W. S. Twenhofel - Ext. 3437

# DEPARTMENT OF THE INTERIOR

## INFORMATION SERVICE



GEOLOGICAL SURVEY

For Release, APRIL 13, 1944.

### THE SHAKAN MOLYBDENITE DEPOSIT, KOSCIUSKO ISLAND SOUTHEASTERN ALASKA

A report on the molybdenite deposit near Shakan, Kosciusko Island, southeastern Alaska, has been prepared by the Geological Survey, United States Department of the Interior, according to a statement by the Director of the Survey, William E. Wrather. The deposit was examined by G. D. Robinson and R. A. Harris during August 1943.

The deposit is in a narrow brecciated fault zone, which is mineralized with the sulfide minerals molybdenite, pyrite, pyrrhotite, chalcopyrite, and sphalerite. The deposit is exposed in 14 prospect pits and a 570-foot adit driven along the fault. It contains about 4,500 tons of measured ore containing about 1.5 percent of $MoS_2$ in addition to indicated reserves aggregating between 10,000 and 20,000 tons of ore estimated to contain 1.5 percent of $MoS_2$. An additional few tens of thousands of tons may be inferred.

A limited number of mimeographed copies of the report, with maps, are available to those directly interested and may be obtained upon application to the Director, Geological Survey, Washington 25, D. C.



P.N. 39352

UNITED STATES
DEPARTMENT OF THE INTERIOR
Geological Survey
Washington

# THE SHAKAN MOLYBDENITE DEPOSIT, KOSCIUSKO ISLAND, SOUTHEASTERN ALASKA

by

G. D. Robinson

Shakan is an abandoned cannery village on the east shore of Shakan Bay, near the northern end of Kosciusko Island, southeastern Alaska (see fig. 1). It is about 65 miles by water southwesterly from both Wrangell and Petersburg, the nearest ports. The molybdenite deposit (see fig. 2) is three-fifths of a mile southerly from Shakan, at an altitude of 690 feet. The deposit is near the head of the large valley south of Shakan and can be reached with little difficulty, although there is no well-defined trail.

Northern Kosciusko Island is rugged, and below 2,000 feet is heavily timbered with hemlock and spruce. Locally dense growths of devil's club and alder impede travel. Talus, glacial till and vegetation cloak most of the surface, and rock outcrops are rare. The climate is mild and humid.

During and shortly after the first World War the Alaska Treadwell Gold Mining Company developed the property, driving 570 feet of tunnel and excavating 14 surface cuts. A compressor was installed and a tramway, docks and camp were built; none of these improvements is now usable. Nearly 200 analyses were made of samples from the tunnel and the open cuts; these analyses form the basis of the grade estimates in this report. Development stopped with the drop in price of molybdenum after the war, and no ore was shipped.

The Alaska Juneau Gold Mining Company now owns the property, which includes 11 patented lode claims and 4 mill-site claims.

During the development period, the deposit was the subject of private reports by R. G. Wayland and Livingston Wernecke of the Alaska Treadwell Gold Mining Company, and was briefly examined and described by J. B. Mertie, Jr.1/

---

1/ Mertie, J. B., Jr., Lode mining in the Juneau and Ketchikan districts: U. S. Geol. Survey Bull. 714, pp. 118-119, 1921.

and Theodore Chapin 2/ of the Geological Survey. More recently, A. F. Buddington 3/ presented the results of a laboratory study of specimens from the deposit. The Bureau of Mines 4/ examined the deposit in 1942 and announced plans to explore and develop it. The proposed work had not been started in March 1944.

Mr. P. R. Bradley of the Alaska Juneau Gold Mining Company very kindly furnished the analytical data used.

This report summarizes field work done by the Geological Survey during the period August 1 to September 3, 1943.

## GENERAL GEOLOGY

A thick sequence of massive white crystalline limestone, exposed along the east shore of Shakan Bay north of Shakan and extending eastward into Dry Pass, conformably underlies a thick sequence of dark thin-bedded graywacke and argillite, exposed along the shore south of Shakan and on Hamilton Island (see fig. 2). As recognized by Buddington and Chapin 5/, these rocks are probably on the east limb of a large, complexly-crumpled syncline trending north-northwesterly and are probably of Silurian age.

