Some Zinc-Lead Deposits of the Wrangell District Alaska

GEOLOGICAL SURVEY BULLETIN 998-B

Some Zinc-Lead Deposits of the Wrangell District Alaska

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ZINC AND LEAD DEPOSITS OF SOUTHEASTERN ALASKA

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A description of the deposits at Groundhog Basin, Glacier Basin the Lake claims, and Berg Basin

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PREFACE

As a part of its investigations in southeastern Alaska between 1941 and 1948, the U. S. Geological Survey studied in detail eight deposits that contain sphalerite or sphalerite and galena as the predominant ore minerals with lesser amounts of chalcopyrite in a few deposits. These deposits are at Tracy Arm, Groundhog Basin, Glacier Basin, the Lake claims east of Virginia Lake, Berg Basin, Moth Bay, Mahoney Creek, and Dora Lake. These deposits are described in the several chapters of this bulletin.

Zinc and lead minerals are also known or reported at the Hyder district, Whiting River, and Farragut River on the mainland, Cornwallis Peninsula on Kuiu Island, the Keku Islets north of Kuiu Island, Cholmondeley Sound and Beaver Mountain on Prince of Wales Island, Woewodski Island, Taylor Creek on Kupreanof Island, and Coronation Island. Some of these occurrences are noted elsewhere in the geological literature.

To date (1953) no major zinc or lead deposit in Alaska has come into production. Lead has been produced as a byproduct at the Alaska-Juneau gold mine and from the Riverside mine, Hyder district. In 1947 and 1948 about 70 tons of zinc and lead concentrates were shipped from Mahoney Creek to Kellogg, Idaho.

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By H. R. GAULT

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ABSTRACT

The deposits at Groundhog Basin are ore-bearing beds in a belt of metamorphic rocks that lies between the Coast Range batholith on the east and a quartz diorite mass on the west. The ore was formed by replacement of certain beds in the metamorphic belt and is of two general types: solid-sulfide ore consisting principally of pyrrhotite, sphalerite, and galena; and disseminated-sulfide ore consisting of sphalerite and other sulfide minerals disseminated in pyroxene granulite. The deposits have not been explored sufficiently to justify making specific estimates of the tonnage of ore at Groundhog Basin, but it appears reasonably certain that several hundred thousand tons each of solid and disseminated ore are present. The solid ore contains about 8 percent of zinc, 1.5 percent of lead, and 1.5 ounces of silver per ton. The disseminated ore contains about 2.5 percent of zinc and 1 percent of lead.

INTRODUCTION

Groundhog Basin is on the mainland of southeastern Alaska about 13 airline miles east of Wrangell. (See fig. 3.) The basin is accessible from a point on Eastern Passage near the mouth of Mill Creek about 9 miles by water from Wrangell. A Forest Service trail begins a few hundred feet north of the mouth of this creek and extends for about 1 mile to the southwest end of Virginia Lake. An old trail was cut out along the north side of the lake in 1942, but access to the east end is best made by small boat. It is about 2 miles across the lake

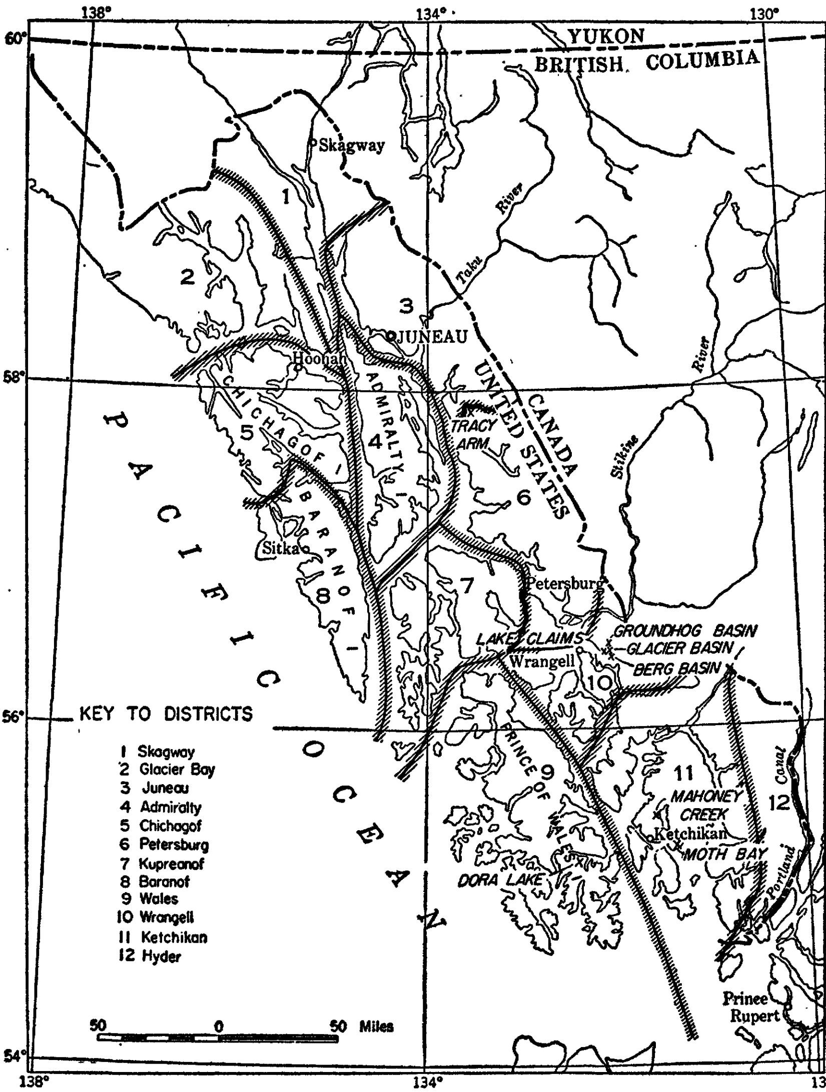

FIGURE 3.—Sketch map of southeastern Alaska showing location of some zinc-lead deposits.

to the mouth of Porterfield Creek and the start of an old sledge trail, cleared and repaired by Ventures Ltd., in 1942, that extends for about 5½ miles to a small cabin near the mouth of the South Fork Porterfield Creek. (See pl. 4.) A foot trail also begins at Virginia Lake 2,000 feet north of the mouth of Porterfield Creek and joins the sledge trail 3½ miles from the lake, but it crosses about 2 miles of muskeg, and the sledge trail is therefore preferable. From the cabin on the South Fork Porterfield Creek a trail about 1 mile long leads to the deposits in Groundhog Basin.

Groundhog Basin is characterized by steep slopes and generally rugged relief. (See pl. 5.) Slopes rise from about 2,500 feet near the center of the basin floor to more than 5,000 feet in some places. The South Fork Porterfield Creek, draining Groundhog Basin, drops about 2,000 feet in 1⅓ miles.

Timberline in Groundhog Basin is at an altitude of about 1,000 feet. Near the cabin are good stands of spruce and hemlock that are suitable for general mine and camp use.

During the summer of 1942, members of the U. S. Geological Survey made a detailed investigation of the zinc deposits of Groundhog Basin and in 1943 mapped the continuation of the deposits south into Glacier Basin. Prior to these investigations only brief studies of the deposits had been made (Wright and Wright, 1948, p. 188–189; Buddington, 1923, p. 58–63).

A representative of Ventures Ltd. briefly examined the Groundhog Basin zinc deposits in the spring of 1942 and collected 12 samples. From November 1942 to March 1943 the company carried on a more extensive exploration program, but the work was greatly handicapped by an unusually severe winter. Two diamond-drill holes were completed and a third drill hole was begun but was discontinued before all the ore bodies at the surface were tested at depth. Diamond-drill cores totaling more than 600 feet were recovered and were logged by the Geological Survey in 1943. Ventures Ltd. has kindly made the results of its investigation available to the Survey.[1]

In 1942 J. C. Roehm, of the Territorial Department of Mines, collected several samples for analysis. The results of his analyses have also been made available to the Survey.

The four patented claims in the Groundhog Basin are owned jointly by William D. Grant, Katherine S. Blackburn, B. Y. Grant, and the Donald Sinclair estate of Wrangell, Alaska. Two mill sites have been located, one near the zinc deposits and one at tidewater near the mouth of Mill Creek. Most of the exploratory work was done more than 20 years ago (Buddington, 1923, p. 58–63).

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[1] Smith, Alexander, 1943, Report on Groundhog Basin claims, Wrangell district, Alaska. [Private report dated April 13.]

GEOLOGY

The deposits are ore-bearing beds of the Wrangell-Revillagigedo belt of metamorphic rocks that has been intruded by quartz diorite of the Coast Range batholith and its associated stocks and sill-like masses. The metamorphic rocks originally were sediments, but these have now been strongly folded and dynamically metamorphosed to high-grade schists and gneisses. Dikes and sills of quartz porphyry and basalt cut both the schists and gneisses, and the quartz diorite.

A granite sill at least 1,000 feet wide crops out along the northeast side of the South Fork Porterfield Creek. (See pl. 4.) In many places the contact of the sill with the older gneisses and schists is covered or inaccessible, but where the contact is exposed it is parallel to the foliation of the gneisses and schists. The sill may extend for several miles northwestward across the valley of Porterfield Creek. Its southern end is northeast of, and stratigraphically above, the north end of the outcrop zone of the principal zinc deposits. At its southern end the sill terminates abruptly except for a few apophyses that continue to the southeast as smaller sills. The granite grades laterally into quartz porphyry in these smaller sills.

Fine-grained schists and gneisses constitute the bulk of the rocks in the metamorphic belt, although thin bands of phyllite also occur. The gneisses are largely hornblende, biotite-hornblende, and pyroxene varieties, and the schists are largely quartz-biotite, biotite-feldspar, and biotite-muscovite varieties. Locally the schists and gneisses are garnet bearing, and fine-grained banded pyroxene hornstones are intercalated with the ore beds.

The metamorphic rocks are bounded on the northeast and southwest by intrusive masses of quartz diorite, which is most commonly a gray coarse-grained rock composed of plagioclase, biotite, hornblende, and quartz. Near the contacts with the metamorphic rocks the quartz diorite is foliated.

Younger dikes and sills of quartz porphyry and basalt are abundant in Groundhog Basin. Minor amounts of fluorite and topaz are widely distributed in the quartz porphyry dikes and sills and in the granite sill north of the ore deposits.

In any one outcrop the sills are parallel to the bedding of the metamorphic rocks. Where traced for several miles, however, it becomes obvious that their general trend is a few degrees more northerly than that of the bedding. This slight discordance reflects the fact that the basalt sills as well as the quartz porphyry bodies commonly crosscut the metamorphic rocks for very short distances but at large angles.

The bedding and cleavage of the metamorphic rocks are generally parallel in strike and dip. The strike ranges from N. 15°–45° W.; the dip commonly is 60°–70° to the northeast but ranges from 45° to vertical. In general the contact of the metamorphic rocks with quartz diorite is parallel to the bedding and dips steeply to the northeast. Most of the dikes strike N. 15°–30° E. and are vertical or nearly so. A breccia vein, which is approximately parallel to the bedding, extends through the area and lies between ore beds 3 and 4 to the north and below ore bed 3 to the south. Small faults, many of which are filled with quartz, cut the bedding.

TYPES OF ORE

The ore is of two general types, a solid-sulfide type and a disseminated-sulfide type. These two types grade into each other. The solid ore is black, dark gray, or brown and is composed principally of pyrrhotite, sphalerite, and minor amounts of galena. Quartz, hornblende, pyroxene, epidote, and garnet are the predominant gangue minerals. The ore commonly is banded; the bands range from 1 to 15 millimeters in thickness. Individual bands ordinarily are made up predominantly of one sulfide mineral. The footwall of the solid ore generally is well defined; the hanging wall is less distinct but more regular than the footwall. The wall rocks nearest the ore are commonly light colored, banded or ribboned hornstones.

The disseminated ore is dark green to brown. Sphalerite is the only sulfide mineral that can be recognized readily, but other sulfides, chiefly pyrrhotite, are present. In some places the sulfide minerals are disseminated through the pyroxene granulite, and in others they are concentrated in pods and discontinuous bands.

The mineralogy, continuity, and structure of the ore and the proximity of a large granitic body suggest that the deposits were formed by replacment of certain beds in the metamorphic section by means of mineralizing fluids emanating from the large granitic body nearby.

ORE BEDS

STRATIGRAPHIC RELATIONS

Four zinc-bearing beds are known in Groundhog Basin and in this report are designated 1, 2, 3, and 4. Bed 1, also known as the Lee Bed, is stratigraphically the lowest. Bed 4 is the highest and is the "main vein" described by the owners and by Buddington (1923).

