

## A BARITE DEPOSIT NEAR WRANGELL.

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### LOCATION.

An interesting deposit of barite was found by the writer in September, 1913, on one of the Castle Islands in Duncan Canal, a long, narrow, shallow bay that extends northward into Kupreanof Island from Sumner Strait. The Castle Islands, which consist of a group of six or seven islets ranging from 600 feet to 1 mile in length, are about 7 miles northwest of Beecher Pass, one of the entrances to Duncan Canal. Duncan Canal lies 3 to 10 miles west of the well-known Wrangell Narrows, and the barite deposit is about 40 miles northwest of the town of Wrangell, the distance being measured along the navigable waterway. The nearest port is Petersburg, at the north end of Wrangell Narrows, about 25 miles distant.

The approximate location of this deposit is indicated on the map (Pl. III) which shows the marble deposits in a portion of southeastern Alaska.

### FORM AND EXTENT.

The deposit of barite forms a rock mass on the east side of the second island in the group, counting from the southeast. The mass stands as a block connected with the rest of the island by a low, narrow neck, about 200 feet long, that is covered by water to a depth of 5 to 10 feet at high tide. The top of this barite outlier stands about 35 feet above high-tide level. The mass as exposed is roughly elliptical in shape, its major axis extending in a direction about N. 30° W. It is possibly 75 feet wide by 200 feet long at the maximum. (See fig. 1.) Its extent below low water would be difficult to determine, and its thickness, measured perpendicular to the lamination, is uncertain, but it is probably not less than 140 feet. Near the southeast end, which is narrow and more pointed than the northwest end, erosion has cut a notch in the deposit to a point within a few feet of high-tide level. Below the base of the cliff, which is washed by extreme high tides, the beach slopes away in all directions and at low tide is 30 to 50 feet wide with the water level some 15 feet lower than the base of the cliff. All the visible part of this cliff and the surrounding beach, is composed of barite, either in place or as a talus

deposit. A rough calculation, based on measurements by pacing, indicates that there should be more than 50,000 short tons of barite available above high-tide level.

There is little in the appearance of the mass or in its geologic relations and structure to suggest its nature or origin, but it may rep-

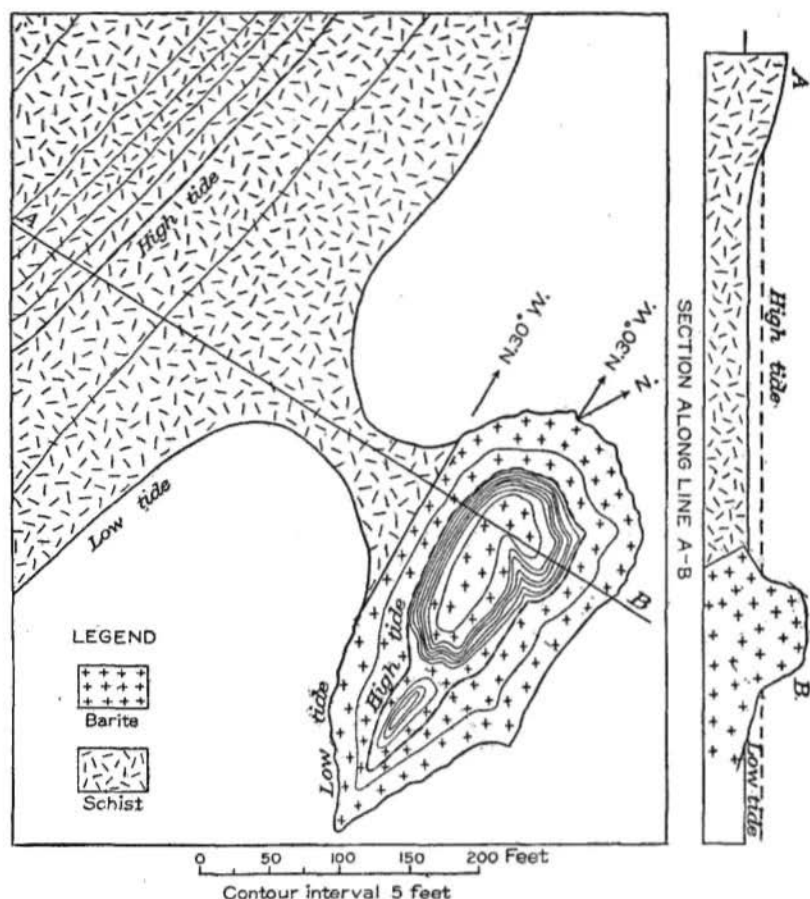


FIGURE 1.—Sketch map and section of barite deposit on one of the Castle Islands, Wrangell district.

resent the residual portion of a large vein or lens of barite, extending parallel to the schistosity of the adjacent rock and representing the replacement of limestone by barite.

