BULLETIN OF THE GEOLOGICAL SOCIETY OF AMERICA
VOL. 15, PP. 283-288, PLS. 12-13 JUNE 25, 1904

MOLYBDENITE AT CROWN POINT, WASHINGTON

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(*Presented before the Society December 30, 1903*)

CONTENTS

INTRODUCTION

The occurrence of molybdenite (MoS_2) at Crown Point, Chelan county, Washington, is one of the most interesting in the United States for several reasons: First, because practically the entire commercial supply of the mineral in the United States for 1902 was mined at this locality. The amount is given by Dr J. H. Pratt as about twelve tons of ore.* Second, because the locality presents an interesting illustration of the geologic relations of the substance; and third, because so large a quantity of this comparatively rare mineral naturally furnishes excellent specimens representing the mineralogical character of molybdenite.

Commercially molybdenite is important as the chief source of molybdenum. This element has long been used as a pigment for coloring silk, leather, and porcelain. The color which it furnishes is a brilliant, uniform, and permanent blue, and is especially prized for glazed ware.

* Mineral Resources of the United States, 1902, p. 7.

Molybdenum finds a limited use in chemical laboratories for the detection of phosphoric acid and as a medicine for the cure (?) of dropsy.* The chief demand for the element, however, is one which has arisen recently in the manufacture of steel, a fraction of a per cent producing an effect analogous to that obtained by the employment of wolfram and nickel. The price paid for molybdenite ores varies to a surprising degree, from $150 to $1,500. The variation is caused largely by the presence or absence of chalcopyrite, a small amount of the substance having a very deleterious effect.

Literature

Though the Chelan deposit has been known and worked for a number of years (since 1897 or 1898), the literature in reference to it is meager. In Hintze's comprehensive list of occurrences it is not mentioned. The only references which the writer has found are in the Washington Geological Survey report for 1901 † and the "Mineral Resources of the United States" from 1899 to 1902.

A short visit to the mine in 1902 enabled the writer to collect specimens of the mineral, gangue, and country rock, and to take photographs of the lode.

Occurrence of Molybdenite at other Localities

Petrographical Relationships

At fifty or more localities in different parts of the world where molybdenite is reported, it occurs in a great variety of rocks and associated with many different kinds of minerals. A survey of these occurrences shows that it is found in practically all of the main groups of rocks, as the following list will indicate.* It is found in

1. Conglomerate (Switzerland).
2. Granular limestone (Hessen, Ungarn).
3. Contact of marble with pyroxenite (California).
4. Serpentine (Tirol).
5. Garnetite (Hessen).
6. Amphibolite schist (Finland).
7. Chlorite schist (Kärnten, Sweden, Finland).
8. Talc schist (Finland).
9. Mica schist (Switzerland, Sweden).
10. Gneiss (Baden, Mähren, France, Norway, Connecticut).
11. Basalt (Sardinia).
12. Pyroxenite (Canada).

* Fuchs et Delauney: Traité des Gites Mineraux et Metalliferes, 1893, ii, p. 175. D. C. Davies: Earthy and other Minerals, and Mining, 1892, p. 324.

† Washington Geol. Survey Annual Report, vol. i, pp. 92-93.

13. Gabbro (Harz).
14. Syenite (Norway).
15. Granite (Schläsien, Böhmen, Bayern, England, Norway, Ceylon, Tasmania, New South Wales, Victoria, and various parts of Canada and the United States).

This last named occurrence—that is, with granite—is by far the most usual and typical.

ACCOMPANYING MINERALS

The mineral association is not less varied than its petrographical relationships. It is associated with the following minerals, arranged in mineralogical order: Silver and gold, sphalerite, pyrrhotite, pyrite, bornite, chalcopyrite, arsenopyrite, fluorite, quartz, magnetite, cassiterite, rutile, calcite, orthoclase, oligoclase, pyroxene, tremolite, hornblende, garnet, scapolite, zircon, tourmaline, muscovite, biotite, apatite, barite, wolframite, scheelite—some thirty minerals in all.

