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GEOLOGY AND ORE DEPOSITS IN THE REID INLET AREA, GLACIER BAY, ALASKA

WITH ADDED NOTES ON A MINERALIZED ZONE NEAR LITUYA BAY

By

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This report is preliminary and has not been edited or reviewed for conformity with U. S. Geological Survey standards and nomenclature

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GEOLOGY AND ORE DEPOSITS IN THE REID INLET AREA, GLACIER BAY, ALASKA WITH ADDED NOTES ON A MINERALIZED ZONE NEAR LITUYA BAY

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ABSTRACT

A gold-bearing area of about 7½ square miles, first discovered by Mr. Joseph Ibach in 1924, exists near the head of Glacier Bay between Reid and Lamplugh Glaciers.

The dominant rock type in the area is granodiorite which is intruded into bedded rocks that may be of Paleozoic age. The bedded rocks consist of conglomerate, limestone, and black graphitic schist. A light-colored quartz diorite younger than the granodiorite crops out south of the mapped area.

Most of the ore deposits are found in fissure type quartz veins. These occur in both the granodiorite and in the older bedded rocks. The mineralizing solutions which brought in the gold have altered the country rock for as much as a few tens of feet to each side of the fissures. Locally, this altered rock is gold-bearing, but in the places sampled the gold content was found to be too low to permit profitable mining.

Most of the quartz veins tend to be lenticular, both horizontally and vertically, and the gold tends to be concentrated in discrete spots along the veins. These factors tend to make the ore spotty and its location unpredictable. This has given rise to the concept that the ore in the area has a tendency not to continue below the surface.

Geologically there appears to be no reason to believe that gold mineralization is confined to surface outcrop.

The LeRoy and Rainbow properties are the only two that have yielded significant quantities of gold within the mapped area, but the veins on the Highland Chief and probably the Beattie claims appear to be of sufficient size and grade to be potential ore producers.

The LeRoy mine is the largest in the area. The ore body consisted of a fissure type quartz vein averaging between 2 and 3 feet in width with a length of about 60 feet, but at high all of the ore in the main vein had been mined out above the main working level. Ore probably amounting to several hundreds of tons was mined and milled from the Rainbow vein.

The results of an investigation of a mineralized area near Lituya Bay is included in this report. The mineralized material consists of hydrothermally altered rock found in volcanic rocks believed to be of Mesozoic age. The gold content is too low to permit profitable mining, although it is possible that undiscovered spots exist in which the gold concentration is sufficiently high to be of economic significance.

GEOLOGY AND ORE DEPOSITS IN THE REID INLET AREA

Introduction

The gold-bearing mineralized zone in the area between Reid Inlet and Lamplugh Glacier has been known since 1924, and although several geologists visited the area briefly in the past no detailed examination was ever made. J. . . Reed visited the area in 1936 and published a short report (Reed, 1938). In 1954 another United States Geological Survey party spent most of the interval between August 1 and August 18 examining the area; this report summarizes the results of that investigation.

The mapped area, about 2½ miles wide and slightly more than 3 miles long, is near the head of Glacier Bay between Reid and Lamplugh Glaciers about 150 miles by water from Juneau (fig. 1). Not all of this area has been examined in detail, however, and certain parts, especially along the south and west sides, have been examined either by a single traverse or not examined at all.

A map suitable for plotting the geology of the area was not available, and consequently a base was prepared from aerial photographs using Multiplex equipment.

Geography and accessibility

The mapped area which lies entirely within the limits of Glacier Bay National Monument consists of steep, bare mountains bordered on the east by Reid Inlet and Reid Glacier and on the west by Lamplugh Glacier (fig. 2). The north side is bordered by Glacier Bay. The

Glacier Bay area as far south as Hugh Miller Inlet is treeless and largely devoid of vegetation. In general, rock exposures are excellent but the slopes adjacent to Reid Inlet and Glacier Bay are covered with a mantle of glacial debris to an altitude of about 1,000 feet. Many steep-sided gullies have been cut into and through the nearly unconsolidated material, exposing some bedrock even in these covered areas. The bare rock surfaces can be quite easily climbed and few spots exist which are totally inaccessible. Although the area can be quite easily covered by one on foot, it is impossible, for the most part, for wheeled vehicles to traverse the country.

