, heavy spar and quartz. Yellow pyrite exists in small quantity in the gangue, and by its oxidation has furnished masses of iron oxides. No arsenical ores could be detected in the samples which have fallen under my observation, nor does the blowpipe detect either lead, antimony or copper.

Hitherto bismuthinite has been a rare species in N. America, and I do not know that it has before been found in quantity likely to give it a commercial value.* In the Beaver vein, the metal is said to form about five per cent of the mass.

When this locality is properly opened for mining we may hope to obtain an abundance of good mineralogical specimens of these several species. I am indebted to Mr. J. B. Meader of Salt Lake, and to Col. Head of San Francisco, for the specimens from Beaver, which I have examined.

3. *Wulfenite.*—In a former communication (this Journ., III, iii, 195) I pointed out the absence, so far as observed, of phosphates among the mineral species found in the Wahsatch Range, and the existence of molybdic acid as wulfenite in its place. Further observation has confirmed this statement. In a subsequent visit to that region, and more recently, I have received from Major Wilkes, of Salt Lake City, wulfenite from the Empire mine, Lucin District, Box-Elder County, Utah, in the Wahsatch Range, which for beauty is rarely equalled by the same species from any known locality. The crystals are thin tables 20 to 30^{mm}. broad, of a pure yellow color set on a deep brown iron ochre, and making splendid cabinet specimens.

4. *Orpiment and Realgar.*—These two species are found with galenite in a vein known as the "Lucky Boy mine," in Butterfield Cañon, which is in the Oquirrh Range on the west side of Jordan Valley, Utah.

5. *Priceite.*—This borate of lime, which I received from Mr. Thomas Price, in San Francisco, in March, 1872, has been noticed by Mr. Chase, and its mode of occurrence and probable origin described by him in this Journal (III, v, 287), accom-

* I have observed it in minute prismatic crystals in the well-known chrysoberyl locality at Haddam, Conn.

panied by two analyses. A recent examination of this mineral —of the soft chalky variety—affords the following results. Its specific gravity is 2·262 to 2·298. It resembles chalk, but is even softer than that mineral. Its powder under a half inch magnifying power is seen to consist exclusively of minute rhombic crystals. It is insoluble in water which removes only a very minute quantity of common salt, not a constituent of the mineral. It dissolves completely in dilute hydrochloric acid, and this solution promptly deposits abundant crystals of boric acid. Its filtrate is completely free of sulphates, and reacts only for lime, with a trace of iron and alumina. In the close tube it evolves abundant neutral water, and at a red heat fuses to a white enamel. The spectroscope discloses from its solution in hydrochloric acid only the double spectrum of boric acid, with the lines of calcium and sodium. It contains no carbonate of lime, which might very naturally be looked for. Five grams of the air-dried mineral afforded me by the volumetric method only 0·7 c.c. of CO_2, equivalent to $\frac{1}{11111}$ of calcium carbonate in the weight taken—hardly a trace.

Its water of constitution is very constant—and it is almost non-hygroscopic. Two determinations of the water in the air-dried mineral gave 18·395 and 18·40 per cent of water, while two of the same dried at 212° gave each 18·29 per cent.

Dried at 212°, three analyses made by hydrofluoric acid—which leaves the boric acid to be determined by the loss—gave as follows:

	1.	2.	3.	Mean.	Oxygen ratio.
Water	18·29	18·29	18·29	18·29	1·8
Lime,	32·38	31·37	31·73	31·83	1
Na Cl Fe Al	·93	1·00	·97	·96	
Boric acid	48·50	49·34	50·01	49·00	3·7

The oxygen ratio gives approximately 4B, 3Ca, 6H; the lime is a little too high. The probable formula of the mineral is $Ca^3B^4H^6$, which makes the mineral to differ from hydroboracite by containing one-third less water and no magnesia. This formula requires: water 19·48, lime 30·21, boric acid 50·36 =100.

This mineral is certainly different from the cryptomorphite of How, to which it has been provisionally referred by Price and others. It has the microscopic crystallization described by Dr. Robb as belonging to the Nova Scotia species; but the absence of soda and the greater ratio of the protoxide base carries it much nearer to hydroboracite, from which it is separated by containing no magnesia and less water. It is certainly not a mechanical mixture, as its finely divided condition might seem to indicate. The microscope completely sustains the constant results of analysis on this point. As it appears therefore to be

a new species, I would propose for it the name *priceite*, in honor of Mr. Thomas Price, the well known metallurgist of San Francisco. Mammillary and radiate masses of aragonite, some of great size, but more frequently as crusts, occur with the priceite, and were at first mistaken by the miners for a variety of this borate of lime.