The association with sulfides and oxides is that most characteristic of the occurrence in quantity in veins. The association with carbonates and silicates is that shown by particles disseminated in rock masses.

FORM OF DEPOSITS

The form of the deposit shows some variety, inasmuch as the mineral under consideration is found in rifts, impregnations, in quartz druses, in beds and lenses, in beds of magnetite, in copper and cassiterite veins, in veins of compact tremolite, and in veins of fluorite, barite, and most commonly quartz. Lacroix † says that molybdenite is rarely found in metalliferous veins.

Location of Crown Point Mine

Chelan county is a little north of the center of Washington. Through it from southeast to northwest stretches lake Chelan for about 60 miles in a narrow rock gorge from 2 to 4 miles in width. In many places the banks are so steep that a fisherman could not find standing room. The mountains rise 5,000 feet or more above the lake. In rugged beauty this lake is probably unsurpassed by any of the lakes of North America. Its picturesqueness has been well described by Russell.‡

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* An extended list of localities is given in Hintze's Handbuch der Mineralogie, i. See also:
Lacroix: Min. de l. France, tome 2, p. 461.
Mugge: N. Jahrbuch, 1898, i, p. 109.
Chelsius: N. Jahrbuch, 1902, i, p. 336.
Bell: Transactions Am. Inst. Mining Engineers, xiv, p. 692.
American Journal of Science, 1886, 1889, 1898.

† Mineralogie de la France, 2, p. 461.

‡ I. C. Russell: Lakes and Rivers of North America.

Twelve miles from the head of the lake, on the southwest side, opens up a valley which extends 20 miles westward to near the summit of the Cascades. It discloses folded metamorphic and igneous rocks. Through the valley runs Railroad creek, making a fall of 4,000 to 5,000 feet in 20 miles from its source to the surface of the lake, which is only 1,100 feet above tide level. At the head of the valley rises a granite cliff so precipitous that many would-be visitors to the mine withdraw without attempting the ascent.

That the molybdenite-bearing ledge was ever discovered is surprising, and gives an indication of the minute scrutiny with which prospectors have gone over the country. The first tunnel is 900 feet above the miners' cabin at the foot of the cliff, and the face of the cliff makes an angle of from 60 to 80 degrees from the horizontal. Access to the mine is made possible by a rope fastened to an iron peg in the rocks (plate 12, figure 1).

Form of the Deposit

The molybdenite occurs in a quartz vein, a blanket vein outcropping along the nearly perpendicular face of a granite cliff for several hundred feet. In general, it is nearly horizontal, but at times has an inclination of from 5 to 6 degrees toward the west (plate 12, figure 2). Its average thickness, which is from 2 to 3 feet, and the general horizontal position are well shown in plate 13, figure 1). Two tunnels have been driven into the cliff, one extending 195 feet toward the northeast and the other 80 feet westerly. There are something more than 100 feet of open workings. The molybdenite does not occur near the center of the vein. Thus it differs from the Mono county, California, occurrence.* At Crown Point it is found in small seams several inches in thickness, extending in all directions through the quartz vein from side to side. At no time is the molybdenite found in the accompanying granite, but is always separated from it by a layer of quartz.

Inclosing Rock

The rock in which the molybdenite-bearing quartz vein is found is a greenish gray biotite granite. It is from medium to fine grained, and even in texture. Of the composing minerals, the quartz is firm, compact to granular, with occasional crystal faces, and usually glassy and white when not discolored by iron oxides. The feldspars are opaque and colored greenish by the decaying biotite, which is changing to chlorite. Thin-sections show under the microscope that the quartz is well filled with fluid inclosures and is xenomorphic in relation to the feldspar and biotite. The feldspars are so kaolinized as to be almost