During some of the time the claims near Reid Inlet were being prospected, a caterpillar tractor was used. The tractor was brought into the country by the way of the Ptarmigan Creek drainage basin while snow still covered the ground. It was possible for the tractor to reach the divide between Ptarmigan Creek and the creek that drains into Reid Inlet at a point near its entrance. From the divide a road was built to the southeast, mainly in unconsolidated material, to a point directly above the Incas prospect on the slope of the mountain west of Reid Inlet. An aerial tram was built from the southeast end of the road to Reid Inlet and during the summer months while prospecting and mining were in progress, supplies and equipment were brought in and some ore was removed over the aerial tram.

The Rambler group of veins cropping out about 3½ miles south of the terminus of Lamplugh Glacier on the west side of the mapped area are difficult to reach. At present the only practical way of building a

road would be to extend it along the mountainside parallel to Lamplugh Glacier. The mountainside here is solid rock without a softening mantle of overburden, and any road constructed here must be literally blasted out of the side of the mountain for considerable distances. The character of the surface of Lamplugh Glacier is changing rapidly, however, and within the last few years the crevasses have become fewer and more widely spaced and the surface of the glacier south of the veins has become smooth. If this same trend continues, it may be possible eventually to use the glacier, at least in part, as a means of reaching these veins. Such a route, except in the upper part is not practical at present, however.

Another deterrent to mining in the area is the abundant snowfall which covers the ground at high altitudes until the latter part of the summer. For example, some of the veins at the Highland Chief claim at an altitude of about 2,800 feet were still covered by snow when the writer visited the area during the middle of August in 1954.

No person has spent the winter in the upper part of Glacier Bay but apparently the upper part of the bay freezes over for extended periods stopping all navigation. In the past, Glacier Bay and its related bays and fiords have been at times filled by numerous icebergs which would almost prohibit navigation, but this factor is rapidly becoming less important as the glaciers retreat and become less active. In 1954 the writer experienced little difficulty with the ice. If, however, large scale mining operations were to be undertaken, the operators must take into account the fact that intermittently, impassable barriers of ice will form in the upper part of Glacier Bay.

There are no large natural harbors entirely sheltered from ice near Reid Inlet, but small boats can find shelter at several places east of Russell Island and in the small natural bay at the entrance to Reid Inlet. The latter can be entered only at high tide by boats of small draft however. During 1954 the writer found that little ice beset the area opposite the mouth of Ptarmigan Creek and boats could anchor there for periods of a few days without trouble from ice.

Few climatic data have been recorded for the area. In general, the climate is much like the rest of the northern end of southeastern Alaska. Precipitation probably amounts to about 95 inches per year. The summer months are the driest and the fall from September through December, the wettest. The writer has worked in, and visited the upper part of Glacier Bay over a period of several years and has found that although the rainfall may be nearly as great as that farther south on Chichagof Island, there are fewer cloudy or partly cloudy days.

There are no permanently occupied dwellings in the area. A small cabin has been erected on the shores of Reid Inlet near its outlet and another has been built about half a mile from salt water on Ptarmigan Creek. A mine mill has been erected about 1,000 feet south of the cabin on Ptarmigan Creek on the northern slopes of Mt. Parker. These are the only buildings in the upper part of Glacier Bay. The nearest inhabited dwellings are at Gustavus near the mouth of Glacier Bay. A cabin is maintained by the National Park Service at Bartlett Cove located 6 miles northwest of Gustavus. For the past several years this has been intermittently occupied during the summer months. The nearest

settlement where supplies can be purchased is Hoonah which is about 75 miles by water from Reid Inlet.

There are few land animals in the area. Prospectors have reported seeing several bears, and the writer has seen the tracks of wolves south of Reid Inlet. The waters afford a home for large numbers of hair seals, some otters, and water fowl. A few halibut and salmon are caught in the upper part of the bay and as the ice retreats salmon spawn in more and more of the streams and lakes.

Acknowledgments

During the time the mapping was in progress, Mr. Joseph Ibach of Lemesurier Island kindly spent several days showing the writer those veins and prospects that were known to him in the Reid Inlet area. Mr. and Mrs. Albert Parker also were helpful in making the records and history of the LeRoy mine available and Mr. Phil R. Holdsworth of the Territorial Department of Mines spent several days examining the LeRoy mine with the writer. Mr. Holdsworth also kindly consented to the writer's use of the base map of the mine which was prepared in his office. This map accompanies the present report and is the one on which the geologic information concerning the LeRoy mine has been plotted (fig. 3). The writer gratefully acknowledges the help and interest shown by the above-mentioned people.