Bed 4 was traced for a horizontal distance of 3,700 feet and through a vertical range of 1,500 feet. The northernmost exposure of bed 4 is in the north face of the drift in tunnel 2. At that place the ore is 4 feet thick. Diamond-drill hole 1 of Ventures Ltd. cut bed 4 about 80 feet north of this point. The northern 1,350 feet of the ore bed as mapped in 1942 was cut by diamond-drill holes 1 and 2. It contains solid-sulfide ore, but it is not continuous throughout the entire 1,350 feet.

The vertical range of solid ore in this 1,350 foot interval is about 675 feet. This part of the bed is from 1½ to 8 feet wide and averages about 3 feet in width. The ore in the southern 2,225 feet is disseminated. Its width ranges from 5 to 11 feet and averages 6½ feet.

According to Buddington's map, the ore bed extends about 1,200 feet northwestward from and about 250 feet lower than the ore cut by diamond-drill hole 1. It also extends about 1,450 feet northwestward from the northernmost surface exposure seen in 1942. This 1,450-foot interval was covered by talus in 1942.

At its most northerly outcrop, ore bed 3 is about 15 feet stratigraphically below bed 4, and at its most southerly outcrop it is about 75 feet below bed 4. Part of this difference in stratigraphic distance is the result of the intrusion of sills between the beds. Bed 3 is not a continuous ore body although it contains some sphalerite along its outcrop length. This bed is composed almost entirely of disseminated ore except in the northern 1,000 feet where at least two and possibly three shoots of solid ore (see pl. 7) are indicated, two from surface exposures and one from drill-hole and underground data.

Tunnel 1 is the lowest tunnel and the only one on the southwest side of the valley. (See pl. 8.) It is at an altitude of 1,620 feet, is 16 feet long, and cuts ore bed 1. Tunnel 2 (pls. 7 and 8) is at an altitude of 1,870 feet and is a crosscut 160 feet long. Ore beds 2, 3, and 4 and a slightly metallized breccia vein are exposed in the crosscut. At the end of the crosscut a drift follows the no. 4 ore bed 20 feet northwestward and 50 feet southeastward. (See pl. 7.) At the southern end of the drift a crosscut, which extends southwestward for 13 feet, passes through the breccia vein and into ore bed 3.

The no. 3, or main tunnel, at an altitude of 2,075 feet, is 410 feet southeast of tunnel 2. Tunnel 3 is 170 feet long and cuts the no. 4 ore bed 100 feet from the portal. The no. 4, or upper tunnel, is 75 feet vertically above tunnel 3 and 60 feet to the northeast. It is 16 feet long and cuts ore bed 4.

Diamond-drill hole 2 (pl. 7) intersects ore beds 3 and 4 and a basalt dike not exposed at the surface. Diamond-drill hole 2 intersects ore beds 3 and 4, the breccia vein, and the composite dike exposed at the surface 140 feet southeast of the portal of tunnel 2 and about the same altitude. Diamond-drill hole 3 was not completed but intersects ore bed 2 about 50 feet below the surface.

Diamond-drill hole 2 intersected beds of solid ore and disseminated ore intercalated with gneiss both below and above a breccia vein that lies above ore bed 3 and below ore bed 4 on the surface and in tunnel 2. (See pl. 7.) Although the breccia vein cut by diamond-drill hole 2 is much wider than that at the surface and in tunnel 2, it is believed to be the same vein. Therefore the intercalated ore-bearing beds and gneiss which lie respectively below and above the breccia vein in diamond-drill hole 2 are thought to represent ore beds 3 and 4. At the surface, in drill hole 1 and in tunnel 2, the easternmost ore bed is identified as ore bed 4. This intercalation of ore and gneiss may be the result of faulting or may represent interbedded material that the ore-bearing fluids did not replace.

Bed 2 lies 10 to 65 feet stratigraphically below bed 3. At the surface ore bed 2 is composed of both solid and disseminated ore along the northern 150 feet of its outcrop length. Farther south it grades into green-banded gneiss which thickens to the south; locally the bed contains small amounts of sphalerite. The ore material in this 150 feet ranges from 4 to 24 inches in width and average 8 inches in width. Because of the thinness of the mineralized zone and the lack of distinctive lithologic features, bed 2 could not be traced continuously as far as beds 1, 3, and 4 although it probably extends similar distances. Ore bed 2 was not identified in drill holes 1 and 2. In tunnel 2 the mineralized zone is less than half an inch thick. A 1½-foot zone of disseminated ore, assumed to be ore bed 2, was penetrated in diamond-drill hole 3. (See pl. 7.)

Bed 1 was traced for more than 4,300 feet horizontally and through a vertical range of almost 1,900 feet. The bed is zinc-bearing along its entire exposed length except for a 100-foot interval about 175 feet southwest from the right-angle bend in the South Fork Porterfield Creek. There the bed is represented by about 1 foot of magnetite-bearing rock. Magnetite makes up about 50 percent of the rock and is the only metallic mineral which has been identified.

Solid-sulfide ore is exposed in tunnel 1 where bed 1 attains an observed maximum thickness of 2 feet. This ore thins abruptly both laterally and vertically. Several small ore shoots 6 to 12 inches wide and 15 or more feet long crop out along the extension of bed 1 to the south. The sphalerite is most commonly along the hanging wall of bed 1.

Three prominent sills are associated with the ore beds in Groundhog Basin. (See pl. 8.) In the vicinity of tunnel 4 and to the north the sills are stratigraphically above the ore beds. The lowest sill cuts across ore bed 4 about 850 feet southeast of tunnel 3. Farther southeast the middle and upper sills also break across ore bed 4.

In the southern part of the mapped area the lowest and middle sills split ore bed 3 for at least 600 feet along its outcrop length into a series of interlacing sheets of ore and igneous material. Farther to the south the sills appear stratigraphically below ore bed 3.

MINERALOGY

Pyrite, pyrrhotite, sphalerite, galena, chalcopyrite, and magnetite, and probably tennantite, tetrahedrite, and cubanite have been identified in the ore. Associated minerals are quartz, biotite, chlorite, hornblende, pyroxene, actinolite, and small amounts of garnet and apatite.

Dark-brown to black sphalerite of the iron-rich variety marmatite is the only zinc mineral known in Groundhog Basin. Although the index of refraction of this sphalerite has not been precisely determined, all the samples tested have an index of refraction greater than 2.40, according to Miss Jewell J. Glass, of the Geological Survey. Chemical analyses indicate that this sphalerite is marmatite with an Fe:Zn ratio of 1:4 or 1:3.5. The sphalerite contains abundant inclusions of chalcopyrite and pyrrhotite that are rounded to angular and commonly arranged in lines parallel to crystallographic directions in the sphalerite. Some of the inclusions are less than 0.001 millimeters in diameter, but more than 50 percent are between 0.002 and 0.005 millimeter.

One sample of sphalerite free of megascopically visible inclusions of other minerals contained 12.74 percent of iron (analyzed by Samuel H. Cress, Geological Survey). A second sample of sphalerite was completely analyzed and contained the following:

Analysis of sample of sphalerite from Groundhog basin

[Analyst, K. J. Murata, Geological Survey]

Zn	50.28	CaO	None
Fe	14.44	MgO	.25
S	32.65	Dissolved SiO_2	.18
Cu	.26	Insoluble	.66
Cd	.46	Moisture, 110°	.06
As	.39		
Mn	.04		99.67

A spectrogram (by K. J. Murata, Geological Survey) of this second sample showed tin, indium, and titanium to be present in addition to the above-listed components.

Five additional samples of ore and one of selected nearly pure sphalerite were examined spectrographically by Cyrus Feldman, of the Geological Survey. Elements identified in the ore and the sphalerite include titanium, tin, arsenic, calcium, cobalt, nickel, barium, manganese, antimony, cadmium, and silver.

A trace of gold has been reported in samples collected by the Bureau of Mines, but gold was not spectrographically identified in material collected by the Geological Survey. The silver content is generally proportional to the lead content although some nearly lead-free material contains appreciable silver. The cadmium is in the sphalerite.

BRECCIA VEIN

An extensive brecca vein, nearly parallel to the bedding, lies between ore beds 4 and 3 at their northern outcrops but cuts across bed 3 about 200 feet northwest of the right-angle bend in the South Fork Porterfield Creek. South of this bend in the creek the vein is stratigraphically below bed 3. The breccia vein is about 40 feet thick in diamond-drill hole 2, but it has not been identified in diamond-drill hole 1. Broken ground at the end of diamond-drill hole 1 seems to indicate that the breccia vein, which lies between ore beds 3 and 4 in diamond-drill hole 2, may cut across and lie stratigraphically above ore bed 4 at a point beyond the end of this drill hole. (See pl. 7).

The breccia vein is made up of sheared fragments of metamorphic rock. Along much of its outcrop the vein is silicified and is cut by a network of drusy quartz veins. Many of the small cross faults that cut the metamorphic rocks and the quartz diorite also contain drusy quartz veins. The breccia vein in tunnel 2, however, is a sheared pyroxene rock slightly metallized with galena, pyrite, sphalerite, and chalcopyrite. Fluorite is also present in the breccia vein and in the small cross faults throughout Groundhog Basin, but it is a conspicuous constituent only at altitudes above 2,500 feet. The fluorite generally occurs as crystals in the quartz veins.

MINERALIZED SILLS

Some of the quartz porphyry sills and apophyses of the large granite sill contain small amounts of pyrite, pyrrhotite, galena, and sphalerite. The sulfide minerals occur in patches or are disseminated in a dense dull-gray matrix throughout part of the width of the sills for distances of 25 to 100 feet along their strike. Lack of time and the inaccessibility of the slopes prevented locating and tracing all these sulfide-bearing sills. Those sills that have been examined are not economically important.

A small deposit of molybdenite crops out about 1,500 feet N. 30° E. from tunnel 1 near the southern end of the large granite sill (Twenhofel, Robinson, and Gault, 1946).

RESERVES

TONNAGE

No ore has been produced from Groundhog Basin, and the estimates of reserves given below are mostly of indicated and inferred ore.

The solid ore of bed 4, as known at present, extends for 1,350 feet horizontally and has an average width of about 3 feet. Using a factor of 8 cubic feet per ton, there would be about 500 tons of ore per foot down the dip of this bed. On the basis of surface outcrops, however, about 22 percent of the bed is lean ore and waste. If this relationship is assumed to hold with depth, it reduces the indicated tons per foot down the dip to about 400. The lowest exposure of solid ore in bed 4 is in tunnel 2 approximately 675 feet below the highest known surface exposure. Inasmuch as ore bed 1 is cut in tunnel 1, it is reasonable to assume that ore bed 4 also persists to this level, which is an additional 250 feet below tunnel 2. This ore extends for an unknown distance northward. The owners have reported a sample of material that probably was solid ore taken about 1,000 feet northwest from the point where bed 4 is cut by diamond-drill hole 1. For calculating reserves it is assumed that solid ore persists for 600 feet down the dip of bed 4, and a block of ore containing 240,000 tons is therefore indicated. If bed 4 is continuous northward to the point from which the owners have reported an assay, the block of ore described above is increased by about 180,000 tons of inferred ore.

Bed 3 contains at least two and possibly three known shoots of solid ore. The southernmost shoot is 130 feet long and averages 5.5 feet wide; the second or middle shoot is 120 feet long and averages 2.8 feet wide. The northernmost shoot, which is exposed only in tunnel 2 and in diamond-drill hole 1, may be the continuation in depth of the second shoot. The first and second shoots may contain about 130 tons of ore per foot of depth down the dip.

Bed 2 apparently is not economically important. Although bed 1 contains solid ore in tunnel 1, the tonnage of ore that can be estimated is very small.

The estimate by Ventures Ltd. of ore per vertical foot of depth for beds 3 and 4 over a horizontal distance of 940 feet is 481.7 tons.[2] The 940 feet, however, does not include the southern 400 feet of solid ore used in the Geological Survey estimate, presumably because this interval was not tested by Ventures Ltd. This company used a thickness of 3.90 feet for bed 4 and 3.95 feet for bed 3 over the 940-foot interval tested, whereas the Survey used 3.0 feet for bed 4 and 4.2 feet for bed 3 over a 1,355-foot interval. Ventures Ltd. estimates that 75 percent of bed 4 and 43 percent of bed 3 is ore over the interval tested by that company.

The Geological Survey estimates are believed to be minima and would probably be greatly increased by further exploration. The continuation of the ore beds northwest of diamond-drill hole 1 is suggested by the owner's sample mentioned above. The ore has been tested in depth for only about 100 feet below the surface by the tunnels and drill holes.

Any estimate of reserves southeast from the place where solid ore grades laterally into disseminated ore in beds 3 and 4 would be of doubtful value at this time. Disseminated ore is known to crop out sporadically over a distance of 2½ miles between Groundhog Basin and Glacier Basin.