The sediments are intruded by a large stock, of which only a small part is in the mapped area. Biotite quartz diorite and subordinate hornblende quartz diorite are exposed along Dry Pass (see fig. 2) and probably occupy most of the valley east of the hills flanking the prospect area, and extend unknown distances to the south and east. A belt of hornblende diorite borders the quartz diorite on the west, separating the quartz diorite from the graywacke-argillite sequence and in part from the limestone sequence. The contact between the graywacke-argillite beds and the hornblende diorite is transitional, suggesting much interaction between the sediments and the intrusive fluids. The relative ages of the intrusives are not known. The sediments and the stock are cut by many dikes, including dacite, granite aplite, granite pegmatite, andesite, basalt and diabase. The intrusives are probably contemporaneous with those on the mainland comprising the Coast Range batholith of Upper Jurassic or Lower Cretaceous age.

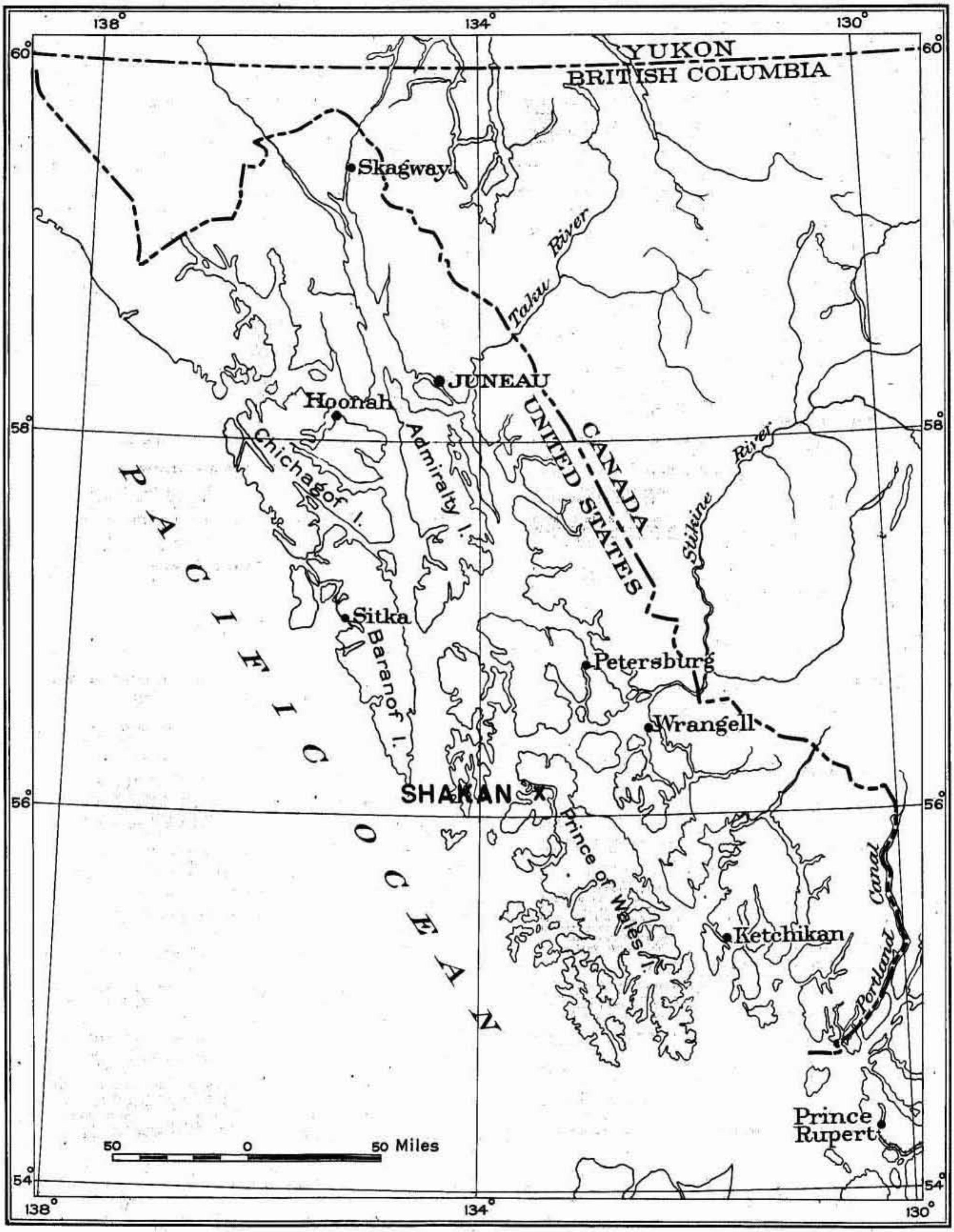
---

2/ Chapin, Theodore, Mining developments in the Ketchikan district: U. S. Geol. Survey Bull. 692, p. 89, 1919.