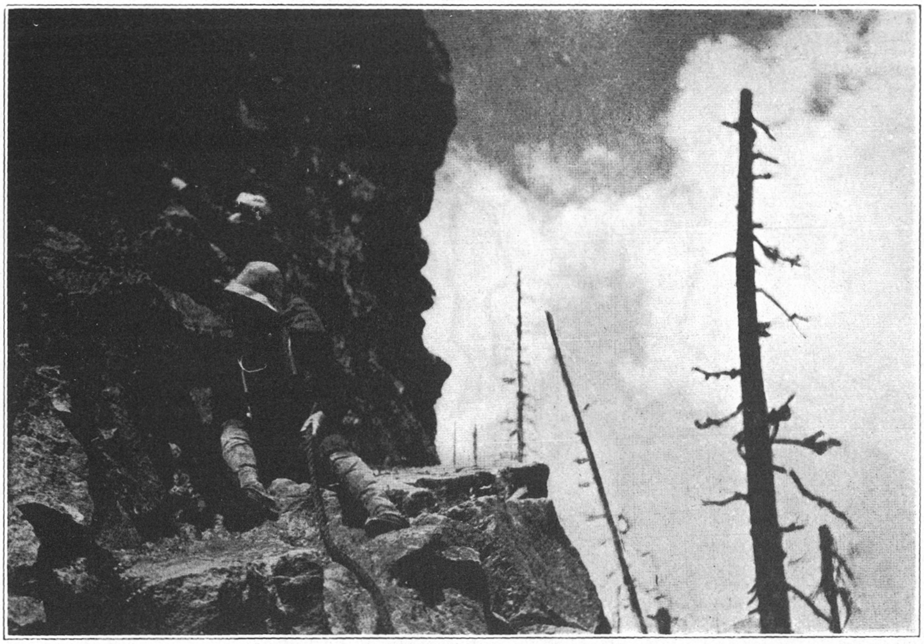

FIGURE 1.—GRANITE WALL CONTAINING MOLYBDENITE VEIN

This vein is 900 feet above miner's cabin

FIGURE 2.—DIP OF QUARTZ VEIN AT FIRST TUNNEL

MOLYBDENITE-BEARING VEIN IN GRANITE

FIGURE 1.—HORIZONTAL QUARTZ LEDGE AT A POINT RICH IN MOLYBDENITE

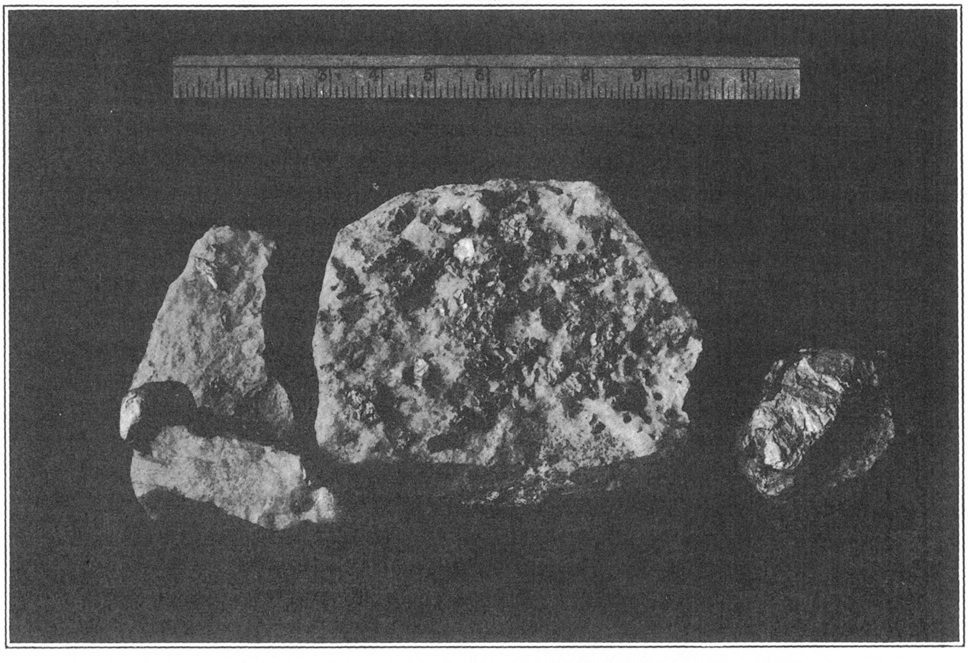

FIGURE 2.—MOLYBDENITE CRYSTALS IN QUARTZ

MOLYBDENITE IN QUARTZ

devoid of optical properties. The biotite occurs in large bunches and tufts. It discloses various stages of chloritization. The accessory minerals are few and unimportant.