[2] Smith, Alexander, op. cit., p. 11.

GRADE

Analyses of surface, underground, and drill-core samples taken by the Geological Survey, by the Bureau of Mines, and by Ventures Ltd. are given in table 1. The localities where the samples were taken are shown on plates 7 and 8.

TABLE 1.—*Analytical results on samples from the Groundhog Basin zinc deposits*

[In sample column, letters indicate collector: F, Ventures Ltd.; B, Bureau of Mines; G, Geological Survey]

Surface Samples

Sample	Length of cut (feet)	Ore bed	Zn (percent)	Pb (percent)	Ag (ounces per ton)	Remarks
F-45	2.5	1	4.4	3.7	4.4	Above tunnel 1.
F-42	2.9	1	6.4	Tr.	.14	Do.
F-44	5.0	1	1.1	Tr.	.12	Do.
F-47	3.3	1	10.5	2.1	1.6	South of tunnel 1.
F-46	1.0	1	8.4	4.7	2.1	Do.
F-48	1.3	1	4.1	.1	.1	Do.
F-49	1.2	2	6.3	Tr.	.06	
F-50	1.7	2	1.0	Tr.	.16	
F-51	2.7	2	2.5	Tr.	Tr.	
F-52	1.6	2	2.5	Tr.	.06	
F-53	2.2	2	14.1	Tr.	.10	
F-54	1.7	2	10.7	Tr.	.72	
F-55	2.5	2	Tr.	Tr.	.14	
G-8	8.4	2	10.44	0		Composite of 7 samples 25 feet apart.
F-29	1.6	3	9.5	Tr.	.86	
F-33	3.5	3	10.1	Tr.	.36	
F-34	3.2	3	4.7	Tr.	.16	
F-36	2.6	3	12.1	Tr.	.54	
F-37	2.4	3	12.0	Tr.	1.3	
F-38	2.5	3	11.6	Tr.	1.2	
F-39	1.2	3	15.0	Tr.	.38	
F-40	3.0	3	.1	Tr.	.18	
F-41	3.9	3	10.5	Tr.	.4	
F-28	4.0	3	1.3	.4	4.9	
F-11? [1]	5.0	3	11.5	Nil	1.7	
F-23	5.5	3	5.5	7.1	2.4	
F-21	4.7	3	9.4	Tr.	1.4	
F-22	3.0	3	Tr.	.4	2.9	South of interval tested by Ventures Ltd.
B-2	2.0	3	11.0	.1	1.00	
B-4	3.0	3	9.4	.1	1.10	
G-9	2.6	3	5.35	.45		
G-10	6.6	3	8.39	.59		
F-13	2.9	4	8.7	5.8	3.7	
F-14	1.8	4	6.4	5.0	2.1	
F-16	1.7	4	7.5	6.1	3.3	
F-17	1.5	4	1.7	1.5	2.2	
F-18	3.5	4	5.5	3.5	2.8	
F-19	7.1	4	6.6	4.8	3.2	
F-20	2.9	4	18.4	3.2	2.3	
B-3	4.0	4	12.0	2.0	1.80	
G-11 [2]	2.4	4	9.96	3.49		
G-12	9.6	4	2.98	.44		Silicate ore.
G-13	6.5	4	1.03	.37		Do.
G-14	4.5	4	3.62	1.62		Do.

Underground Samples

Sample	Length of cut (feet)	Ore bed	Zn (percent)	Pb (percent)	Ag (ounces per ton)	Remarks
F-30	2.0	1	6.1	9.3	8.0	Southeast wall, tunnel 1.
F-31	3.0	1	1.6	Tr.	.2	Do.
G-7	[3] 3.8	1	8.84	.68		Northwest wall, tunnel 1.
F-56	3.3	3	8.8	Nil	.22	D. D. H. 1.
F-61	6.3	3	9.0	Tr.	.66	D. D. H. 2.
F-62	1.5	3	6.1	.3	.24	Do.

[1] Map accompanying Ventures Ltd. report shows two samples numbered 11; in this table and figure 3, the question mark (?) distinguishes between them.
[2] Poor sample because of inaccessibility of outcrop.
[3] Sample cut across 2.4 feet of ore.

TABLE 1.—*Analytical results on samples from the Groundhog Basin zinc deposits*—Continued

Underground Samples—Continued

Sample	Length of cut (feet)	Ore bed	Zn (percent)	Pb (percent)	Ag (ounces per ton)	Remarks
F-27	3.0	3	Tr.	Tr.	0.42	Tunnel 3.
G-2	3.5	3	7.39	0		Northwest wall, tunnel 2.
F-58	4.6	4	14.8	Nil	.32	D. D. H. 1.
F-57	5.5	4	15.6	Nil	.34	Do.
F-59	3.4	4	.2	Nil	.10	Do.
F-1	4.5	4	8.3	Nil	.32	Tunnel 2.
F-2	5.5	4	2.5	Nil	.16	Do.
F-3	2.3	4	17.1	Nil	.40	Do.
F-4	3.0	4	11.4	Nil	.36	Do.
F-5	3.0	4	4.4	Nil	.08	Do.
F-6	3.5	4	1.6	Nil	.12	Do.
F-7	1.5	4	1.8	Nil	.38	Do.
F-63	1.3	4	1.4	Tr.	.72	D. D. H. 2.
F-64	4.5	4	10.1	6.8	9.1	Do.
F-11	9.5	4	5.9	6.6	4.6	Northwest wall, tunnel 4.
F-8	3.5	4	4.3	3.7	2.5	Southeast wall, tunnel 4.
F-9	2.0	4	3.4	1.5	1.8	Do.
F-10	3.5	4	7.1	6.6	4.2	Do.
F-24	5.0	4	12.2	2.7	1.8	Northwest wall, tunnel 3.
F-25	4.3	4	11.2	3.6	2.4	Southeast wall, tunnel 3.
B-1	3.25	4	8.3	.1	.35	Northwest end, tunnel 2.
B-5	2.6	4	9.7	2.3	3.05	Southeast wall, tunnel 4.
B-6	3.3	4	6.2	3.7	2.95	Do.
B-7	3.5	4	9.8	.1	1.35	Northwest wall, tunnel 3.
G-1	4.0	4	2.28	1.02		Northwest end, tunnel 2.
G-3	1.6	4	3.97	0		Southeast end, tunnel 2.
G-5	3.0	4	15.26	1.13		Northwest wall, tunnel 3.
G-6	7.0	4	8.67	2.73		Southeast wall, tunnel 4.

Miscellaneous Samples of Material Other Than Ore

Sample	Length of cut (feet)	Location	Zn (percent)	Pb (percent)	Ag (ounces per ton)	Remarks
F-43	13.0	Below ore bed 1	Tr.	Tr.	0.12	Above tunnel 1.
F-32	5.5	do	0.7	Tr.	.12	In tunnel 1.
F-60		Above ore bed 3	Tr.	Nil	.06	D. D. H. 1, grab sample.
F-35	2.4	Below ore bed 3	Tr.	Tr.	.04	Surface.
F-15	3.0	Below ore bed 4	Tr.	Tr.	.08	Do.
F-26	21.6	Above ore bed 4	Tr.	Tr.	.01	Tunnel 3.

From analyses of the samples of solid ore in beds 3 and 4 taken by the Geological Survey, by the Bureau of Mines, and by Ventures Ltd., the weighted averages of the grade of ore for bed 3, bed 4, and beds 3 and 4 together, have been determined. These averages are given in table 2.

TABLE 2.—*Grade of ore from ore beds 3 and 4, Groundhog Basin zinc deposits*

	Bed 3	Bed 4	Beds 3 and 4
Zn percent	7.59	7.37	7.45
Pb percent	.62	2.21	1.66
Ag ounces per ton	1.05	1.59	1.40

The grade of ore for the 940-foot interval tested by Ventures Ltd. as estimated by that company is given in table 3. This grade is apparently a weighted average.

TABLE 3.—*Grade of ore as estimated by Ventures Ltd., for ore beds 3 and 4, Groundhog Basin zinc deposits*

	Bed 3	Bed 4	Beds 3 and 4
Zn percent	8.43	8.4	8.3
Pb percent	1.2	2.95	2.5
Ag ounces per ton	1.25	2.3	2.0

The gold content of samples collected by the Bureau of Mines ranges from a trace to 0.01 ounce per ton; the iron content ranges from 20.60 to 28.60 percent. The copper content is about 0.03 percent.

The Geological Survey collected three samples of disseminated ore southeast of the sharp bend in the South Fork Porterfield Creek at an altitude of about 2,700 feet. The zinc content of these three samples is much lower than that of the solid ore, but the average thickness of this lean ore, over an exposed length of about 1,500 feet, is probably twice that of the solid ore farther northwest. The weighted average of the grade of disseminated ore in bed 4, based on these samples, is 2.5 percent of zinc and 0.67 percent of lead, over an average width of 6.9 feet.

A sample of the breccia vein in tunnel 2 contained 0.64 ounce of silver per ton but no gold. In places the breccia vein contains small amounts of zinc and lead.

RECOMMENDATIONS

In any further exploration of the Groundhog Basin deposits an attempt should be made (1) to test the extension of ore beds 3 and 4 to the northwest from the vicinity of tunnel 2; (2) to test further the downward extension of ore in the vicinity of tunnel 2 and especially in other areas where solid ore crops out at the surface; (3) to sample adequately the surface exposures of solid ore in bed 4 throughout the 400-foot interval not known to have been previously systematically sampled; (4) to determine the grade of the disseminated ore at the surface in beds 3 and 4, southeast of the outcrop area of solid ore; and (5) to determine the metallic content at depth of beds 3 and 4 southeast of the outcrop area of solid ore.

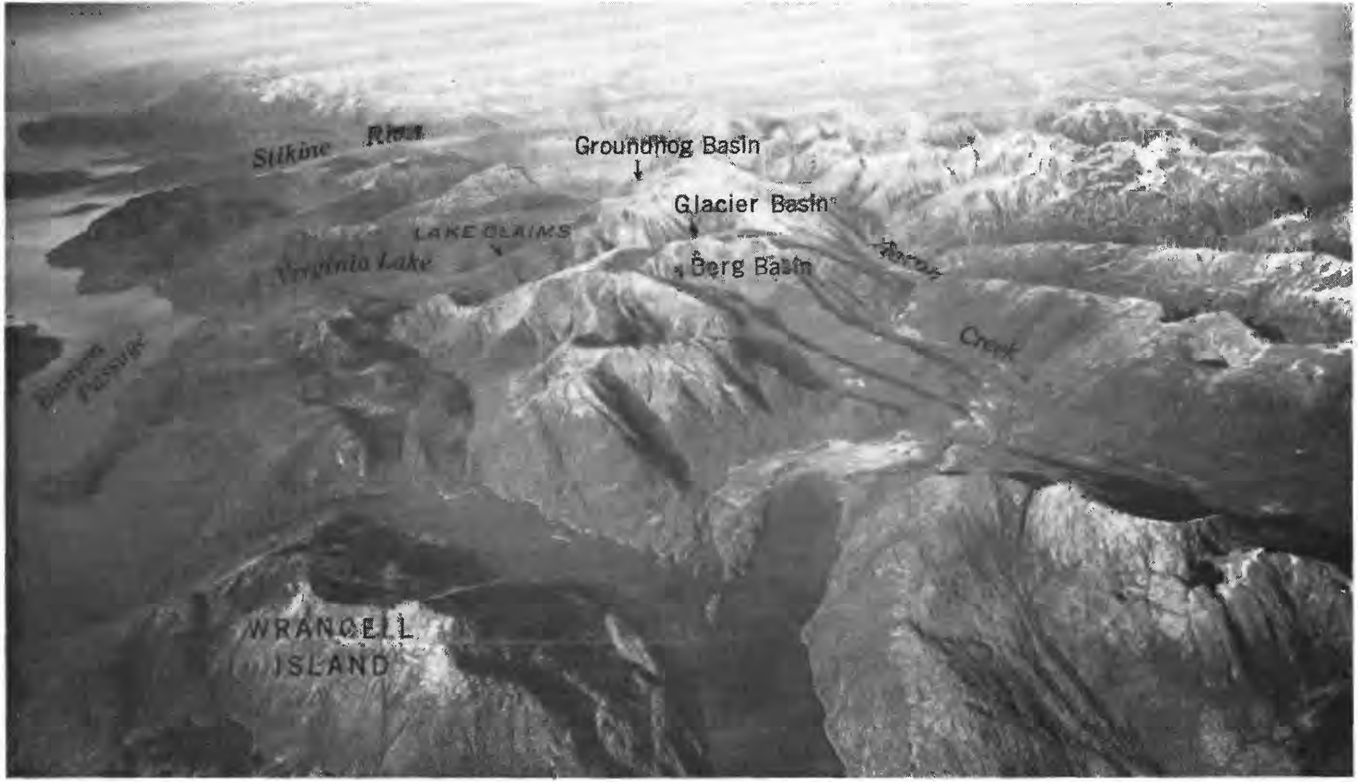
1. In order to explore satisfactorily the area northwest of tunnel 2, the beds should be exposed by test pits or their presence or absence otherwise determined at intervals of not more than 150 feet.