3/ Buddington, A. F., Molybdenite deposits at Shakan, Alaska: Econ. Geol., vol. 25, pp. 197-200, 1930.

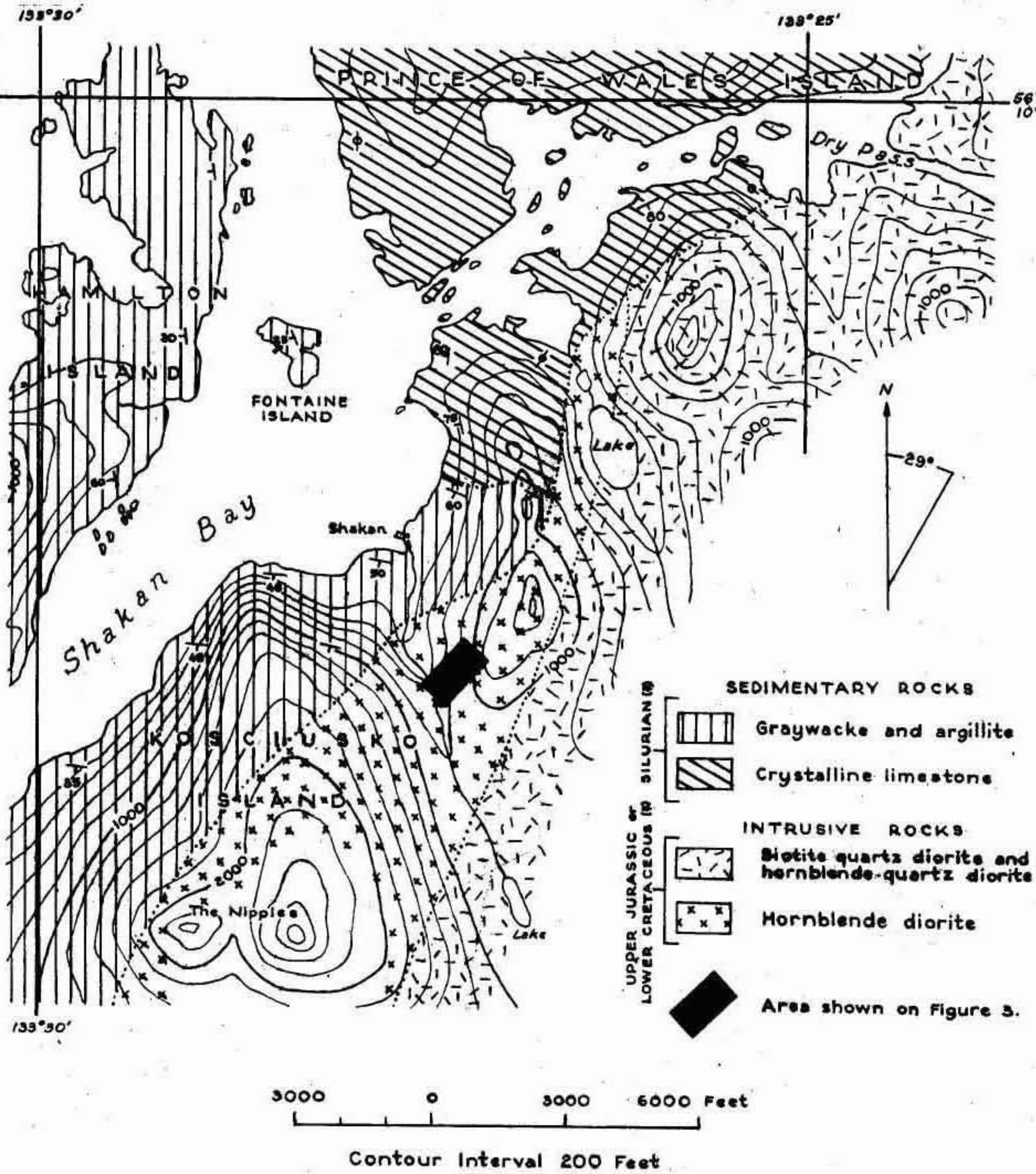
4/ Bureau of Mines, Shakan molybdenum deposit: War Minerals Rept. 108 (restricted), 9 pages, March, 1943.