#### GEOLOGIC RELATIONS.

The barite is very much jointed and is so fractured at the surface, probably by the action of frost, that the material is broken into fragments not more than 3 or 4 inches in thickness. The beds strike N. 30° W. and dip steeply toward the northeast. On the southwest side facing the island, a granular schistose rock is just visible at low

tide. This schistose rock strikes N. 30° W. and dips steeply northeast, just as does the barite. The neck connecting the barite outlier with the rest of the island is composed of schistose material, which becomes finer grained and more thinly laminated toward the main part of the island. The island itself is composed mainly of schist.

The nearest islet toward the southeast, about 1,000 feet distant from the barite deposit and nearly in strike with it, is composed wholly of schist, and the next islet toward the northwest at a less distance is composed mainly of schist, together with some cherty limestone and veins of calcite. No other deposit of barite was observed and time was not taken to search for more, but the similar appearance of other cliffs on islands in the group farther north, as observed through a field glass, suggests the possibility of other deposits.

The schistose rock adjacent to the barite, and apparently dipping below it, is gray in color, granular in texture, crumpled to a slight extent, much jointed, and the grains have been flattened to a lens-shaped section. J. B. Mertie, of the United States Geological Survey, finds in a thin section of this rock the following minerals, all of which he regards as secondary: Chert, quartz, barite, a little plagioclase feldspar, a little mica, sulphides, and titanite. When treated with dilute hydrochloric acid, it emits an odor of hydrogen sulphide, but does not liberate carbon dioxide.

#### CHARACTER OF THE BARITE.

The barite, where fresh, is mostly a finely crystalline grayish-white rock with thin grayish-blue veins and clouded areas and a few thin black streaks. Exceptionally some of the barite is coarsely crystalline and white, and some white quartz is present in thin seams and small segregations. Pyrite is nearly everywhere present in fine specks disseminated through the mass or arranged in rough parallelism with the grayish-blue veins in the rock. The thin black streaks are segregations below the surface of the barite of fine specks of dark minerals, among which are probably galena, sphalerite, magnetite, and graphite. Molybdenite is also suggested but was not found by qualitative test. Grains of magnetite can be separated from the powdered rock by means of the magnet. At the surface the material is strongly stained with iron rust, resulting from the weathering of the iron pyrites.

Thin sections studied by Mr. Mertie showed the barite to contain titanite (in part leucoxene derived from ilmenite), iron oxides, and metallic sulphides. The powdered material examined under the microscope by E. S. Larsen showed, in addition to barite, quartz, sphalerite (?), magnetite, and metallic sulphides. The thin sections

show the barite crystals to have been strained and granulated, and probably the barite was metamorphosed along with the bordering schist. The pyrite crystals appear to be secondary to the barite. The powdered barite is grayish white and under a hand lens shows many particles of metallic sulphides. Laboratory experiments outlined on another page suggest that with proper mechanical manipulation it may be possible to bleach the material on a commercial scale.

### ASSAYS AND ANALYSES.

The presence of metallic sulphides in abundance warranted assays for the precious metals, and a sample weighing about 50 pounds was averaged from the surface of the deposit. According to the results of the assays, metals are not present in sufficient quantities to permit the barite to be classed as a metalliferous ore, and its commercial value consequently will depend on the quality and marketability of the barite itself.