2. Diamond drilling to test further the downward extension of ore in the vicinity of tunnel 2 would be complicated by the steep dip of the beds to the northeast away from the creek. Drill sites perhaps could be selected near the creek from which the beds might be tested to depths of a few hundred feet below their outcrops. As late as August there is usually some snow in the stream south of tunnel 2.

3. The 400-foot interval of solid ore in bed 4 not tested by Ventures Ltd. is exposed along a cliff and special consideration would have to be given to methods of sampling it.

4. The disseminated ore in beds 3 and 4 southeast of the outcrop area of solid ore is considerably thicker than the solid ore farther northwest. The grade of this disseminated ore should be determined more adequately although the few data available and inspection of outcrops indicate that it is of relatively low grade.

5. The vertical gradation from solid ore to disseminated ore in bed 4 at an altitude of about 2,500 feet and the more abundant occurrence of fluorite in the breccia vein and small faults have been suggested as indicating a vertical mineral zoning. If such zoning exists, solid ore may be present at depth in the area southeast of the outcrop zone of solid ore.



COAST RANGE EAST OF WRANGELL

Aerial view showing location of zinc deposits

VIEW NORTH FROM THE TOP OF THE SOUTH SLOPE OF GLACIER BASIN

PART 2. ZINC-LEAD DEPOSITS AT GLACIER BASIN, WRANGELL DISTRICT

By H. R. Gault, D. L. Rossman, and G. M. Flint, Jr.

CONTENTS

ABSTRACT

The deposits at Glacier Basin are of two types: sphalerite- and galena-bearing pyroxene granulites, and quartz-fluorite veins containing lesser amounts of sphalerite and galena. The sulfide-bearing granulites are similar to the disseminated-sulfide type of ore at Groundhog Basin, 2½ miles northwest of Glacier Basin. Four sulfide-bearing granulite beds are recognized in Glacier Basin. One of these has been traced northwestward for about 2 miles, almost to Groundhog Basin, and is thought to be the same bed as one of the ore beds at Groundhog Basin. The total known horizontal extent of the ore beds is more than 3 miles. The grade of the ore in the pyroxene granulite is about 1.6 percent of zinc and 1 percent of lead. The quartz-fluorite veins contain about 0.14 percent of zinc and 0.09 percent of lead. Many hundred thousand tons of sulfide-bearing granulite and several million tons of sulfide-bearing vein material are probably present at Glacier Basin.

INTRODUCTION

Glacier Basin is on the mainland of southeastern Alaska about 13 airline miles east of Wrangell (fig. 3) and is about 10 miles by trail and by boat across Virginia Lake, from tidewater (pl. 4). A Forest Service trail starts from Eastern Passage a few hundred feet north of the mouth of Mill Creek and extends for about 1 mile to the west end of the lake. It is about 2 miles across Virginia Lake to the start of a blazed trail that leads from the southeast end of the lake to

Glacier Basin. The trail is about 6½ miles long and follows the valley of Glacier Creek.

Glacier Basin is an impressive topographic feature about 1½ miles long and one-quarter to one-half mile wide. The floor of the basin is a flat area of muskeg, alluvium, and glacial debris. A few low rock ridges extend out from the sides in the middle of the basin and others rise above the flats near each end. At the southwest end of the basin the flat area breaks off abruptly in a 400-foot drop to the floor of a smaller basin below Glacier Basin. The northeast end of Glacier Basin rises steeply several hundred feet to Nelson Glacier, which flows southeastward past the northeast end of the basin. (See pl. 9)

The south side of Glacier Basin rises from about 2,000 feet at the floor to an altitude of nearly 3,500 feet. The north side of the basin rises to a ridge that extends westward from Nelson Glacier toward Virginia Lake. (See pl. 4.) The highest point on this ridge is at an altitude of 4,820 feet and is known as Marsha Peak. Both the north and south slopes of Glacier Basin are furrowed by several long steep gullies. Five on the north slope are designated for reference from west to east as gullies 1, 2, 3, 4, and 5. (See pl. 6.)

There is no large timber in the basin. Alders and small spruce trees grow between altitudes of 2,000 and 3,000 feet. Some of the slopes are partly covered with heather to an altitude of about 3,800 feet.

According to Buddington (1923, p. 66), the ore deposits are reported to have been discovered about 1899 by Nelson and Smith. Since that time several groups of claims have been located on both the north and south slopes of Glacier Basin (Wright and Wright, 1908, p. 189). The most recent claims are said to have been located in 1943 by several persons from Wrangell.

The exploratory work in Glacier Basin consists of two small adits in gully 4 at altitudes of 2,253 feet and 2,285 feet (pl. 10) and a short adit several hundred feet east of gully 4 at an altitude of about 2,100 feet. The lower adit in gully 4 has about 42 feet of workings; the upper adit has about 40 feet.

Glacier Basin has been briefly described by the Wrights (pp. 188-189), and by Buddington (pp. 66–67). The results of a U. S. Geological Survey field examination during July, August, and September 1943 of Glacier Basin and the ridge extending northwest from Marsha Peak are summarized below. One of the main purposes of the field investigation was to trace the ore deposits of Groundhog Basin, which were examined in 1942, southward into Glacier Basin. (See pl. 9.)

GEOLOGY

The principal rock unit in Glacier Basin is a sequence of metamorphic rocks included between two masses of quartz diorite. (See pl. 9.)

The metamorphic rocks are part of the Wrangell-Revillagigedo belt of rocks that extends for many miles along the western side of the Coast Range batholith in southeastern Alaska. Quartz porphyry and basalt sills and dikes have intruded the metamorphic rocks and the quartz diorite in the western part of the area. Bodies of breccia that resemble dikes or sills also cut the metamorphic rocks.

The metamorphic rocks originally were sedimentary rocks but are now principally gneiss and schist that contain some interbedded amphibolite, marble, and pyroxene granulite. The different types of gneiss include biotite-quartz, pyroxene-feldspar, hornblende, hornblende-biotite, and garnet-kyanite varieties. The schist in general contains the same minerals as the gneiss. Many beds of gneiss, schist, and amphibolite contain small amounts of pyrite and pyrrhotite, and their weathered surfaces are characteristically brown or rust colored. The marble beds are composed of gray to white almost pure marble and dark-brown impure marble. Some of the pyroxene granulites are mineralized with sphalerite, galena, pyrrhotite, and magnetite; these granulites are referred to in this report as "ore beds."

The bedding and cleavage of the metamorphic rocks are nearly parallel in strike and dip. The regional strike of the metamorphic rocks is about N. 25° W. and the dip is generally about 60° to the northeast. (See pl. 9.) Small drag folds occur within many of the beds and locally small areas are intensely folded. No large-scale folding has been recognized in the sequence of metamorphic rocks extending from Glacier Basin to Groundhog Basin.

Many faults cut the metamorphic rocks and a few cut the quartz diorite in the western part of the area. Observed displacement along faults are small. Three sets of faults are common in the area: one set nearly parallels the bedding, another strikes northeast and is almost vertical, and the third ranges in strike from N. 45° W. to N. 75° W. and dips steeply to the northeast. At many places the bedding faults and the northeast-trending faults contain quartz-fluorite breccia veins.

At some places the western contact of the metamorphic rocks with quartz diorite is parallel to the bedding and at others it cuts across the bedding. (See pl. 9.) The quartz diorite commonly contains inclusions of the metamorphic rocks. The eastern contact of the metamorphic rocks with quartz diorite seems to parallel the bedding. Hornblende is the predominant mafic mineral in the quartz diorite which bounds the belt of metamorphic rocks on the east, whereas biotite is the common mafic mineral in the sill-like mass of quartz diorite west of the belt of metamorphic rocks.

Pegmatites composed of quartz, feldspar, and muscovite occur in a thick section of gneiss east of the sill zone where they are associated with injection gneiss. The pegmatites are long flat lenses almost parallel to the bedding.

Most of the sills and dikes of Glacier Basin and vicinity are quartz porphyry. The sills, which far exceed the dikes in number, range from half a foot to 100 feet in thickness and average about 12 feet in thickness. Individual sills have been traced for over 4,000 feet. Most of the sills lie in a zone about 2,000 feet wide (pl. 9), but within the sill zone are several sill groups composed of 3 to 10 individual sills. In some groups the sills are in contact with each other; in other groups they are separated by metamorphic rock 5 to 25 feet thick. Along much of their outcrop the sills are nearly parallel to bedding, but at many places they cut across bedding for short distances, generally in a northeast-southwest direction. Most of the quartz porphyry bodies in Glacier Basin are sills, but a few large quartz porphyry dikes also cut the metamorphic rocks.

The quartz porphyry rocks include several types which differ principally in grain size and color. The phenocrysts are quartz and feldspar in a dense groundmass of smaller sericitized feldspar grains. The rocks are white, tan, light gray or light gray-green.

Mafic sills and dikes occur throughout Glacier Basin and vicinity, but they are less numerous and generally thinner than the quartz porphyry sills and dikes. The mafic sills and dikes range in thickness from 1/3 to 8 feet and average 1½ feet in thickness. The dikes strike northeastward and at many places cut the quartz porphyry sills. Most of the mafic rocks are dark green to black basalts. A few are porphyritic and contain phenocrysts of feldspar and hornblende.

Bodies of breccia that resemble dikes or sills crop out southeast and northwest of Marsha Peak. (See pl. 9.) The breccia is composed of slightly altered fragments of metamorphic rock and quartz porphyry in a matrix of very small fragments and comminuted material of the same rock types. The fragments range in size from slightly less than 1 inch in diameter to blocks 2 feet wide and 10 feet long. Veinlets containing quartz, orthoclase, and galena cut the breccia (Gault, 1945, p. 389–390).

DETAILED GEOLOGY, GULLY 4

The geology and structure of many small areas in Glacier Basin and vicinity show in detail many of the characteristics of the geology and structure of the large area. The geology of part of gully 4 is typical of much of the geology of Glacier Basin. (See pl. 10.) Three sills are exposed in this part of the gully. The western sill terminates near the portal of the upper adit and crops out again south of it. A quartz-fluorite breccia vein lies on the hanging wall of the middle sill north of the upper adit. Near the adit it cuts across the middle sill and becomes thicker. A short distance south of the lower adit the vein splits. The eastern split continues along the hanging wall of the middle sill. The western split cuts across the middle sill to the footwall, parallels the footwall for a short distance, and then cuts across to the footwall of the western sill.

Much of the metamorphic rock near the upper adit is slightly metallized pyroxene granulite and at the portal there is about 4 feet of almost solid-sulfide ore. This material extends only a few feet into the adit.

The breccia vein and middle sill near the upper adit and in part of the lower adit are cut by a stockwork of quartz veinlets. Some of the quartz veinlets contain small amount of galena and sphalerite.

ORE BEDS

The term "ore bed" is used in this report to designate dark-green to gray-green medium-grained pyroxene granulite, which is composed principally of pyroxene that is partly replaced by sphalerite, galena, and pyrrhotite, or by magnetite. Locally the beds contain small amounts of feldspar, hornblende, garnet, epidote, and quartz. The ore beds are similar to the disseminated-sulfide-type ore in Groundhog Basin a few miles to the north. Two types of ore have been recognized in Groundhog Basin: a solid-sulfide type and a disseminated-sulfide type. Where the ore beds are almost completely replaced by sulfide minerals, the ore is the solid type; in the disseminated type, the sulfide minerals are disseminated through or are in pods and bands in the pyroxene granulite. Only disseminated ore has been recognized in Glacier Basin. The weathered surfaces, which are brown and green, are pitted and are ridged parallel to the bedding. In some exposures the weathered ore beds crumble into dull-brown granules.

Sphalerite and galena are the most readily recognized sulfide minerals in the ore beds. At some places sphalerite is more abundant, but at others galena is more abundant. Some of the sphalerite in the ore beds of Glacier Basin is slightly lighter brown than that in Groundhog Basin and presumably contains less iron. In those areas where magnetite occurs, it is the only recognizable ore mineral.

The ore beds range from 4 inches to about 20 feet in thickness. At many places the ore beds interfinger with, alternate with, or grade into light-gray to light-green pyroxene-feldspar gneiss. Ore beds and bands of alternating ore beds and pyroxene gneiss make up lithologic units that crop out from Glacier Basin to Groundhog Basin. Each unit below an altitude of about 3,000 feet in Glacier Basin is composed principally of ore bed. At higher altitudes, the ore beds are thinner, grade into pyroxene gneiss, and occur as poorly defined lenses in pyroxene gneiss.