5/ Buddington, A. F. and Chapin, Theodore, Geology and mineral deposits of southeastern Alaska: U. S. Geol. Survey Bull. 800, p. 308, 1929.




37448

FIGURE I: INDEX MAP OF SOUTHEASTERN ALASKA SHOWING LOCATION OF SHAKAN MOLYBDENITE DEPOSIT




Geography modified from U.S. Coast and Geodetic Survey Chart 8172.

Geology by G.D. Robinson, 1943.

FIGURE 2: GEOLOGIC RECONNAISSANCE MAP OF VICINITY OF SHAKAN MOLYBDENITE DEPOSIT, KOSCIUSKO ISLAND, SOUTHEASTERN ALASKA

# MOLYBDENITE DEPOSIT

## General description

The molybdenite deposit is in a narrow brecciated fault zone, near the middle of the belt of hornblende diorite (see fig. 2). Molybdenite is sparsely disseminated in the diorite in a few places far beyond the zone, but significant mineralization appears to be confined to the fault zone and the immediately adjacent country rock.

The fault zone ranges in thickness from less than 1 foot to more than 10 feet, and has an average thickness of 4 feet (see figs. 3 and 4). The zone persists throughout the length of the tunnel and has been traced on the surface for about 800 feet. In detail, the strike of the fault zone ranges widely and abruptly; the average strike in the western part of the tunnel is about N. 85° W., in the eastern part about N. 70° E. The few surface exposures strike similarly. Dips average between 20° S. and 25° S. in the western part of the tunnel and between 10° S. and 15° S. in the eastern part; short segments of the zone have dips as great as 35° and as small as 5°. Dips on the surface range from 20° S. to 35° S., although one questionable dip of 15° S. is recorded. In most places the zone is bounded by fractures filled with gouge, generally about 1 inch thick but locally as much as 6 inches thick; in some places either or both of the limiting fractures feather out into many irregular fractures, with little or no gouge, and the limits of the zone are indefinite. Breccia blocks of hornblende diorite, ranging from less than 1 inch to more than 30 inches in maximum dimension, are the principal material filling the zone. The diorite fragments are separated by bands, generally less than 1 foot thick, of igneous and hydrothermal materials introduced at various times during repeated reopenings of the fault zone, and by silicified gouge. Some irregularly shaped masses of introduced material are as much as 4 feet wide and more than 10 feet long. Included in the introduced matrix are granite pegmatite; quartz-adularia, quartz, and calcite veins; diabase and aplite dikes; zeolite encrustations; and iron, copper, zinc and molybdenum sulfides and their decomposition products. The fault zone constitutes a composite vein.

## Ore minerals

Molybdenite ($MoS_2$) is the only mineral present in economic quantities. It occurs as disseminated fine grains, as crystals in cavities still partly open, as coatings on crystals of other minerals and, more rarely, in veinlets. Other sulfide minerals in the vein, in order of decreasing abundance, are pyrite, pyrrhotite, chalcopyrite and sphalerite. These minerals generally occur as small irregular masses of nearly solid sulfide. In addition, pyrite is a very common vein constituent, and chalcopyrite, pyrrhotite and sphalerite are in a few veins. Negligible amounts of gold are reported in analyses.

. . . .

Weathering of the sulfide minerals has produced small amounts of molybdite ($Fe_2O_3 \cdot 3MoO_3 \cdot 7\frac{1}{2}H_2O$), limonite, hematite, chalcanthite ($CuSO_4 \cdot 5H_2O$) and perhaps other minerals.

The ore minerals with their decomposition products aggregate about 5 percent of the vein filling.

Gangue

The principal gangue is the diorite breccia previously described, which aggregates more than half of the total waste. The breccia fragments are in many places marginally replaced by sulfide minerals and by gangue minerals.

At some places, particularly in the eastern part of the tunnel, a hard, dark, fine-grained, banded rock occupies part of the vein. The banding parallels the vein boundaries. This material probably represents gouge developed during brecciation previous to or accompanying mineralization and hardened by addition of silica.

About half of the introduced gangue is pegmatite, consisting mainly of pink orthoclase but containing some quartz, biotite, muscovite and sphene. The pegmatite is coarse-grained, contains many vugs, and is much crushed.