History

Gold-bearing veins were first discovered in the Reid Inlet area by Mr. Ibach in 1922. He first landed near the mouth of the creek which

later became known as Ptarmigan Creek, and prospected southeastward toward Reid Inlet. At that time Reid Glacier extended nearly to the outlet of Reid Inlet and no protected harbor existed. He discovered the veins which he staked and named the "Monarch", and the "Incas". The year after his original discovery, Glacier Bay National Monument was closed to prospecting and mining and little could be done until 1936 when the Monument was again opened to prospecting. At this time, Mr. Ibach discovered and staked the Rainbow and Sentinel veins near the northern edge of the area and in about the same year, the veins on the Highland Chief group of claims were discovered and staked by Mr. Ibach and Mr. Rex Beach. Many other veins were discovered at about the same time, including the Galena vein near the west shore of Reid Inlet and the Rambler group of veins near the east side of Lamplugh Glacier. Several veins were also found on the east side of Reid Inlet, including two at an altitude of about 2,000 feet which have been staked as the Whirlaway and Hopalong claims and one vein found closer to the shore of Reid Inlet at an altitude of 800 feet which has been staked as the Sunrise claim. The location of these veins has not been shown on the geologic map.

About the only mining activity before 1937 consisted of sluicing some of the partially decomposed material from the surface of some of the veins. In 1937 the Newmont Mining Company under the direction of Benjamin Benedict leased the Highland Chief and Rambler claims. They spent several months examining and sampling the veins on these claims as well as others found within the mapped area. The company gave up

its lease after it was decided that the veins were too inaccessible to permit profitable mining. Sometime, probably before 1941, Mr. Irach and Mr. Tom Smith started an adit on the Rainbow vein but because of lack of proper mining equipment they soon abandoned the work. They spent the remainder of the season mining the decomposed vein material from the veins on the Galena claim. Similar mining operations were carried out before 1941 on the Whirlaway and Hopalong claims east of Reid Inlet, on the Sentinel, the upper and lower Rainbow veins near the northern edge of the area and on the Incas veins west of Reid Inlet.

The LeRoy veins, now owned by the Mt. Parker Mining Co., were found in 1938 by Mr. Abraham Lincoln Parker and his son, Leslie F. Parker. Mr. Abraham Lincoln Parker was a resident and one of the founders of Gustavus. In his old age, when he had become almost too incapacitated to work, he decided that he wanted to own and operate a gold mine. For several seasons he worked on designing and building a small, two-stamp mill at his home at Gustavus. Upon completion of the mill, it was dismantled and he and Leslie Parker towed the mill by raft to the upper part of Glacier Bay. They anchored in the small indentation in the shoreline opposite Ptarmigan Creek and decided to start prospecting from this location. Within a few hours after leaving the boat, they had discovered the LeRoy vein and had ascertained that it contained a considerable amount of gold. Within a few days they had moved the mill up Ptarmigan Creek to a position below the vein. An aerial tram was built and mining was started. This is the only instance known to the writer when the mill was actually built before the prospect was discovered.

After the death of Mr. Abraham Lincoln Parker during the winter of 1941, the mine was leased to a group of men who adopted the name of the LeRoy Mining Company. The six men, namely, Norman Crooks, Raymond Crooks, Harry Billingen, Chris Billingen, Mike Siler and Bill Berig, worked the mine during the summer months of 1941, 1942, 1944, and 1945. By 1945 they had mined most of the ore above the main working level in the LeRoy mine and had leased the Rainbow and Incas claims from Mr. Beach. They milled the ore from the Rainbow claim in the mill on the LeRoy property.

Another mining operation was under way during part of the time that the mining activities were being carried on by the LeRoy Mining Company. During 1941, the year the LeRoy Mining Company started operations, four men, Mr. August Crop, Joe Kajich, Jack Fanning, and Jon Smith, under the name of the Mt. Fairweather Mining Company, leased the Monarch claims from Mr. Beach. During the summer an aerial tram was built from the beach on Lelu Inlet to a point near the Monarch vein. Ore was mined from the surface of the vein, transported to the beach and then taken by boat to Lanestrick Island where it was milled and the gold recovered. The operation did not prove profitable and the Fairweather Mining Company gave up their lease at the end of the season.

In about 1945, a drift was started on the Monarch No. 1 vein under the supervision of Mr. James Jordan. Development work continued for the next three years, and during this time the 200 foot

tunnel was completed on the Monarch No. 1 vein and another aggregating approximately 1[illegible] feet in length was driven on Monarch No. 2 vein. The exact time the tunnel was driven on the Lucas property is not known to the writer but it must have been before 19[illegible].