6. *Ulexite.*—The boronatrocalcite of Ulex proves to be an abundant mineral in Nevada and Arizona. The specimens of this species which I have examined are from near Columbus, Esmaralda County, Nevada, where it occurs in beds of considerable extent, mixed with sulphate of soda and gypsum. It is found in round masses, as large as the fist and larger, which when broken show the fine fibers of silky luster not to be distinguished from the *tiza* of Peru. This species, it is said, occurs abundantly in the Arizona desert, and also near Wadsworth, Nevada, much mingled with dirt.

Near Columbus, Nevada, they have likewise found large quantities of borax diffused in the soil, and Prof. Price informs me (June 6, 1873), "that all the borax produced there is obtained by lixiviating the soil and crystallizing out the borax in the usual way. I have been informed by trustworthy parties that they can manufacture at least forty tons of commercial borax every day; the difficulty is to find a market for so much."

About twenty miles west of San Bernardino, California, is the so-called "Cane Spring District," where ulexite is found over an area, said to be about ten miles in width by fifteen in length. The surface of the ground is covered with efflorescent salts, commonly known as "alkali," beneath which the borax salts (chiefly *ulexite*) are found, at a depth of a few inches, when they exist at all. As these "alkaline" wastes are now attracting attention from the commercial importance attached to the borax salts, we may hope to obtain yet other contributions of interesting species. The saline salts removed in obtaining the borax salts recur again after an interval of time, during which the process of solar evaporation in a rainless region brings up by capillary action from a lower stratum fresh portions of the saline solutions. It is a fact long familiarly known to travelers in these desolate regions, that while the lagoons, where any exist, contain only water too strongly saline to be drank, that wells sunk to a moderate depth in the saline soil afford water which can be used. This water is only a more dilute solution of the same salts, which on reaching the surface by capillarity, form the peculiar "alkali" incrustations of the desert.

7. *Borax.*—On the eastern slope of the Sierra Nevada, not far from Walker's pass, borax is found in what appears to be the bed of an ancient lake, large crystals of tinkal having been found in the hardened mud, like the well known crystals of borax found in the mud of Clear Lake in California. But by

far the largest quantity of the borax exists mixed with other salts, incorporated in a sort of indurated mud from which it is extracted by lixiviation.

I have examined several samples of this material which Prof. Price has kindly sent me. One of them, by his assay, contains about half its weight of borax. It is a light gray clay-like looking body, with a strongly saline and alkaline taste, effervesces with dilute hydrochloric acid, and tinges the flame of alcohol green. They are all alike in reacting alkaline, and for sodium, boracic acid, chlorine and sulphuric acid. The portion insoluble in water is attacked by dilute hydrochloric acid with effervescence, and contains alumina, lime, a little ferric oxide and magnesia. Minute crystals of gypsum exist in some of them, but no gaylussite, glauberite or boracite could be detected. Similar deposits containing borax exist in Panamit and Death's Valley in Lower Nevada, which desolate districts have yet to receive a careful scientific examination, for which, in Professor Price's opinion, they offer an interesting but certainly not very inviting field. There are few parts of the earth's surface where human life and endurance are more severely taxed.

8. *Chrysocolla.*—This species, in specimens of unusual size and beauty, is found in a vein, or heavy deposit, of thirty to forty feet in thickness, in the railroad mining district, Elko county, Nevada. Above one hundred tons of it were sent last year to the Revere Copper Company, where it yielded 28½ per cent of copper.

9. *Compact Anglesite.*—This variety of anglesite occurs in large quantity at the Union mines near Cerro Gordo, Inyo county, California, in an Alpine region about twenty miles east of the Sierra Nevada mountains, and at an elevation of more than 8,000 feet above tide. The mineral vein, or ore deposit, occurs in limestone and makes its appearance on the west slope of the mountain (which rises some thousand feet or more higher than the vein). It was indicated at surface by a few boulders or isolated masses of galena, which on exploration ran into a nearly continuous mass of galena mixed with a reddish-brown sand colored by sesquioxide of iron, but without quartz or epigene species derived from lead. Singularly enough, the carbonates of lead occur *below* the anglesite, mixed with the latter species and with galena. At the depth of 600 feet from surface, the ore course is about fifty feet wide, the entire absence of water at that depth and above being a noticeable fact, in considering the paragenesis of species. Water is brought by mules and Indians from a distance of some miles, to supply the hoisting machinery and other needs of the mine, at a cost of 10c. per gallon, and is economized by a careful condensation.