Vuggy, intricately fractured quartz-adularia veins and masses are common, although less abundant than pegmatite. In addition to clear glassy quartz and white euhedral adularia, the rock contains well-formed crystals of bright-green epidote. The proportions of quartz and adularia range widely.

Veins and masses of pink calcite and of clear and cloudy quartz are numerous. Small diabase and aplite dikes appear sporadically in the vein. Some fractures and cavities are lined with zeolite crystals, principally laumontite ($CaO \cdot Al_2O_3 \cdot 4SiO_2 \cdot 4H_2O$).

The vein materials are in general randomly distributed with reference to the boundary walls. They are all present above the mapped hanging wall and below the mapped footwall, but are much more abundant between these surfaces. Laterally, the relative proportions of the vein materials range widely on both a large and small scale. The large-scale differences in mineral proportions are shown on fig. 4.

Country rock

The hornblende diorite country rock ranges widely in grain size and in the relative proportions of light and dark minerals. According to Mertie 6/ the rock "varies somewhat in character and composition but in general is composed of zonally grown plagioclase feldspar....with an average composition perhaps of andesine; a small amount of orthoclase; considerable hornblende; and biotite, augite, iron oxides and apatite." Inclusions which appear to be partly-digested graywacke and argillite fragments are abundant.

---

6/ Mertie, J. B., Jr., op. cit.

## Structure

Small-scale faulting evidently occurred repeatedly during mineralization. Only the limiting faults and a prominent cross-fault are mapped (see fig. 4).

The faults which limit the vein are well defined fractures which probably were developed before the mineralization. There has been some post-mineralization movement along the boundary faults, as is indicated by the presence in the gouge of fragments of sulfide minerals and introduced gangue minerals. The amount and nature of the boundary-fault displacements is not definitely known. The effective displacement is believed to be small, perhaps not exceeding a few feet, as indicated by the small range in thickness of the vein, in comparison with the large range in strike and dip. In the tunnel, the thicker parts of the vein are in general the more steeply dipping parts. For this reason, it is supposed that the effective displacement was of the normal type, the south (hanging) wall having moved down relative to the north (foot) wall.

West of the tunnel portal the fault zone appears to be much thinner and may disappear in places between the portal and the most westerly exposure in the creek bed, where it is poorly developed and not more than 2 feet thick. Although the zone thins to about 2 feet in cuts 10 to 13 (see fig. 3) near the east end of the exposures, cut 14 shows a vein thickness of nearly 6 feet, and the zone probably continues somewhat farther. No great continuation of the zone beyond the present limits can be safely predicted.

A cross-fault offsets the vein in the adit, about 260 feet from the portal. This fault is nearly vertical and strikes about N. 5° E. The west wall has an apparent upward displacement of about 5 feet and a southward displacement of about 15 feet, relative to the east wall.

## Factors influencing molybdenite distribution

The analyses, as shown on figure 5, indicate that the molybdenite content of the vein is relatively high in the open cuts and at the west end of the adit, and negligible or relatively low in the remainder of the adit. In those portions of higher molybdenite content the vein dips more steeply, and contains higher proportions of pegmatite and quartz-adularia than in the portions of low molybdenite content.

The well-mineralized part of the vein on the adit level dips 20° to 35°. The poor condition of the surface cuts precludes accurate dip determinations, but the few dips taken range from 20° to 35°, except in cut 8, in which the dip is about 15°. The barren and poorly mineralized parts of the vein in the adit generally dip 5° to 15°, although one 20° dip is recorded. If the effective displacement of the vein walls was of the normal type, as previously suggested, the vein fractures would have been relatively open in more steeply dipping portions and relatively closed in less steeply dipping portions; the steeper, open parts would have been favorable places for mineral deposition. This may explain the failure of ore exposed on the surface between cuts 6 and 14 to continue down dip to the eastern parts of the adit level. Comparison of dip data with analyses (see figs. 3 and 5) shows that the relation between steeper dip and better ore is not constant and may prove to be merely local. However, this relation may be of value as a guide to ore and should be kept in mind during any future development.

It is believed that mineralization is more intense in the pegmatite and quartz-adularia for structural reasons only. The kind of movement which produced the openings localizing the gangue appears to have been repeated prior to the introduction of molybdenite and thus to have produced similarly-placed openings for the passage of molybdenite-bearing solutions. Moreover, the rocks in question contain numerous vugs and fractures in which molybdenite could readily be deposited from passing solutions.