Production

Information on the amount of gold recovered from individual mines is either lacking or incomplete. The amount of gold recovered through the sluicing operations of Mr. [illegible] from the surface out-crop lying above the weathered veins throughout the area probably amounts to less than [illegible] ounces. From 19[illegible] to 19[illegible] at least [illegible],[illegible]00 tons of high grade ore has been mined and milled from the several mines in the area, from which a recovery of about [illegible] per ton was made.

Geology

Bedded rocks

The rocks in the area between [illegible] Inlet and [illegible] Glacier are dominantly [illegible] but include [illegible] of older, metamorphosed

sedimentary rocks that are entirely surrounded by the granodiorite (fig. 2). Because the sedimentary rocks have little bearing on the ore deposits it was not deemed worthwhile, for the purpose of this report, to study or describe them at length. They crop out mainly in two areas; one is an elongate band that trends slightly west of north through the central part of the area, and the other is a smaller mass that extends from the drainage basin of the east part of Ptarmigan Creek eastward to the headwaters of the largest creek draining into the entrance of Reid Inlet. In both, the strike is parallel to the long direction of the body and the dip is steep but variable. Another area where mixed sediments and igneous rocks crop out is on the mountain between the Highland Chief claims and Lamplugh Glacier on the southern edge of the mapped area. Besides these three fairly distinct zones, which are composed essentially of bedded rocks, a considerable amount of igneous rock in the southern end of the mapped area contains a large amount of almost completely assimilated and recrystallized older rock. In these, the metamorphism has been so complete that the original structure and character of the rock cannot be ascertained in the field.

The bedded rocks consist of a black graphitic rock which is now largely a black graphitic schist, metamorphosed limestone and conglomerate listed in the order of decreasing abundance. As far as the writer could observe, the bedded rocks, with the exception of the black graphitic schist, appeared to be as favorable a host for the ore bodies as is the granodiorite. The black graphitic schist, on

from some distance that the two can best be seen as separate and distinct units. Both are fairly light-colored, medium- to coarse-textured igneous rocks containing abundant plagioclase, orthoclase, quartz, and subordinate hornblende and biotite. The rocks have been metamorphosed and individual grains show preferred orientation.

The metamorphism has been relatively low grade and has resulted mainly in the formation of chlorite minerals at the expense of the hornblende, and of saussuritization and other types of alteration of the feldspar. In most of the thin sections examined, there appears to have been a later introduction of quartz. In the hand specimen, the effect of metamorphism is shown by the fact that the dark colored minerals no longer exhibit sharp boundaries against other grains, but rather grade through an appreciable zone into other minerals. This gives the rock a somewhat lusterless appearance and makes megascopic identification of the dark minerals rather difficult.

Near the southern edge of the mapped area near Reid Glacier the granodioritic rock has assimilated large amounts of older rock and this recrystallized material is darker colored and contains more ferromagnesian minerals than does the granodiorite. This type of assimilation is common in the igneous rocks in the Glacier Bay area.

No direct evidence was found concerning the age of the granodioritic rocks in the mapped area. The granodiorite geographically lies in the zone of igneous rocks which intruded the earth's crust in a southeast-trending belt extending to Chichagof and Baranof Islands. The igneous rocks are believed to have been intruded during

the formation of the Coast Range batholith in early Cretaceous time. Probably the granodiorite in the area between Reid Inlet and Lamplugh Glacier was formed during this period of igneous activity. The granodiorite is, however, more silicic than most of the rocks belonging to the Coast Range batholith and possibly it is of a different age and genetically unrelated to the Coast Range batholith.

Another type of [illegible] rock which is lighter colored and has a more even texture than that found in the granodiorite crops out south of the mapped area. This rock is quartz diorite, and has neither been appreciably metamorphosed nor is it highly foliated. In outcrop and in the hand specimen the rock has a fresher appearance than does the granodiorite. Because it is essentially unmetamorphosed, and because [illegible] which are similar to it cut the granodiorite, it is believed that the quartz diorite is younger.

This quartz diorite [illegible] may be contemporaneous with some of the younger [illegible] quartz diorite intrusions present on the west coast of Chichagof Island and in the southern end of the Fairweather Range. Those on Chichagof Island are known to cut sedimentary rocks of Mesozoic age and are therefore younger. Those in the Fairweather Range [illegible] and are believed to be of the same age as those found farther north on Chichagof Island.