Four ore beds are recognized on the north slope of Glacier Basin (pl. 9) and are designated as ore beds *A*, *B*, *C*, and *D*. These beds are exposed in gullies 1, 2, 3, and 4, respectively. From their lowest exposures to altitudes of about 2,900 to 3,300 feet in Glacier

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Basin the ore beds are continuous. Above these altitudes, they are discontinuous.

Ore bed *A*, exposed along the east wall of gully 1 (pl. 9), is the most westerly and stratigraphically is the lowest ore bed. It has been traced up gully 1 from its lowest exposure at about 2,350 feet to an altitude of about 2,650 feet. Northward from that point it is covered by talus for a horizontal distance of 1,650 feet. North of this 1,650-foot covered area, ore bed *A* or its equivalent pyroxene gneiss is exposed almost continuously for 2,300 feet to near the crest of the north slope of Glacier Basin. The southern 1,600 feet of this 2,300-foot part of the bed is light-green pyroxene granulite and pyroxene gneiss 4 to 8 feet thick. Small amounts of galena and sphalerite are disseminated along or near bedding planes and fractures in the ore bed. The northern 700 feet is a light gray-green pyroxene gneiss containing several small zones of galena and sphalerite. For about 800 feet north from the crest of the north slope and on the west side of the ridge extending northward from Marsha Peak there are practically no exposures of ore bed. North of this 800-foot interval, ore bed *A* is again exposed for 3,300 feet before it is covered by talus and snow. Along this 3,300-foot extent the ore bed is 4 inches to 2 feet thick, increasing in thickness northward. In part of the northern half of this 3,300-foot interval ore bed *A* is recognized as two units, each about 1 foot thick and several feet apart. The weathered outcrop is dark brown. In several places magnetite replaces the ore bed.

Magnetite is an important constituent of the portion of ore bed *A* shown in figure 4. In the northern part of the area shown, two beds of magnetite-bearing granulite are intercalated with light gray-green pyroxene gneiss. These two beds locally have been thickened by drag folding. They grade into barren pyroxene gneiss near the southern end of the area shown in figure 4. The southern continuation of ore bed *A* into Glacier Basin lies about 70 feet east of the magnetite-bearing granulite. At its northern end the eastern part of ore bed *A* contains sphalerite, but it is magnetite bearing about 700 feet south of the area shown in figure 4.

Two possible interpretations of this offset in ore bed *A* are (1) that ore bed *A* has been displaced along a fault zone represented by the two veins which join near the southern end of the area and lie between the two segments of the ore bed; or (2) that because of lithologic changes in the beds, the northern continuation pinches out to the south and the southern continuation represents a stratigraphically higher bed.

There is a covered interval of about 2,200 feet between the northernmost exposure of ore bed *A* of Glacier Basin and the southernmost

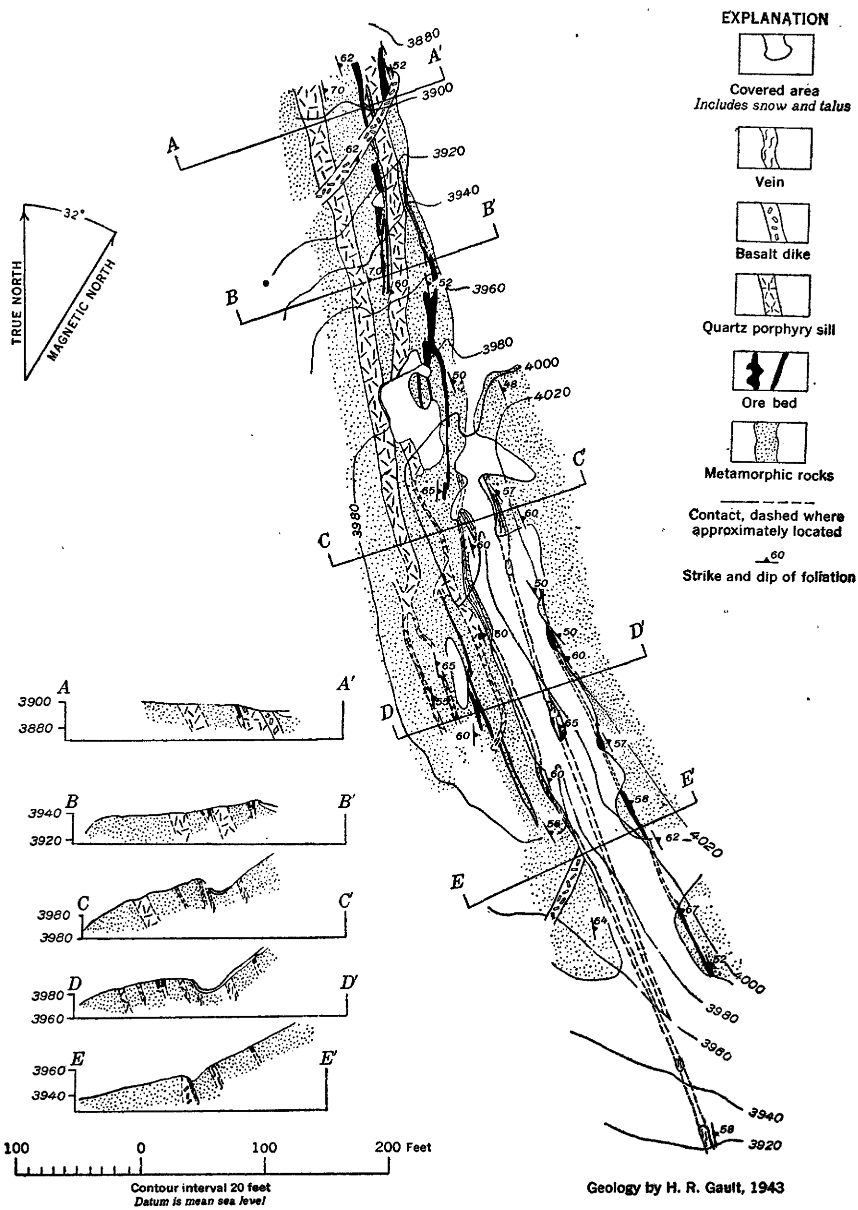

Figure 4.—Geologic map and sections showing ore bed *A* in an area northwest of Marsha Peak, Glacier Basin, Wrangell district.

exposure of ore bed 1 of Groundhog Basin. Both ore beds *A* and 1 are stratigraphically the lowest ore beds in their respective areas, however, and projection of either ore bed along its strike would connect one with the other. Therefore, it is thought that ore beds *A* and 1 may represent parts of the same bed.

Ore bed *B* crops out discontinuously at lower altitudes in gully 3 for a horizontal distance of 3,500 feet. From the lowest exposure, at an altitude of 2,060 to about 2,900 feet, the ore bed is about 6 feet thick. From an altitude of about 2,900 to about 3,700 feet ore bed *B* thins from 5 to about 1½ feet, and the amount of sulfide minerals is less than at lower altitudes. Ore bed *B* has not been recognized north of its highest exposure on the north slope of Glacier Basin.

Ore bed *C* is exposed discontinuously in the cliff on the east side of gully 3 from an altitude of 2,170 to about 3,100 feet for a horizontal distance of about 2,200 feet. (See pl. 9.) In this 2,200-foot interval ore bed *C* is 10 to 20 feet thick and most of it contains disseminated galena and sphalerite. North of this 2,200-foot interval several exposures of ore bed between gullies 3 and 4 and one exposure 850 feet westward from Marsha Peak are thought to be the same bed as ore bed *C*.

The offset to the east of the continuation of ore bed *C* at the higher altitudes seems to be due in part to thickening of the sequence of metamorphic rocks by intrusion of quartz porphyry and in part to local drag folding and faulting of the metamorphic rocks between gullies 3 and 4 at approximate altitudes of about 3,300 to 3,700 feet. The 600-foot exposure of ore bed whose southern limit is 2,100 feet northwest of Marsha Peak is thought to be the same bed as that exposed 850 feet west of the peak and may represent the northward continuation of ore bed *C*. Several exposures of this ore bed crop out about 1 mile north of Marsha Peak near the westernmost margin of Nelson Glacier and are tentatively identified as the same bed as that in the 600-foot exposure 2,100 feet north of the peak.

Ore bed *D*, which at some places is interbedded with gray coarse-grained siliceous marble, crops out in gully 4 between altitudes of 2,125 feet and about 2,900 feet for a horizontal distance of about 2,100 feet. Ore bed *D* has not been found between the northern end of this 2,100-foot interval and the exposure of ore bed 350 feet westward from Marsha Peak. This exposure 350 feet westward from the peak and the exposures of ore bed north from the peak are thought to be the same bed as ore bed *D*. In this bed is a zone about 50 feet long and 1 foot thick of solid-sulfide-type ore composed principally of galena. This solid ore is north of the basin proper. Another ore bed crops out about 1,900 feet north of Marsha Peak (pl. 9) and is thought to lie statigraphically above ore bed *D*.

The stratigraphic position of ore beds *B*, *C*, and *D* in relation to the ore beds in Groundhog Basin is uncertain. Projection of the beds *B*, *C*, and *D* along their strike would place them stratigraphically above the ore beds in Groundhog Basin. The stratigraphic thickness between beds *A* and *D* in Glacier Basin is much greater than between beds 1 and 4 in Groundhog Basin, and this greater thickness is not proportional to the amount of quartz porphyry added to the section. None of the ore beds of Glacier Basin is known to be continuous into Groundhog Basin although the two stratigraphically lowest ones are tentatively correlated. Although the ore beds can be traced with little difficulty at lower altitudes, the beds equivalent to the ore beds at high altitudes have been traced only sporadically because it is difficult to distinguish them from other rocks in the section and because they are interrupted by many quartz porphyry sills.

No ore beds have been recognized on the south slope of Glacier Basin. Except for their absence, the topography and geology of the south slope in general are mirror images of the topography and geology of the north slope. However, beds of marble crop out on the south slope at the stratigraphic positions approximately corresponding to the ore beds on the north slope. Four marble beds are recognized on the south slope west from the gully opposite gully 4. If the ore bed exposed near the west margin of Nelson Glacier about 1,900 feet north of Marsha Peak is projected south along its strike it would about coincide with a marble bed in gully 5. A corresponding marble bed is exposed on the south slope in the gully opposite gully 5.

In view of the similarity of the geology of the north and south slopes of Glacier Basin and the similarity of the stratigraphic position of the ore beds on the north slope and certain marble beds on the south slope, it is probable that the ore beds grade southward into marble beds and that the ore beds may represent metamorphosed and mineralized marble beds.

VEINS

The veins in Glacier Basin and vicinity occur in shear and breccia zones similar to those in Groundhog Basin. The sulfide minerals in the veins are galena, sphalerite, pyrrhotite, pyrite, and chalcopyrite, which commonly are finely disseminated in altered and silicified fragments of country rock and in fine-grained quartz that cements the brecciated material. At a few places veinlets of solid-sulfide minerals are present. Locally masses of galena ranging in weight from 5 to 50 pounds occur as fissure and cavity fillings. Some light-colored altered bands of sheared metamorphic rock in the veins are partly replaced by pyrite and quartz.

The gangue consists of quartz, fluorite, and the silicate minerals of the metamorphic rocks. Quartz occurs as fine-grained material replacing the breccia fragments, as vein filling, and as drusy coatings in fissures and vugs. The fluorite is coarsely crystalline and is intimately associated with quartz.

Some veins consist of breccia blocks cemented with quartz whereas others consist of only moderately fractured rock that is cut by a network of quartz veinlets. Most of the breccia fragments consist of metamorphic rock, but quartz porphyry fragments occur in those veins that lie along or cut across porphyry sills and dikes. Nearly all the metamorphic rock and quartz porphyry fragments are altered and silicified. The veins in general are parallel to the sills and to the foliation in the metamorphic rocks. Vein contacts are well defined.

The maximum range in thickness of the veins is from a few inches to 30 feet, but most of the veins range from 1½ to 10 feet in thickness. The veins pinch and swell, but nearly all of them maintain a uniform thickness for at least 100 feet along their strike. Most of the veins 2 feet or more thick probably extend for distances of several thousand feet. At many places the veins cut across the bedding and the quartz porphyry sills. These crosscutting veins trend northeastward. Most of them extend only short distances, but a few extend for at least 500 feet.

The characteristics of the veins in Glacier Basin and vicinity are about the same regardless of their locations. Most of the veins occur in the zone of quartz porphyry sills, but several have been found east of the sill zone on both the north and south slopes of Glacier Basin.