The fault zone was doubtless the principal channel for the mineralizing fluids. At the time of molybdenite introduction it was apparently not bounded by much gouge, and some molybdenite was deposited beyond the bounding fractures.

## Grades and dimensions of ore shoots

The determination of the grades and dimensions of minable segments of the vein presents a number of problems. Because the molybdenite content ranges widely and abruptly, the limits of economic mineralization within the vein are assay limits and cannot be located accurately. Although most molybdenite is between the mapped hanging wall and footwall, minable concentrations also are present locally a few feet beyond these walls near some of the richer parts of the vein.

Measurements and analyses used herein are from records of the Alaska Juneau Gold Mining Company (see fig. 5), with the exception of a single sample collected and analysed by the Bureau of Mines. All the Alaska Juneau Gold Mining Company analyses were made in the period 1917-1921. The data below illustrate the wide range in results obtained by different analysts in that period 7/. Parts of the same sample from each of the open cuts were analysed by the developing company and by two commercial analysts. The molybdenite contents of five of these samples are listed:

| Cut from which | Percent of $MoS_2$ | | |
|---|---|---|---|
| sample was taken | Alaska Juneau | Abbot Hanks | Smith & Emery |
| 1 | 0.94 | 1.11 | 1.36 |
| 3 | 0.86 | 2.56 | 1.50 |
| 4 | 0.75 | 1.05 | 0.61 |
| 7 | 0.28 | 0.30 | 0.50 |
| 9 | 0.68 | 2.61 | 0.61 |
| Average: | 0.70 | 1.53 | 0.92 |

7/ Bradley, P. R., letter of December 27, 1943.

No information is available to the Geological Survey as to the analytical methods used and it cannot be stated which group of results is the most nearly correct. The results of the Alaska Juneau Gold Mining Company are consistently low in comparison with the others.

In the discussion of grade which follows, the cut-off used in calculations has been arbitrarily set at 0.5 percent of $MoS_2$.

There is little agreement among three sets of analyses made of adit samples taken by the Alaska Juneau Gold Mining Company. The samples taken in Group A of fig. 5 apparently represent an attempt to test the deposit between the boundary fractures of the vein. The samples are moil samples taken 5 feet apart from all portions of the tunnel containing any visible molybdenite.

Samples of Group B were apparently taken to check the grade of the richer part of the vein. The samples are moil samples taken 10 feet apart across the entire height of the adit, which in most places is several feet greater than the vein width. At most places "top" and "bottom" samples were taken for Group B. The division apparently was made for the purpose of discriminating between the $MoS_2$ content of a pegmatite dike which intermittently follows the hanging wall in this part of the adit, and the content of the remainder of the vein. Most of the "top" samples contain more molybdenite than the corresponding "bottom" samples. The difference is in part attributable to the fact that "bottom" samples extend from a few inches to a few feet below the footwall of the vein.

During the driving of the first 220 feet of the adit, between three and five "face samples" — Group C — were taken for each 10 feet of adit. The width of each sample is not recorded, and only a numerical average can be calculated for this group.

Although Group B samples ("top" and "bottom" combined) are considerably longer than Group A samples, the average molybdenite content reported for Group B (1.85 percent) is much greater than that reported for Group A (1.17 percent) for nearly the same footage. The average molybdenite content reported for Group C (2.83 percent) is nearly 2½ times that reported for Group A and more than 1½ times that reported for Group B.

Only one complete set of analyses of surface samples is available.

To choose among the three groups does not seem advisable, and to compute an average directly from them is not worthwhile because the groups are not entitled to equal consideration. The metallurgical sample taken by the Bureau of Mines provides the only recently taken check of ore grade. The sample was "taken from the wall of the adit between 164 and 167 feet and from hanging wall to footwall" 8/. The sample contained 2.92 percent of $MoS_2$

---

8/ Bureau of Mines, op. cit., p. 4.

It is apparent that a precise statement of ore grade cannot now be made. In the writer's opinion Group C analyses are too high, and the true grade of the ore in the adit is approached by Groups A and B.