Dike rocks.--The rocks in the Glacier Bay area have over large areas been cut by a large number of parallel dark-green mafic dikes. In areas as much as several square miles in size, these dikes make up at least [illegible] percent of the total rock by volume. This same type

of dike is intruded in the area between Reid Inlet and Lamplugh Glacier. Here most of these dikes trend approximately east as they do in the other parts of the Glacier Bay area and are generally nearly vertical. Most of these dikes are older than the period of gold mineralization as is attested by the fact that the gold-bearing solutions which altered the country rock also altered these dikes. As far as the writer is aware, these dikes are unrelated to those solutions which caused the gold deposits to form. They have, however, at least in one place, influenced the deposition of the ore. At the face of the tunnel in the LeRoy mine one of these dikes cuts diagonally across the fracture which contains the LeRoy vein. The dike appears to have served as a barrier or dam to the ore-bearing solutions and apparently was the cause for the increased width and tenor of the ore in the area adjacent to the dike.

An examination under the microscope shows the dike rocks to be medium grained with a diabasic texture. Alteration consists of moderate replacement of the original pyroxene by both a green amphibole and green biotite. Later all three minerals and probably plagioclase as well were slightly altered and replaced by chlorite. The pyroxene is augite, that, because of its pinkish color in thin section, is believed to be somewhat titaniferous.

Other similar mafic dikes from the Glacier Bay area contain olivine and although none was found in specimens of mafic dikes collected between Reid Inlet and Lamplugh Glacier probably some dikes occur in the area which do contain olivine. The plagioclase has a mean index of refraction

of 1.5° and is labradorite-bytownite (An_{70}). Plagioclases of two ages are present but no large difference was found in their indices of refraction and probably both have nearly the same composition. The older occurs as phenocrysts which have been quite intensely altered. The younger consists of clear sharply twined lathlike crystals of plagioclase which penetrate augite.

In a few places within the mapped area, the granitic rocks are cut by a light-colored aplitic type of dike rock. Typically, these dikes are irregular in width and rather discontinuous. They both cut, and are cut by, the dark-colored dikes and apparently both are of about the same age. The aplite dikes have been somewhat metamorphosed probably at the same time the granodiorite was metamorphosed. Although fine-grained and texturally somewhat different from the granodioritic rocks, they have very nearly the same color in outcrop and are rather difficult to distinguish from the granodiorite unless seen on well-exposed fresh surfaces. For this reason they are often undetected. They appear to have little, if any, relationship to the ore bodies or to the ore mineralization. They were noted to be altered in the same manner as is the country rock adjacent to the ore-bearing veins and thus are undoubtedly older than the period of mineralization.

East of Reid Inlet, a few dikes of quartz dioritic composition and granitic texture were noted which appear fresh and unmetamorphosed. Because they are unmetamorphosed they are believed to be younger than the period of metamorphism and perhaps are related to the younger quartz dioritic rock found south and west of the area. None of these dikes

were found adjacent to the gold-bearing veins and associated altered zones, and their relation to the gold mineralization is not known. The dikes are, however, somewhat mineralized and one specimen which was collected by the writer contained abundant pyrite and some arsenopyrite. It is reported that other parts of this same dike contain molybdenite, but no molybdenite was found in the dike by the writer.

Ore deposits

The gold-bearing veins found in the area were introduced along pre-existing fractures in the granodiorite and metasedimentary rocks. The wall rock adjacent to these fractures is highly altered. The iron in the altered rock is easily oxidized and weathering has stained the rock to a rust-red color. The visible effects of alteration extend in places 10 to 15 feet to each side of the vein. Most of the altered zones contain some gold and although the gold is generally associated with quartz, some altered rock does contain appreciable amounts of gold that is unassociated with quartz. Although the altered zones all probably contain some gold, relatively few contain enough to make exploitation profitable. There is no fundamental genetic difference between those that contain low concentrations of gold and those containing concentrations of gold sufficiently high to be classed as ore.

Because the plotted distribution of the altered zones tends to bring out those areas within which the gold-bearing mineralization has been most intense, all altered zones known to the writer have been shown on figure 2. A knowledge of the distribution of these zones should be of value to the prospector or geologist working in the area.

Many more veins and altered zones occur in the mapped area than have been shown on the map, however. One area which may contain a large number of these zones is in the mountain slopes above the southwest headwall of Ptarmigan Glacier. Another area which is known to contain several quartz veins, lies on the ridge south of Mount Parker. Many quartz veins crop out on the east side of the mountain facing Reid Inlet about 3,000 feet northeast of the Highland Chief vein; these have not been shown on figure 2.