The following results were obtained from two independent assays of the material:

*Assays of material from the barite deposit near Wrangell, Alaska.*

	Burlingame (Denver, Colo.).	Ledoux & Co. (New York City).
Gold.....	0.03	0.010
Silver.....	.79	1.05
Copper.....	.05	.07
Lead.....	None.	.29
Zinc.....	1.27	1.14

The results of a quantitative chemical analysis by W. C. Wheeler, of the United States Geological Survey, are as follows:

*Quantitative analysis of barite from vicinity of Wrangell, Alaska.*

	Original analysis.	Recalculated analysis.
Silica (SiO <sub>2</sub> ).....	5.05	5.05
Iron oxide (Fe <sub>2</sub> O <sub>3</sub> ).....	.77	.77
Titanium oxide (TiO <sub>2</sub> ).....	None.	None.
Calcium oxide (CaO).....	Trace.	Trace.
Magnesium oxide (MgO).....	Trace.	Trace.
Barium oxide (BaO).....	58.60	58.60
Strontium oxide (SrO).....	.37	.37
Sulphur trioxide (SO <sub>3</sub> ).....	34.74	33.69
Carbon dioxide (CO <sub>2</sub> ).....	None.	None.
Lead oxide.....	.15	.....
Lead sulphide (PbS).....	.....	.16
Zinc sulphide (ZnS).....	.....	1.68
Manganese dioxide (MnO <sub>2</sub> ).....	Trace.	Trace.
	99.68	100.32

The original analysis showed a surplus of sulphur trioxide and the quantity of zinc sulphide was not determined, but its percentage was calculated as the equivalent of 1.27 per cent of zinc, as determined by the first assay. In like manner the percentage of lead sulphide was calculated by combining 0.15 per cent of lead oxide, which was found by analysis, with a sufficient quantity of the sulphur trioxide to form lead sulphide.

According to this analysis the material contains about 89.16 per cent of barium sulphate, or barite, and is therefore a little less than 90 per cent pure. The chief impurity is silica, and for many purposes for which barite is used, as will be outlined later, a moderate percentage of silica is not deleterious, nor is the strontia, which is too small in quantity to be separated. All the remaining minerals, which are mainly metallic oxides and sulphides, must aggregate less than 4.5 per cent, although only about 2.61 per cent is shown by the analysis. This is not a high percentage of objectionable impurity, and probably is below that carried by shipments of raw barite from many mines.

#### GENERAL NOTES ON BARITE.

##### MINERALOGY AND OCCURRENCE.

Barite (also termed barytes) or heavy spar is barium sulphate, the chemical formula of which is  $\text{BaSO}_4$ . The recorded occurrences of barite indicate that it is a mineral of aqueous origin and that it is formed as a direct deposit from waters or as a precipitate when waters of certain compositions mingle.<sup>1</sup> The pure mineral is composed of barium monoxide (baryta,  $\text{BaO}$ ) 65.7 per cent and sulphur trioxide ( $\text{SO}_3$ ) 34.3 per cent. The specific gravity is 4.3 to 4.6; the hardness is 2.5 to 3.5. Barite is usually a white, opaque to translucent, crystalline material, generally a little softer than calcite but harder than gypsum. It differs from both gypsum and calcite in its greater specific gravity and by the fact that it is practically not affected by acids. A common form of the mineral is an aggregation of straight or slightly curved cleavable plates, but it occurs also in granular, fibrous, and earthy masses, in the form of stalactites and concretions, as well as in single and clustered crystals. Few deposits of barite are wholly pure, the most common impurities being silica, fluorite, lime, magnesia, and the oxides of iron, manganese, and aluminum. The reddish and yellow stains, which are characteristic of much of the commercial barite when freshly mined, are due in large part to iron oxide. Fine crystals of galena and sphalerite are often found either disseminated or segregated in barite.

Barite occurs in veins in both sedimentary and igneous rocks as a gangue of metallic ores and also where it is the predominant mineral.

<sup>1</sup> Clarke, F. W., The data of geochemistry, 2d ed.: U. S. Geol. Survey Bull. 491, p. 555, 1911.

It occurs also as a cement between the grains of sandstone, as a replacement of limestone, as concretions in shale, and as a sinter deposited by springs. The deposits in the United States which at present supply the greater part of the output are situated in southeastern Missouri and in the Appalachian valleys of Georgia, North Carolina, Tennessee, and Virginia, where it is found generally in cherty and gravelly clay, residual material from limestone, dolomite, and quartzite.<sup>1</sup> Kentucky has vein deposits which are little developed.

A shear zone containing quartz and barite is reported by P. S. Smith to occur at the Tyee claim,  $1\frac{1}{2}$  miles west of Crab Bay, on Annette Island, in southeastern Alaska. The barite is white and has a granular crystalline texture, resembling the barite of the Castle Islands, but the largest clear piece of barite noted would measure only about 1 inch by  $2\frac{1}{4}$  inches.