RESERVES

GRADE

The Geological Survey collected 15 chip samples in Glacier Basin. Eight samples are from veins and seven are from ore beds (for locations see pl. 9). The analytical results on the material collected are given in table 4. All sample cuts are approximately perpendicular to the bedding or to the walls of the veins. Although fluorspar is a common mineral in the ore, the recoverable fluorite (table 4) cannot be considered economically important.

The weighted average of the grade of the samples taken from the mineralized pyroxene granulite in Glacier Basin is 1.66 percent of zinc and 1.09 percent of lead; that of the samples taken from the veins is 0.14 percent of zinc and 0.09 percent of lead. Obviously the few samples collected do not represent precisely the grade of the ore beds or the veins, but it is thought that they do represent the order of magnitude of the grade of the material.

TABLE 4.—*Analytical results on samples from Glacier Basin*

[Glacier Basin samples are designated in this table and on plate 9 by the symbol GB]

Sample (GB no.)	Rock type	Length of cut (feet)	Zn[1] (percent)	Pb[1] (percent)	F[1] (percent)	Ag[1] (ounces)	Au[2] (ounces)	Location and altitude in feet	Remarks
1	Pyroxene granulite	12.0	1.71	2.05		None		Gully 3, alt. 2,180	Ore bed *C*; lowest exposure slightly weathered.
7[3]	do	4.0	1.55	2.00				Gully 3, alt. 2,940	Ore bed *C*; GB-7 is stratigraphically lowest; GB-8 continues from GB-7; GB-9 continues from GB-8 and is stratigraphically highest; aggregate of lengths represents 11 feet of ore bed at least 12 feet thick.
8[3]	do	2.0	.48	.52				do	
9[3]	do	5.0	.64	.44				do	
2	do	5.0	5.34	.31		None		Gully 2, alt. 2,060	Ore bed *B*; lowest exposure.
11	do	2.5	.17	.03				Gully 1, alt. 3,650	Ore bed *A*; near upper limit of metallized portion.
12	do	6.0	.42	.41				North of Marsha Peak, alt. 4,330.	Ore bed north of Marsha Peak.
3	Vein	5.0	.20	.05	1.14			Gully 3, alt. 2,140	GB-3 and 4, from same vein; GB-3 is breccia-type vein; GB-4 is moderately sheared and altered metamorphic rock.
4	do	3.0	.10	.12	1.03	None	None	do	
5	do	2.0	.05	.17	1.50	None	None	Gully 4, alt. 2,130	GB-5 and 6 from same vein; GB-5 is fractured metamorphic rock with fluorite-bearing quartz veinlets. GB-6 is moderately sheared metamorphic rock.
6	do	4.8	.24	.04	.33			Gully 4, alt. 2,140	
14	do	2.2	.26	None				South slope, 2,650	Sheared and altered dark-colored metamorphic rock.
15	do	3.0	.07	.17	.16	None	None	South slope, 2,980	Same vein; GB-15 is light-colored pyrite-bearing altered metamorphic rock. GB-16 is from 12 feet of dark breccia-type vein containing fluorite.
16	do	3.2	.08	None	2.06	None	None	South slope, 2,950	
17	do	5.0	.07	.19	.14	None		Gully 5, alt. 4,150	Brecciated country rock in matrix of quartz cut by quartz veinlets.

[1] Analyst, Norman Davidson, Chemical Laboratory, Geological Survey.
[2] Analyst, Samuel H. Cress, Chemical Laboratory, Geological Survey.
[3] Weighted average, GB-7, GB-8, GB-9: zinc, 0.94; lead, 1.02.

TONNAGE

There has been no lead or zinc production from Glacier Basin, and exploratory work has been confined to the two adits in gully 4 and the adit east of gully 4. Many hundreds of thousands of tons of mineralized pyroxene granulite are inferred, but considering the low grade of the material, it is doubtful if the mineralized granulites in Glacier Basin can be regarded as ore at this time.

At least 12 veins in Glacier Basin have a minimum thickness of 3 feet and a minimum horizontal extent of 600 feet. Of these 12 veins, 6 are 5 feet or more thick and extend at least 1,000 feet horizontally. The known vertical range of the veins in Glacier Basin is more than 2,400 feet. These 12 veins contain, at a minimum, more than a million tons of material, but the grade is too low for the veins to be considered ore.

GENERAL CONCLUSIONS

The low grade and the relative inaccessibility of the mineral deposits of Glacier Basin are unfavorable to an extensive exploration program. In view of the similarity of the geology and mineral deposits of Glacier Basin and Groundhog Basin, any data obtained from further exploration of the latter deposits may make future exploration of the Glacier Basin deposits desirable. If further exploration of the Glacier Basin deposits is considered it would be desirable to know more accurately the grade, widths, and lengths of the sulfide-bearing parts of the pyroxene granulites, particularly of ore beds *B* and *C* at their lower altitudes.

The solid-sulfide type of ore crops out in Groundhog Basin from altitudes of about 1,600 to about 3,500 feet. Between altitudes of about 2,500 and about 3,500 feet in that basin only disseminated-sulfide-type ore was recognized. On the other hand, the lowest exposures of ore beds in Glacier Basin are of the disseminated-sulfide-type ore. With increasing altitude and gradation northward the ore beds in Glacier Basin pass into less metallized material which grades into relatively barren pyroxene gneiss. Therefore it appears that in both Glacier Basin and Groundhog Basin the ore beds contain, in general, less sulfide minerals at higher altitudes than at lower altitudes. Broadly speaking, it also appears that the best metallized material in both basins (pls. 8 and 9) occurs in those parts of the ore beds that are nearest the western quartz diorite.

Whether the facts outlined above are of genetic significance has not been determined. However, there is an implied relationship between the altitude and distance of the ore from the western mass of the quartz diorite and the fact that sulfide-bearing granulites have been traced for 3 miles. This relationship should be borne in mind in any future operations that may be undertaken in the Groundhog-Glacier Basin area.

PART 3. LEAD-ZINC DEPOSITS AT THE LAKE CLAIMS, WRANGELL DISTRICT

By H. R. Gault and G. M. Flint, Jr.

CONTENTS

ABSTRACT

The Lake claims deposits, consisting principally of galena with some sphalerite, pyrite, and chalcopyrite in a gangue of quartz and calcite, have been deposited in a prominent fault zone. The fault zone, 10 to 25 feet thick, is in a sequence of metamorphic rocks near a quartz diorite body. The ore occurs in veins, as filling in breccia, and in discontinuous networks. The ore zone has been explored by three adits and several trenches and stripped areas. About 420 tons of ore per foot of depth are estimated at these two places. This ore contains slightly more than 1 percent of lead, about 1 percent of zinc, and 0.15 ounce of silver per ton. The grade of the ore could be raised appreciably by mining only the vein and breccia types of ore, but the tonnage would be considerably smaller.

INTRODUCTION

The lead-zinc deposits at the Lake claims are on the mainland about 11 miles east of Wrangell. (See fig. 3.) The deposits are about 6½ miles by trail and by boat across Virginia Lake from tidewater on Eastern Passage. A Forest Service trail starts a few hundred feet north of the mouth of Mill Creek on Eastern Passage and leads to the southwest end of the lake, a distance of about 1 mile. (See pl. 4.) Virginia Lake is a little more than 2 miles long. The trail to the deposits starts on the south bank of Porterfield Creek 2 miles east of the lake across the creek from the sledge trail to Groundhog Basin. The deposits are a little more than 1 mile by trail from Porterfield Creek They are several hundred feet below timberline between altitudes of 1,325 and 1,725 feet and are near the crest of a long narrow ridge between Porterfield Creek and Glacier Creek. (See pl. 4.) The claims are reported to belong to J. G. Galvin, of Wrangell, Alaska. This group of claims is probably the same as that described by the Wrights (1908, p. 189–190) as the Margery group.

In 1923 Buddington (pp. 64–65) briefly described the deposits. Results of a six-day examination of the deposits in September 1943 by a Geological Survey party are described below.

Most of the exploratory work was done 20 years or more ago. The principal mineralized zone is exposed by several trenches and stripped areas, and by two adits, which in this report are designated adits 1 and 2. The sides of the trenches have slumped and the trenches are now almost entirely overgrown by vegetation. However, the mineralized zone is still exposed in stripped areas.

The northernmost, or adit 1, is at an altitude of 1,425 feet and is 450 feet south of the cabins. (See pl. 11.) It extends along the mineralized zone for 25 feet. The portal of adit 2, which is at an altitude of 1,420 feet, is 110 feet southwest from adit 1. The workings consist of an 85-foot crosscut, which intersects the mineralized zone 67 feet from the portal, and a drift along the mineralized zone for 25 feet north from the crosscut and for 110 feet south from the crosscut.

A third adit, called adit 3, is at an altitude of 1,550 feet. It is 350 feet southwest from adit 2. The portal of adit 3 was caved in 1943.

If the lead-zinc deposits are explored further, all the old surface workings should be cleared out and several new trenches dug to explore the fault zone more adequately in covered areas, particularly south of adit 3 and north of adit 1. Samples should be cut at frequent intervals at the surface and underground.

GEOLOGY

The lead-zinc deposits are in a sequence of metamorphic rocks near its eastern contact with a quartz diorite mass. The exact position of the contact of the metamorphic rocks with the quartz diorite is inferred, but its general configuration, as shown on plate 4, is probably correct.

The metamorphic rocks are commonly fine grained. They include dark-colored phyllites and slates, quartzites, chlorite schists, and light-colored micaceous phyllites and schists. Bedding and cleavage in the metamorphic rocks are generally parallel in strike and dip, but locally there are small tight folds in which the cleavage transects the bedding. The general trend of the cleavage of the metamorphic rocks near the deposits is N. 15° E., but the strike ranges from nearly due north to about N. 30° E. The cleavage at most places near the deposits dips vertically or steeply to the southeast.

A prominent fault zone that contains the ore deposits trends about N. 15°–20° E. and dips steeply to the southeast. Dark-green to black fine-grained mafic sills border this fault zone, one near the hanging wall and one near the footwall. Similar mafic sills occur in the nearby Groundhog and Glacier Basins where they are definitely younger than the quartz diorite and may be younger than the period of lead and zinc mineralization. It is inferred that the sills at the Lake claims also may be younger than the lead and zinc minerals because neither galena nor sphalerite occurs in them. They are probably also younger than the quartz diorite here.

ORE DEPOSITS

Galena is the most prominent ore mineral, but some sphalerite, pyrite, and small amounts of chalcopyrite are also present. The gangue minerals include quartz; a carbonate, which probably is calcite; and the silicate minerals of the metamorphic rocks.

The ore is localized in the fault zone, which is 10 to 25 feet wide. The degree of shearing in the fault zone ranges widely, and locally bands of gouge as much as 1 foot thick have been developed; elsewhere the rocks are only moderately sheared. The bands of gouge have been traced only short distances. The ore within the fault zone is discontinuous, and the relative amounts and proportions of the sulfide minerals range widely from place to place.

In general, three types of ore are distinguished and are here designated as vein, breccia, and network types. The richest ore is coarsely crystalline galena which forms veins that fill fractures as much as 6 inches wide parallel to the fault zone. In places the ore is composed of bands of coarse-grained and fine-grained galena. Locally, between these bands, are thin lenses or pods of sphalerite and chalcopyrite as much as 1 inch long. The veins pinch and swell and contain small vugs, some of which are lined with quartz crystals. The fissure filling was accompanied by alteration and replacement of the rock along the fractures and along the bedding planes by sulfide minerals and quartz.

The breccia type of ore resembles the quartz-filled breccia zones in the Groundhog and Glacier Basin areas. This ore is composed of coarse galena and sphalerite in a matrix of quartz or calcite or both, which cements the fragments in breccia bands within the fault zone. These breccia bands range from half a foot to 6 feet in thickness. The size and number of rock fragments in the breccia vary appreciably from place to place. Many fracture surfaces and vugs in the breccia are coated with drusy quartz.

The vein and breccia types of ore commonly grade into each other and are generally near the middle of the fault zone.

The third type of ore consists of sphalerite and galena in small fractures that make a coarse network of thin veinlets in fractured and sheared metamorphic rocks. Some sphalerite and galena occur in narrow veinlets along the bedding planes. Sphalerite is more abundant than galena in this ore.

At least seven galena- and sphalerite-bearing veinlets less than 2 inches thick have been found outside the fault zone. These veinlets are nearly parallel to the bedding in strike and dip.

In a small gully 165 feet southeast from the cabins a few narrow fractures containing scattered galena are exposed in the fault zone. A mafic sill lies within and near the western border of the fault zone here.

A vein of nearly pure galena about 4 inches thick is exposed in adit 1, but it pinches out to the southwest.