This anglesite often includes unchanged galena. It is of a gray to grayish-yellow color, sometimes dark, or with seams of

yellow covered with druses of small crystals of anglesite, which are quite colorless, brilliant and transparent. The masses are banded like agates. Its density is 6·08, and its pyrognostic characters are those of anglesite. It contains on an average of mining samples about 55 ozs. of silver to the ton of 2,000 lbs., which is materially less silver than is found in the unchanged galena. The "bullion" (silver lead) of this mine as sent to market contains about 120 ounces of silver to the net ton. My informant for these economical facts is Mr. F. F. Thomas, a graduate in Arts and Science at Yale, who is in charge of the smelting works at these mines.*

10. *Platinum and Iridosmine.*—Since the publication (this Jour., v, 384) of my note on the crystalline sands of the Cherokee gold washings in Butte county, California, I have obtained, through the kindness of Mr. G. A. Treadwell, who at my suggestion gave the proper directions, samples of the heavy sands which accompanied the "clean up" of the gold to the last stage of concentration before going into the melting pot. These heavy sands I find to be largely composed of scales of platinum mixed with yet more abundant iridosmine. When the adhering mercury and other foreign matters which disguise the true character of the platinum residues are removed by a slight washing in acid, the beauty of these species is seen, and it is quite easy to select each by the aid of a glass. A few minute zircons and brilliant microscopic crystals of chromite (?) were selected from the sample of about 25 grams which I received. The search for laurite and the anomalous mineral believed by Dr. Genth to be new (this Jour. II, 246), which he described as occurring among sands from California, in 1853, was not successful.

Mr. Glass, the resident manager, informs me that the platinum and its associate minerals are quite abundant at Cherokee, but as the quicksilver does not amalgamate them they have no means of escape from the mechanical force of the stream which washes away much the larger part, thus entailing a loss which there is no means now known to prevent.

Platinum and iridosmine were very early observed in California by Blake and others, among especially the sands of the surface placers near the sea, on the northern coast and in Oregon. But I believe this is the first notice of their being found in the older deep placers now so extensively worked by the hydraulic process.

The "Black Sands" of the Cherokee deep placer washings I find to be composed chiefly of *chromites*. The magnet selects quite sparingly a few crystals and masses of *magnetite*, some of them being also strongly magnetic. An occasional mass of

* The compact anglesite from Arizona, described by Prof. Brush in this Journal, (III, v, 421) is not distinguishable from the Cerro Gordo mineral.

brown iron (*limonite*) occurs, giving off water in the tube, becoming magnetic by heat, and reacting only for iron. The search for *ilmenite* resulted in finding only chromite, with its well-marked reactions. It is highly improbable but that ilmenite exists, but I have not yet after some time and much pains succeeded in finding it. The mass of sands searched by an exploring-glass, discloses some other species besides the abounding zircons, among which the most conspicuous is *rutile* in minute prisms of a fine red color, transparent, sometimes doubly terminated, but rarely compounded; 68 of these little crystals of rutile weighed only 58 milligrams; garnets, epidote, and a few minute fragments undetermined are sparcely found. We may therefore enumerate the mineralogy of the Cherokee washings, so far as known, as yielding gold, platinum, iridosmine, diamond, zircon, topaz, quartz in several varieties, chromite, magnetite, limonite, rutile, pyrite, almadine garnet, epidote. A further search on larger samples of the sands will undoubtedly reveal yet other species. The matrix which has furnished most of the species enumerated (the gold and platinum metals probably excepted), is probably syenite, boulders of which are among the frequently recurring factors of the gravel mass.

11. *Diamonds in California.*—About twenty well-formed crystals of diamond have been picked out of the "sluices" in the deep placer workings at Cherokee, Butte County, since the attention of the miners has been called to the existence of this gem in such situations. One of these diamonds which I have examined weighs about 2¼ carats, and is of a faint yellowish color, with curved faces, and the form of fig. 58, in Dana's Mineralogy. Some of these stones were of a pure water, and have been cut and set as gems.

12. *Sands of the Arizona Desert.*—The search for "diamonds," "rubies," and "emeralds" in 1872, led to the sending of several expeditions into Arizona and southern Nevada. I have had, by the kindness of Mr. Geo. A. Treadwell, an opportunity of examining a portion of the findings of one of these parties, which explored a region about eighty-five miles northwest of Fort Defiance in Arizona. The region is described as one of porphyritic and other eruptive rocks. The "rubies" are garnets, some of very fine color and good size, but whether pyrope or common garnet, an analysis only can determine. Some of them, cut in San Francisco, which I have seen, compare well in color and beauty with the Bohemian stones. The "emeralds" are chrysolite, too faint in color to be used as gems. The "diamonds" are quartz, some opaline, others hyaline, and all smoothly polished. In addition, I find the alalite variety of pyroxene, fluorite (white), magnetite, ilmenite, oligoclase and jasper.