Barite resembling the material from the Castle Islands in having a granular crystalline texture, though whiter in color, has been found in the mountains about 12 miles west of Hailey, Idaho, north of Deer Creek, according to L. G. Westgate, who reports that the deposit forms a vein which may be as thick as 200 feet but which can not be traced far on the strike. This deposit is associated with calcareous sandstones of Pennsylvanian age.

#### USES AND PREPARATION.

Barite is used principally as a pigment in mixed paints and in the manufacture of lithopone, a white pigment, but there are many other uses for small quantities of it, such as the manufacture of barium salts, which have a wide chemical application, the manufacture of rubber, wall paper, asbestos, cement, artificial ivory, enamels, and for covering packages of ham, cheese, etc.

The value of barite as a pigment<sup>2</sup> in mixed paints, if not used in excess, is due to its whiteness, its weight, and its inertness in the presence of chemically active substances, and also to its aptitude to take color stain uniformly and to make a small quantity of color, such as aniline, cover much surface. In order that the barite may be suitable for the uses mentioned above, it must be free from all associated minerals which do not grind white or which are affected by acids or atmospheric gases. Thus iron oxide and the sulphides of metals, such as iron, lead, zinc, and copper, must be removed, and there must be little lime or magnesia present. The presence of small percentages of clear or white quartz is not objectionable, for it grinds to a white powder and is chemically inert.

In the preparation of barite for the market in the mining regions of Missouri, where the largest quantities are at present produced, the

<sup>1</sup> See chapters on production of barytes in U. S. Geol. Survey Mineral Resources, 1907 to 1912.

<sup>2</sup> Burchard, E. F., Barytes as a pigment: U. S. Geol. Survey Mineral Resources, 1909, pt. 2, pp. 699-700, 1910.

ore is first allowed to stand in the sun and rain, so that much of the residual clay with which it is associated drops off, and hand cobbing, picking, and sorting results in such further cleaning of the material that it is ready for shipment to the mills. The product from some workings in the southern Appalachian region is first washed in log washers to free it of associated clay. Next the barite is separated into two or three grades by hand sorting, after which it is ready for the milling process. Neither of these preliminary processes would be needed for the Alaska barite herein described, as it would be ready for milling directly upon being quarried. Barite is milled by both the dry and the wet process.<sup>1</sup> The wet process is the later and more effective one and is now most generally employed. Several types of mills are in use. The milling consists of crushing, grinding, washing, bleaching, and drying, although not necessarily in the order given. The most troublesome impurities seem to be galena and limonite. Where the galena is disseminated in fine grains through the barite the two minerals are not easily separated by jigging or flotation. The limonite can not be entirely removed by ordinary jigging, and magnetic separation has been attempted but not yet accomplished. Bleaching, however, removes the iron, if that substance is not present in quantity so great as to require an excessive quantity of sulphuric acid, but it does not so readily affect the lead compound, which, when ground with the barite, imparts a grayish tint to the material and thereby reduces its value as a pigment. Lime carbonate is also a deleterious impurity when it occurs in sufficient quantity to require a portion of the acid to neutralize it in the bleaching process.

An outline of the complete process in one of the most thoroughly equipped mills in Missouri is roughly as follows: The crude material is ground in slip mills having granite grinders and granite bases. Water is fed into these mills and the ground material is floated over the top of the tanks, after which it is pumped into funnel-shaped separators. The contents of the separators are agitated by flowing water and the coarser, rejected material is drawn off at the bottom of the funnel and returns to the slip mills, whereas the finer material floats off at the top of the separators. This material next descends to settling tanks and after forming a sludge is drawn off into bleaching tanks. The bleaching tanks are built of concrete lined with refractory tile. Bleaching is accomplished by the addition of measured weights of sulphuric acid to the sludge and the agitation of the mass to secure thorough mixture. The acid reacts on the iron oxide and lime present, forming ferrous sulphate and calcium sulphate. The iron salt being soluble and the calcium salt partly soluble, besides having a lower specific gravity than pure barite, these substances,

<sup>1</sup> Burchard, E. F., The production of barytes in 1907: U. S. Geol. Survey Mineral Resources, 1907, pt. 2, pp. 686-687, 1908.



together with the excess of sulphuric acid, are removable in the further washing process to which the material is subjected. For this next washing the material is pumped into washers which employ the float-separation process. Next, the bleached barite passes to settling tanks, after which it is dried by being spread thinly on the surface of a rotating hot drum. From the hot drum the dried material falls or is brushed off and carried to Williams's mills, where it is pulverized, screened, and finally sacked by machine. The essential difference between this process and the others mentioned above lies in the fact that the material is first reduced to a fine condition before bleaching, thereby bringing the sulphuric acid intimately into contact with all portions of the barite.