Veinlets of galena, generally less than 1 inch thick, are present at intervals along the crosscut of adit 2; 27 feet from the portal a 1-foot zone of breccia-type ore is exposed. The main fault zone and two mafic sills within it are exposed in the drift of adit 2. Some breccia-type ore occurs in this drift but it is low grade. The breccia vein here ranges from 3 inches to about 2 feet in thickness. Along the east wall of the drift north from the crosscut is a quartz vein containing abundant pyrite, and on the face of the drift south from the crosscut is a 6-inch band of gouge and about 4 feet of network-type ore in which sphalerite is the most abundant sulfide mineral. The over-all width of the metallized zone exposed in the south face of the drift is at least 5 feet wide.

On the surface above the drift in adit 2 is a stripped area about 80 feet long. A mafic sill is exposed along the eastern edge of the stripped area. Adjacent to the sill on the west is a zone of network-type ore in the center of which is vein ore. Some parts of the vein are almost pure galena. The maximum thickness of the vein is about 18 inches. The width of the metallized zone in this 80-foot area ranges from 3 to 8 feet and averages about 6 feet.

South of the stripped area for about 180 feet are several small exposures of breccia and network types of ore. About 40 feet southwest from the end of the 80-foot stripped area is an exposure of breccia-type ore within a small fault zone outside the main fault zone. This small fault zone possibly is an extension of the 1-foot breccia zone exposed 27 feet from the portal of adit 2.

About 180 feet south of the stripped area on the surface above the drift of adit is a second stripped area nearly 60 feet long. Within this 60-foot stripped area the ore is predominantly of the breccia type and is 2 to 10 feet wide. Mafic sills are exposed along the footwall and near the hanging wall of the fault zone in this area. Some of the network-type ore lies east of the mafic sill near the hanging wall of the fault zone at the north end of the stripped area. The ore in this 60-foot stripped area appears to be the richest exposed ore.

The full width of the main fault zone is exposed in a trench 940 feet southwest from the portal of adit 2. In this trench the zone is about 12 feet wide and contains several narrow veins of galena that are parallel to the fault zone and aggregate a total thickness of about 4 inches. Within the fault zone small fractures cut the foliation and some contain galena and sphalerite. Breccia ore is exposed near the hanging wall of the fault zone, and network ore is exposed near the footwall. About 5 feet of network ore and two mafic sills, one on either side of the fault zone, are exposed in a trench about 1,025 feet southwest from adit 2.

About 350 feet southwest from the portal of adit 2 is a galena-calcite vein 1 to 3 inches thick. The vein is in a zone of moderately sheared rock not in the main fault zone. Adit 3 is reported to have been driven along this vein. Two other galena-calcite veins less than 1 inch wide are exposed along the trail 60 feet northeast from adit 3.

It is probable that the ore was deposited from fluids that may have been differentiates of the quartz diorite mass nearby. The ore deposition was localized along fractures and fault zones and was accompanied by the precipitation of some quartz and carbonates.

RESERVES

TONNAGE

Buddington[3] reports that 1 ton of ore was shipped to the Selby smelter in 1920. No other production from the deposits is known.

The known horizontal extent of the metallized part of the fault zone is about 1,450 feet. However, because of lack of sufficient exposures, ore is inferred only in two intervals along this 1,450-foot distance. One of these intervals is between adit 1 and the small outcrop 440 feet southeast from adit 1 where the average width of the metallized zone is about 6 feet. Assuming a factor of 10 cubic feet of rock per ton, there would be about 260 tons of ore per foot of depth.

The second area of inferred ore is at the southern end of the metallized part of the fault zone. For calculating reserves the mineralized part of the fault zone here is assumed to be 180 feet long and 9 feet wide. If all of this 180-foot distance is ore, there would be about 160 tons per foot of depth.

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[3] Buddington, A. F., 1921, Unpublished field notes in the Alaskan Branch of the Geological Survey.

GRADE

Chemical analyses of samples collected by the Geological Survey (pl. 11) are given in table 5.

TABLE 5.—*Grade of ore at the Lake claims*

Sample no.	Length of sample (feet)	Type of ore	Pb (percent)	Zn (percent)	Ag (ounces per ton)
L-1[1]	3.0	Network ore	0.30	0.26	0.07
L-2[1]	1.2	Gouge	.43	.48	.09
L-3[2]	1.5	Vein ore	6.52	2.20	.67
L-4[2]	2.0	Network ore	.94	1.20	.14
L-5[2]	4.0	do	.16	.16	.07
L-6	9.0	do	.70	.93	.09
L-7	4.0	Breccia ore	1.14	2.25	.09

[1] Aggregate length of L-1 and L-2 represents width of mineralized zone in south face of drift in adit 2.
[2] Aggregate length of L-3, L-4, and L-5 represents approximate full width of mineralized zone.

The weighted average of the grade of ore calculated from these data is 0.99 percent of lead, 1.01 percent of zinc, and 0.12 ounce of silver per ton. This average grade is assumed to be representative of the widths of the mineralized zone that were used in estimating reserves. The average grade could be raised appreciably by mining only vein-type ore and the richer parts of the breccia-type ore. However, the estimated tonnage would be much smaller.

PART 4. A LEAD-ZINC PROSPECT AT BERG BASIN, WRANGELL DISTRICT

By R. G. Ray

CONTENTS

ABSTRACT

The Berg Basin deposit contains argentiferous galena with less abundant sphalerite and pyrite. Galena and sphalerite occur in small irregular pockets within a composite basaltic dike, along the contacts of basaltic dikes with rhyolite, along the contacts of basaltic dikes with schistose country rock where rhyolite crops out close by, and disseminated within the rhyolite. No galena or sphalerite has been found except where basaltic dikes are associated with rhyolite sills and dikes.

A gold quartz vein reported to carry $14 to the ton in gold crops out at the surface. A tunnel 800 feet long has been driven to explore its downward extension. Diamond-drill holes totalling 742 feet were drilled in part to test further the gold quartz vein extension and in part to test the presence of lead and zinc minerals. No significant gold quartz bodies have been cut either in the tunnel or in the drill holes. One diamond-drill hole reportedly penetrated a 5-foot zone of solid and disseminated galena, but exploratory work has not been carried far enough to allow appraisal of the deposit as an ore body. The geologic setting does not appear favorable for any large lead-zinc deposit at the Berg prospect.

INTRODUCTION

Berg Basin lies at the southern end of a mineralized belt that extends from the Stikine River on the north, to Aaron Creek on the south. (See pl. 5.) Investigations of the Berg Basin deposit were carried out during the summers of 1947 and 1948 by the U. S. Geological Survey.

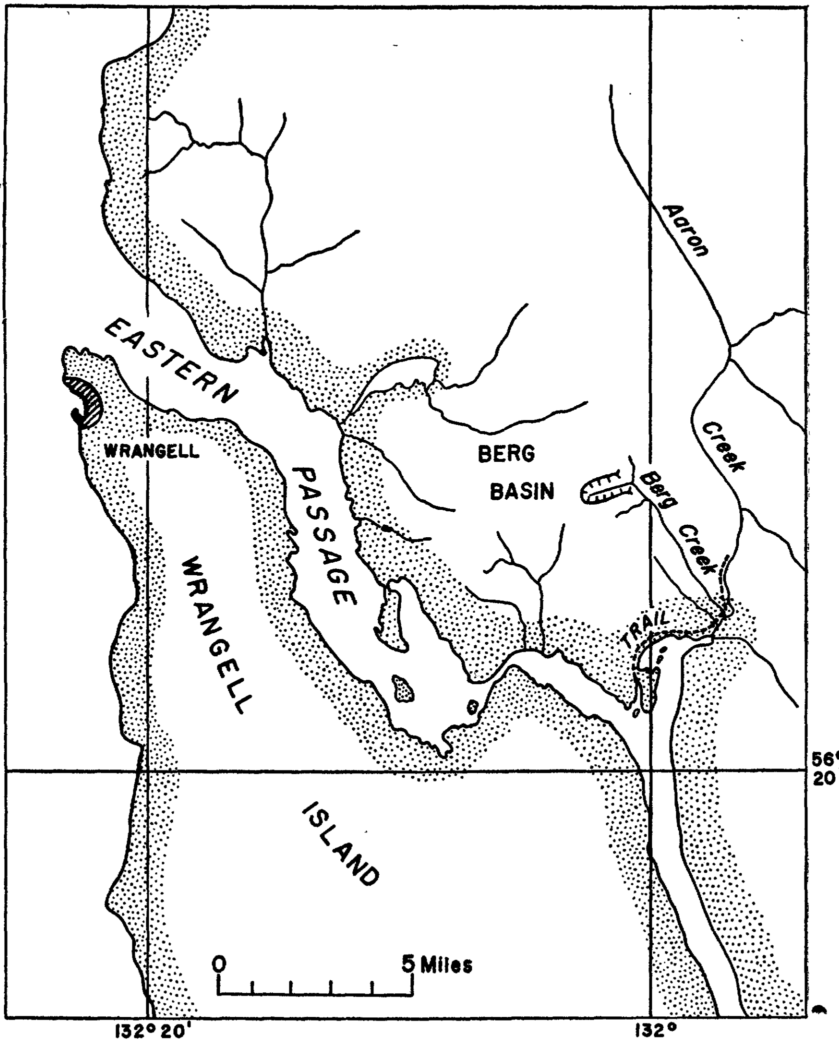

FIGURE 5.—Sketch map showing location of Berg Basin, Wrangell district.

Berg Basin is in an area of rugged relief at the head of Berg Creek 14 airline miles east of Wrangell. (See fig. 5.) The floor of the basin, which has an altitude of about 1,500 feet, is bounded on all sides by mountain peaks as much as 4,430 feet high. Berg Creek valley is a U-shaped glacial trough now floored with glacial debris and slide material from steep talus slopes. A thick growth of alders and salmonberry bushes covers most of the main valley and side slopes. A few small timbers can be obtained within half a mile of the lead-zinc prospect, but no large trees are found closer than timberline, 1 mile downstream.

The prospect is accessible by a trail that extends northward for 7 miles along Berg Creek from a point where the Aaron Creek Forest Service trail crosses Berg Creek. The Berg Creek trail was improved somewhat in 1948. The prospect is at an altitude of about 1,780 feet.

The deposit was discovered and staked in 1907 by Messrs. Lester Berg, J. E. Berg, and Chris Wedow. Development work has continued intermittently since that time. The property is covered by 10 unpatented claims known as the Silver King group, which are now owned by Mr. Ludwig C. Berg, of Sitka, Alaska.

The property has been prospected by several surface pits, by a tunnel nearly 800 feet in length, and by several hundred feet of diamond drilling. Originally the tunnel was driven to explore the downward extension of a quartz vein that crops out on the surface and was reported to carry gold. Late in the summer of 1947 a diamond-drilling program was begun partly to explore further the possibility of locating the gold quartz vein at depth and partly to test the prospect for lead and zinc minerals. Drilling was continued during the summer of 1948.

The writer spent about four weeks in 1947 mapping geology at and around the Berg Basin prospect. Detailed mapping at the prospect was carried out by Brunton compass and steel-tape traverses. Drill cores recovered during the summer of 1948 were examined in mid-September of that year. Cores recovered in the latter part of 1947 were not available for examination.

The only geologic study in Berg Basin before 1947 was made in 1921 during a brief examination by Buddington (1923, p. 67).