Regardless of the true ore grade it is evident from inspection of Group A analyses that a segment of the vein near the western end of the adit has a relatively high molybdenite content, that another short segment at the eastern end has a relatively low molybdenite content and the remainder of the vein on the adit level is essentially barren. For purposes of estimating reserves the ore is assumed to begin 50 feet from the portal and to continue 170 feet along the adit, or 155 feet measured on the average vein strike. The average thickness of the vein in this segment is 4.5 feet, as measured by the writer. However, some of the ore extends beyond the vein walls and it is estimated that the average ore width is not less than 5.5 feet and that the grade is about 1.5 percent of $MoS_2$.

A weighted average of Group A analyses from the last 40 feet of the adit indicates an average of 0.58 percent of $MoS_2$ over an average sampled thickness of 4.5 feet. Both the individual analyses and inspection of the vein indicate that molybdenite distribution is particularly spotty in this portion.

Twenty-one irregularly spaced samples taken from surface exposures in the 520-foot interval between the portal and cut 14 contained a weighted average of 0.99 percent of $MoS_2$ over an average sampled thickness of 4.0 feet. A number of the samples do not represent the full thickness of the vein and apparently none test the country rock immediately adjacent to the vein.

Relating the data from the adit to those from the surface is difficult, unless it is assumed that change in dip was the principal controlling influence on ore distribution. On this basis, the exposures of ore on the surface and at the western end of the adit appear as parts of a single irregularly bounded ore shoot.

The orientation of the shoot cannot be determined satisfactorily. Its long axis probably trends between N. 20° E. and N. 60° E. Its plunge is between 15° S. and 30° S. Its plunge-length from cut 14 to the adit is between 450 feet and 500 feet; the shoot probably continues at least a few tens of feet beyond cut 14 and below the adit. The strike-length of the shoot in the vicinity of the adit is about 155 feet; the shoot doubtless pinches and swells and its strike-length away from the adit is not known. The average thickness of the shoot is assumed to be 5 feet and the average grade 1.5 percent of $MoS_2$.

The low-grade molybdenite-bearing zone at the eastern end of the adit may be on the periphery of another ore-shoot of indeterminate size and grade. However, it is equally likely that it is part of an area of slight molybdenite concentration in a low-dipping and therefore relatively unfavorable portion of the vein.

## Reserves

The estimation of reserves in the Shakan molybdenite deposit is difficult, principally because information on the orientation, dimensions and molybdenite content of the ore shoot or shoots is inadequate. However, it is reasonably certain that the vein between the ore zone in the western part of the adit and at least part of the surface exposures constitutes a body of ore classifiable as measured.

The vein segment bounded by the ore zone in the adit and approximately by cuts 1 to 5 comprises the principal volume of measured ore, as estimated in this report. This segment, outlined as block A, fig. 5, has an area, in the plane of the vein, of about 11,000 square feet and a volume of about 55,000 cubic feet. Assuming a factor of 12 cubic feet to a ton, the mass contains about 4,500 short tons. Ore definitely extends beyond cut 5 and below the adit, and a certain volume of this ore is classifiable as measured, depending on the zone of influence attributed to each sample. However, all of this additional ore is herein regarded as of the indicated class.

If the shoot is assumed to extend below the adit for at least half its strike length, and also to extend at least a few tens of feet downward from the cuts in a direction normal to the line of outcrop, it appears that a tonnage two or three times greater than that of the measured ore is indicated.

On this basis, the total measured and indicated reserves aggregate between 10,000 and 20,000 tons, containing about 1.5 percent of $MoS_2$. About 500 tons of ore were removed in driving the tunnel and are now on the dump, partially mixed with about 2,000 tons of waste.

An additional few tens of thousands of tons may be inferred. The low-grade material near the face of the tunnel may represent an ore shoot, and blind shoots may be distributed in other parts of the vein.

According to the Bureau of Mines 9/ "Metallurgical tests indicate that a high-grade concentrate can be produced by flotation."

## Summary

The molybdenite deposits near Shakan, Kosciusko Island, southeastern Alaska, are in a narrow, low-dipping fault zone in hornblende diorite. Inconclusive evidence indicates that the distribution of molybdenite was probably controlled principally by openings developed in the more steeply dipping parts of the fault zone as a consequence of small-scale normal faulting. Surface and underground workings expose one ore shoot which probably contains between 10,000 and 20,000 tons of measured and indicated ore containing about 1.5 percent $MoS_2$. A few tens of thousands of tons of additional ore may be inferred in extensions of the known ore shoot and in shoots not now exposed.

---

9/ Bureau of Mines, op. cit., p. 9.