In the manufacture of the white pigment lithopone, an intimate mixture of precipitated zinc sulphide and barium sulphate, barite is first reduced from the sulphate to the sulphide of barium, which is soluble, and then treated with a solution of zinc sulphate. The reducing of barite is effected by heating to bright redness a mixture of about four parts of crude barite and one part of a very low ash coal in a rotating furnace.<sup>1</sup> The coal acts as a reducing agent, and converts 60 to 70 per cent of the barite to barium sulphide, the remainder being converted to barium carbonate. A similar principle is employed in the initial stages of the production of other barium salts.

#### POSSIBLE VALUE OF THE BARITE OF THE CASTLE ISLANDS.

The barite described above is not of the highest grade, particularly for use as a pigment, and it will probably require a milling test to determine whether or not it may be possible, commercially, to remove the metallic sulphides and to bleach the color to a pure white. Simple laboratory experiments and comparison of the Alaska material with commercial grades of barite suggest that this may be possible. For example, tests by W. C. Wheeler and the writer show that washing and flotation tends to whiten the finely ground grayish-white powder. Further treatment with hot dilute sulphuric acid containing small quantities of sodium chloride and sodium nitrate bleaches the powder to a shade only slightly less white than that of precipitated barium sulphate or zinc oxide. These experiments are encouraging, and seem to indicate that with the aid of proper mechanical manipulation the process might be made commercially successful.

In the process of manufacture of lithopone and the various salts of barium where crude barite is fused with coal a slightly impure raw material would apparently react as well as one having a high

<sup>1</sup> Phalen, W. C., Production of barytes in 1911: U. S. Geol. Survey Mineral Resources, 1911, pt. 2, p. 968, 1912.



degree of purity, providing the impurities present were not in themselves objectionable. It is possible, therefore, that the Alaska barite is suitable for general chemical purposes.

Probably it would not be practicable to build and operate a barite mill in the vicinity of the deposit, but the raw material can certainly be quarried and loaded on barges very cheaply, and transported to Puget Sound or to San Francisco at low freight rates. The approaches to the Castle Islands, though not very deep, show, according to Coast and Geodetic Survey charts, from 5 to more than 30 fathoms of water. In the immediate vicinity of the islands the depth of the water is such that wharves could be built, and there is plenty of timber at hand suitable for this purpose. On the island of which the barite deposit is an outlier there is level space sufficient for the necessary buildings of a quarry camp. Quarrying of the deposit would evidently be very simple, as the material could be blasted from the face of the cliff and a large output obtained in a relatively short time. Over the top of the mass there is a bushy growth of spruce and cedar with little soil, and if this were stripped off at first the deposit would afford an unusually clean quarry.

#### PRODUCTION,<sup>1</sup> IMPORTS,<sup>2</sup> AND PRICES OF BARITE.

The production of crude barite in the United States in 1913 was 45,298 short tons, valued at \$156,275. This represents the value of the crude material free on board at the mines, and gives an average price for the whole country of \$3.45 a ton of 2,000 pounds. The average price in the southeastern Missouri district was \$3.78 a ton. The imports of crude barite entered for consumption during 1913 amounted to 35,840 short tons, valued at \$61,409, or \$1.71 a ton, and of manufactured barite 5,463 short tons, valued at \$38,155, or \$6.98 a ton. Of these imports, 82 short tons of crude barite, valued at \$144, or \$1.76 a ton, and 601 short tons of manufactured barite, valued at \$3,976, or \$6.62 a ton, were entered at San Francisco, the only Pacific coast port which received any barite during 1913.

<sup>1</sup> Hill, J. M., The production of barytes in 1913: U. S. Geol. Survey Mineral Resources, 1913, pt. 2, pp. 165-166, 1914.

<sup>2</sup> Imports according to Bureau of Foreign and Domestic Commerce, Department of Commerce.