GENERAL GEOLOGY

The Berg Basin area is underlain predominantly by metamorphic rocks (fig. 6) which are part of the Wrangell-Revillagigedo belt of rocks extending along the west flank of the Coast Range batholith in southeastern Alaska. In the vicinity of Berg Basin this belt of metamorphic rocks is about 2½ miles broad. It is bordered on the east by the Coast Range batholith and on the west by two separate sill-like masses of granitic rocks. The foliation in the metamorphic rocks strikes about N. 25° W. and dips to the northeast generally at a steep angle, but in the area between the sill-like masses of granitic rocks west of Berg Basin the strike and dip range widely and the rocks are considerably deformed. The main northwestward structural trend here is largely destroyed. Tight folding is characteristic. Drag folds are very common, and at least one tight fold of large magnitude was observed. The drag folds plunge consistently from 30° to 90° to the southeast. At least part of the stratigraphic sequence probably has

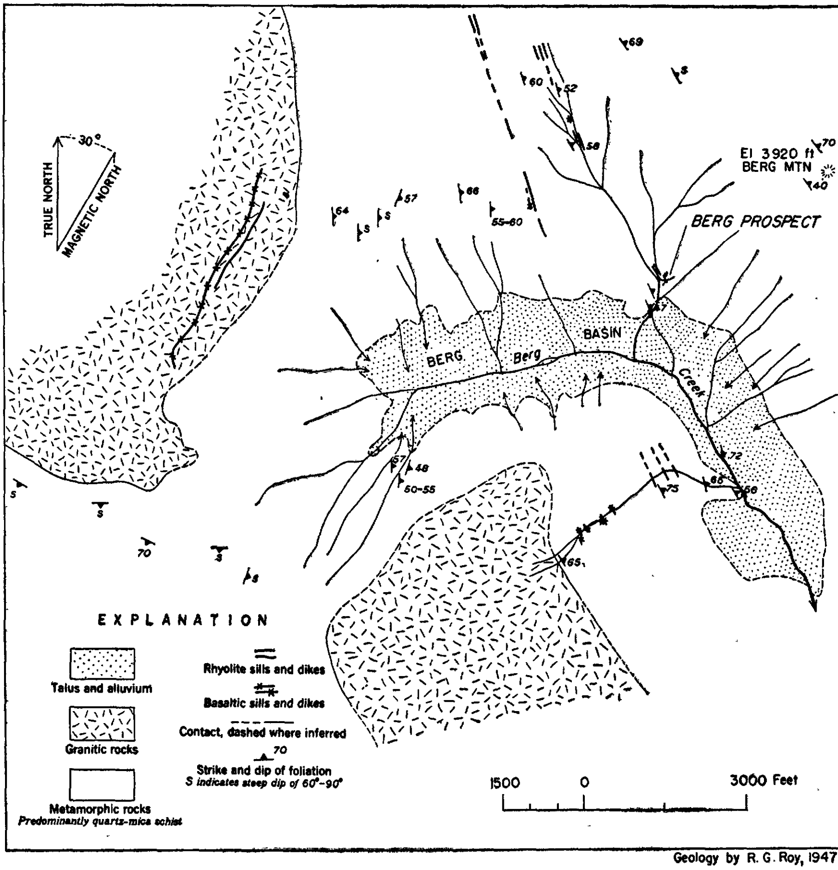

FIGURE 6.—Geologic sketch map of the vicinity of Berg Basin, Wrangell district.

been repeated. In general, the trend of the foliation in the metamorphic rocks is parallel to the contacts between the metamorphic and igneous rocks.

The metamorphic rocks have been derived mainly from sedimentary rocks and now comprise quartzose and micaceous schists and gneisses, along with a few thin bands of marble. The metamorphism probably accompanied the emplacement of the Coast Range batholith and related intrusions. Locally adjacent to satellite intrusive masses the grade of metamorphism is higher in the schists. Pegmatite sills as much as 6 feet thick have been infolded with the sedimentary rocks three-quarters of a mile southwest of the Berg prospect. In some areas ribbon gneisses have been developed where the rocks were steeply tilted with little or no close folding. These rocks are characterized by remarkably straight bands of light-colored material ranging from a fraction of an inch to 2 inches in width.

Sills and dikes of rhyolite and rhyolite porphyry as much as 25 feet thick and basaltic sills and dikes as much as 5 feet thick have intruded both the metamorphic and igneous rocks. The basaltic dikes most commonly crosscut the rhyolite. At least one locality was examined, however, where the rhyolite seemed to be younger than the basaltic dike.

Most of the intrusions of basaltic and rhyolitic material are in the form of sills, which characteristically occur in sill groups. These groups are the southward extensions of sill groups described from Glacier Basin (see p. 32). The rhyolitic sills generally are greater in thickness and can be traced for greater distances than the basaltic types. Pegmatite sills and dikes also are fairly common, but quartz veins are found only occasionally.

In general, both the basaltic dikes and rhyolite dikes and sills have been considerably altered. The feldspars have been replaced extensively by sericite and chlorite. A specimen from one of the basaltic dikes contained a large amount of secondary interstitial calcite.

No faults of large displacement have been observed in the Berg Basin area. Faults parallel to the foliation in the metamorphic rocks are common, however, and contain as much as several inches of gouge. Faults of this type are especially well exposed in the underground workings. (See pl. 12.)

LEAD-ZINC DEPOSIT

Galena and sphalerite are the principal lead and zinc minerals at the Berg prospect. They are found in association with rhyolite dikes or sills that have been intruded by basaltic dikes. In the surface exposures examined the galena and sphalerite occur in small irregular pockets within a composite basaltic dike, along the contacts of basaltic dikes with rhyolite, along the contacts of basaltic dikes with schistose country rock where rhyolite crops out close by, and disseminated within the rhyolite. No galena or sphalerite has been found in Berg Basin except where basaltic dikes are associated with rhyolite sills and dikes.

The original discovery of galena was in a basaltic dike 4 feet thick located 40 to 45 feet N. 55° W. from the portal of the prospect tunnel. (See pl. 13.) Blocks of galena nearly 1 foot in diameter are said to have been found along the dike at the bottom of the main prospect pit, which is now partly filled in. A composite dike here is in contact with schistose country rock, but a few feet to the north it has intruded a hard fine-grained greenish-colored rhyolite. Pods of galena occur within the dike as well as along its contacts with schistose country rock and rhyolite. The largest lens of galena now exposed is 6 to 7 inches thick and about 5 feet long. Some pyrite and black sphalerite also are present. Milky quartz is the predominant gangue mineral.

Analyses of two samples of galena from the discovery pit yielded 27.90 and 28.70 ounces of silver per ton. (Silver and gold analyses by Ledoux and Co., New York, N. Y.) These figures should be interpreted with caution, however, as it is known that in certain silver-lead mining districts there is no consistency in the ratio of silver to galena in the ore. The fact that the galena at Berg Basin is argentiferous, however, may be of considerable significance.

Basaltic dikes in the immediate vicinity of the Berg prospect commonly split into branches. Pyrite, sphalerite, and galena in a gangue of quartz have been localized in one of these forks 170 feet N. 17° W. from the prospect tunnel.

About 90 feet nearly due north of the discovery pit is an outcrop containing sphalerite with some galena in a zone about 8 inches wide and 6 to 8 feet long at the contact of a basaltic dike with rhyolite. (See pl. 13.) The southeast limit of this zone was not determined.

In 1947 diamond-drill hole 2 was drilled a distance of 100 feet from the face of the side drift to test the possible northward extension of the galena-bearing zone along the basaltic dike exposed in the discovery pit. (See pl. 13.) This is a flat hole bearing N. 66° W. At 76 feet a 5-foot zone of solid and disseminated galena is said to have been penetrated. The core was not seen by the writer. This mineralized zone is bounded by basaltic dike material on one side and by rhyolite on the other. In 1948 diamond-drill hole 3 was drilled a distance of 102 feet from the main crosscut (pl. 13) to test further the galena-bearing zone. Only a few grains of disseminated galena were encountered in this drill hole. No analyses have been made as yet to determine the silver content of the galena penetrated in diamond-drill hole 2.

OTHER METALLIC MINERALS

GOLD QUARTZ VEIN

A quartz vein estimated to be about 1 foot thick and reported to contain $14 to the ton in gold occurs within a rhyolite sill on the surface 150 feet N. 62° E. from the tunnel portal and at an altitude about 165 to 170 feet higher than the tunnel portal. This area is accessible with difficulty because of the steepness of the valley wall. The rhyolite sill strikes approximately N. 25°–30° W. and dips fairly steeply to the northeast. Dips of 51° to 57° were measured on the footwall of this sill. Adjacent to the rhyolite on the northeast is a basaltic sill about 4½ feet thick. The exposed part of the hanging wall dips about 60° northeast. From surface exposures it is not evident whether the quartz vein dips with the rhyolite sill or cuts across it. It may be pointed out, however, that a rhyolite sill exposed in the tunnel 216 feet from the portal (pl. 12) also is bounded on the northeast by a basaltic sill similar to that at the surface. These two sills underground are logically the downward extension of those sills at the surface, but the rhyolite in the tunnel, in contrast to that at the surface, contains no vein quartz. A quartz vein 1½ feet thick, however, which may be the downward extension of the vein exposed on the surface, is found in the tunnel at a point 346 feet from the portal. (See inset, pl. 12.) This vein, however, contains only 0.01 ounce of gold per ton.

During the latter part of the 1947 field season an attempt was made by diamond drilling to locate the downward extension of the gold quartz vein at a point beyond the face of the main tunnel. Diamond-drill hole 1 was drilled a distance of 180 feet, but no significant quartz-bearing zones were penetrated. In 1948 this hole was extended to a total distance of 540 feet without cutting any significant quartz bodies.

It is inferred from structural and lithologic data that the thin gold quartz body at the surface either (1) pinches out with depth at a point above the tunnel, (2) pinches locally at the tunnel level, (3) rakes in such a direction, northwest or southeast, so as not to be exposed in the tunnel, or (4) changes dip somewhat and is represented in the tunnel by the quartz vein at 346 feet from the portal, which contains only 0.01 ounce of gold per ton. The relation of the location of the vein on the surface to structure and lithology in the tunnel is shown on plate 12.

Locally the rhyolite sill that has been intruded by the gold quartz vein at the surface contains pyrite and galena. Stringers of sphalerite are present in some of the schistose wall rock. Two basaltic sills each about 1 foot thick cut the metamorphic rocks on the footwall side of the rhyolite sill. Six to twelve inches of quartz is found on each side of one of these sills, but it has not been analyzed for gold content. Galena is reported to have been taken from an old prospect pit nearby.

One quartz sample and two silicic sill samples were collected at the Berg prospect for gold analysis, but no sample contained more than 0.01 ounce of gold per ton. The several adjacent mineralized areas north of Berg Basin that have been examined in detail by the U. S. Geological Survey also are characterized by deposits containing only a trace of gold or no gold at all.

IRON SULFIDES

Iron sulfides are common in the metamorphic rocks, and some of the schist exposed in the prospect tunnel is estimated to contain at least

1 percent of sulfide minerals. On the west side and near the top of Berg Mountain small areas of schist are also mineralized with disseminated sulfides, but no attempt has been made as yet to delimit any of the more conspicuously mineralized zones. Close inspection is necessary to distinguish these sulfide zones from other brownish-weathered zones in which sulfides are sparse and altered biotite is especially abundant. Most of the brownish-weathered zones in the Berg Basin area are of the latter type.

In the underground workings about 175 feet from the portal of the tunnel a light-gray felsite sill is exposed. The sill has a maximum thickness of 14 to 16 inches on the north wall and locally contains one to several percent of pyrite. A channel sample cut from this sill contained only 0.01 ounce of gold per ton.

Zones mineralized with iron sulfides were encountered in diamond-drill hole 1, and it is reported that 6 to 8 inches of solid-sulfide material was penetrated at one place. No gold was detected in an assay of this sulfide material.

GENESIS

In general, the lead-zinc deposits in the Wrangell district probably are genetically associated with the Coast Range batholith or related intrusive bodies. Certainly the galena and sphalerite minerals at Berg Basin are younger than the basaltic dikes, which in turn are generally younger than the rhyolite dikes and sills. If the period of metallization is genetically related to the Coast Range intrusive bodies, then the presence of galena within the basaltic dikes would suggest that these dikes, as well as the rhyolite dikes and sills, were a late phase of Coast Range batholith activity.

Sphalerite and galena were deposited in part as cavity fillings although some replacement and filling of minute fractures took place. These cavities and fractures were probably formed by movement that accompanied the intrusion of the basaltic dikes.

Quartz is the principal gangue mineral along with minor amounts of carbonates. Galena, sphalerite, and pyrite are the predominant sulfides. Chalcopyrite rarely is present. The galena generally is in coarse cubes, and individual crystals commonly are coated with a thin, platy mineral, possibly barite.

Most of the pyrite is massive, but small cubes also have been formed. The sphalerite is dark brown to black and is the iron-rich variety marmatite.

Near the contacts between basaltic dikes with rhyolite or schist the quartz gangue commonly exhibits a comb structure. In some places the original cavities were filled with sulfide minerals although some open vugs still exist. Banding within the sulfide bodies, which is characteristic of low-temperature deposits, was not seen in any of the surface exposures at Berg Basin.

CONCLUSIONS

Diamond drilling undertaken in 1947 reportedly showed the existence of a 5-foot zone of solid and disseminated galena at Berg Basin, but further exploratory work is needed before the presence of an ore body can be validly appraised. The geologic setting at the Berg prospect does not appear favorable for any large lead-zinc deposit, but a small operation may be feasible if high-grade ore is developed. The value of possible galena ore would be enhanced somewhat by its silver content, but the presence of iron-rich sphalerite may be detrimental to any proposed operation. Information obtained from diamond-drill hole 2 suggests that a small high-grade ore body may exist at the Berg prospect. Diamond-drill hole 3, drilled from a point in the main tunnel in 1948, added no significant data regarding a possible galena body because it bottomed within 25 feet of the surface where only small stringers and disseminated grains of galena are known to occur. If further testing of the reported 5-foot zone of solid and disseminated galena penetrated in diamond-drill hole 2 is considered, it might be advantageous to drill from the surface at a point some 200 feet or more northwest of the tunnel portal and at about the same altitude as the tunnel. Before any such plan is considered it would be necessary to determine more accurately the relation of topography to the zone of galena penetrated in diamond-drill hole 2.

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