Analyses

Two analyses of the granite made by Miss Zaumbrecher and two by Mr J. N. Pearce, of Northwestern University, failed to show molybdenum in the granite. This is somewhat surprising, since this element is notably at home in acid igneous rocks.† This would seem to indicate that the molybdenite in the quartz veins was not derived by lateral secretion.

Character of the Molybdenite

The molybdenite occurs in crystals and flakes of varying size (plate 13, figure 2), from minute specks to irregular masses, sometimes 20 millimeters in diameter. The crystals show the characteristic rifts parallel to the side of a hexagonal prism. The prism faces, however, are rarely developed, but the usual form is that of flat pyramids which are built up as shown in plate 13, figure 2. The majority of these pyramids are very beautifully and strongly striated, the striations being parallel to the union of the prism face with the base. Cleavage surfaces are not smooth and unmarked, but are divided by lines elevated at right angles to edge of intersection of pyramid with base, explained by Mugge ‡ not as "glide planes," but rather as the result of bending with "translation" parallel to base (0001). Bent planes are common, and, in addition, evidence of torsion due to molecular stress.

These crystals furnish no new facts upon the crystallography of molybdenite. Being opaque, it is not possible to use optical methods in their study, and hence one of the best means of determination is wanting. It is generally agreed, however, that the mineral is hexagonal, according to the measurements of Brown.§ Repetition twinning in some of the crystals examined seems to accord with this determination. The crystals show fine luster and are very pure.

Paragenesis

The molybdenite crystallizes sometimes before and sometimes after the inclosing quartz. For example, in localities, as in Silesia, it is found

* Mineral Resources of the United States, 1901, p. 266.

† Hillebrand; Bulletin U. S. Geol. Survey, no. 167, p. 53.

‡ Mugge: N. Jahrbuch d. Min., 1898, i, p. 109.

§ A. P. Brown: Proc. Acad. Nat. Sci., Philadelphia, 1896, p. 210.

capping quartz crystals in quartz geodes. At Salzburg it fills out the cavities between well defined quartz crystals. At Crown Point the molybdenite is always separated from the granite which incloses the quartz vein by a layer of quartz, but the quartz is xenomorphic toward the molybdenite, since the form and striations of molybdenite are always evident in the quartz in which the molybdenite crystal is imbedded.

Associated Minerals

As far as the writer is aware, molybdenite is not associated with gold and silver at Crown Point. None of the specimens examined contained either of these metals. The statement of such occurrence made in "Mineral Resources of the United States," 1901, should probably apply to the Holden mine,* a few miles farther down the valley. Some distance from the outcropping of the vein toward the inner part of the tunnel chalcopyrite appears mixed with the molybdenite. The absence of chalcopyrite near the outcropping may be due to the fact that it has been oxidized. It is well known that even in museums the iron sulfide is preserved with difficulty in the presence of moist air. Upon the addition of water to the mineral, pyrite or marcasite readily change into melanterite, which is easily dissolved. The chalcopyrite, while more stable, in open air readily passes into the sulphate, which can be dissolved, and is washed away without leaving a trace. This is a probable cause of the absence of copper ores near the surface.

Source

The suggestions as to the source of molybdenite are mainly negative. If we assume, which is more than probable, inasmuch as the element is not now present, that the neighboring rock at no time contained molybdenite, the source could not have been from lateral secretion. If the neighboring rock did contain the substance, it would be difficult to conceive of leaching so thorough as to remove the last trace; hence we are led to conclude that the material must have been born by descending or ascending waters, and I see no facts to suggest a choice of the alternatives.

*Mineral Resources of the United States, 1901, p. 266.