Gold mineralization decreases to the southeast but a few gold-bearing quartz veins occur as far southeast as the southeastern end of Gilbert Island (fig. 1). Mr. Ibach told the writer that quartz veins crop out on the mountain facing Lamplugh Glacier near its confluence with Brady Glacier northeast of Mt. Bertha. This area is difficult to reach and is virtually unprospected. Mr. Ibach succeeded in reaching it for only a short period of time, and reports that he found considerable quartz both as float on the glacier and in place on the flank of the mountain. He reported one vein to be as much as 50 feet thick. No gold was found in these veins although one showed some green copper staining. Other than this, the mineralization does not appear to have extended as far west as the west side of Lamplugh Glacier nor has it extended north much beyond the edge of the mapped area, for in only one or two localities in the area north of John Hopkins Inlet and in the Tarr Inlet area have any traces of gold ever been reported. Zones of alteration most of which are barren occur along fractures in the country rock in other parts of the Glacier Bay area north of Hugh Miller

Inlet. About the only difference visible in the field between altered zones which contain no gold and those which contain gold is the fact that those containing gold also generally contain some quartz, but quartz is not an infallible indicator of gold.

Galena seems to be a good indicator of high gold content and when seen in the hand specimen it is often possible to see specks of gold either in or adjacent to crystals of galena. In some specimens, the galena has weathered out leaving a reddish residue in the crystal cavity. The residue in many of these cavities contains small flakes of free gold.

The veins in the mapped area follow several different trends. Those in the area between the Incas and the Monarch veins trend north to northwest in one set and northeast to east in another set. The north to northwest trending set apparently continues on both northwest and southwestward into the area between the Rainbow vein and Ptarmigan Creek. The veins on the Highland Chief claims also have a north to northwest strike. Most of the veins in the area between the Rainbow vein and the entrance to Reid Inlet strike to the northeast as well as do most of the veins found in the vicinity of the Rambler vein. The Rambler vein, itself, however, has nearly a due east strike. Dips of all the veins in the area are steep, the lower limit being about 50 degrees, but there is no consistency in the direction of dip even among veins in the same area or in some cases even along a single vein.

LeRoy mine

The LeRoy mine is located on the side of Mt. Parker at an altitude of 950 feet (fig. 2). It is about 4,000 feet from the beach of Glacier Bay to the mine, or about 1 mile by road and trail. A road has been built up a dry stream channel to Ptarmigan Creek where a cabin and the original mill were built. The newer mill, now partly dismantled, is on the lower slopes of Mt. Parker directly below the LeRoy mine at an altitude of about 500 feet. An aerial tram connects the mill to the mine.

The country rock in the vicinity of the LeRoy mine consists of highly recrystallized sedimentary rock and black graphitic schist. The recrystallized rock has an igneous-like texture and some igneous rock may be present. Most of the other rocks found in the same general vicinity, however, are undoubtedly recrystallized sedimentary rock and probably those rocks found at the LeRoy mine are of this origin. The veins at the LeRoy mine consist of a northeast-trending network of veins which dip 50° to 80° to the northwest (fig. 3). The network of veins is fairly well developed and 15 or more crop out in the immediate vicinity of the mine. Although some appear to contain a considerable amount of gold, most are too small to be minable.

The original adit was driven at an elevation of approximately 987 feet along the main LeRoy vein. This level has been completely mined out now and was not entered by the writer. At the surface the vein is small and makes a relatively poor showing but increases markedly in width underground. Another level, almost directly below the first,

at an altitude of 950 feet was driven to mine the ore along the vein. At present all of the ore above this level has been mined out but quartz still exists in the tunnel along a distance of approximately 60 feet. At one place in the floor of the tunnel the vein is 36 inches thick but it has an average thickness of about 22 inches over a length of 45 feet. A third adit was driven about 220 feet northwest of the main working level at the altitude of 950 feet to intersect some of the veins found in that area. Although some ore has been mined in this tunnel, most of the veins here are thinner than those found in the LeRoy mine and are apparently of lower grade. Another vein which strikes parallel to the LeRoy vein crops out about 25 feet to the southeast of the upper adit. This vein has been explored by means of a short open cut. Samples taken from it have a high gold content. As has been mentioned previously a dark-colored mafic dike cuts diagonally across the LeRoy vein. The vein strikes about N. 35° E. and dips 75° to 80° to the northwest and the dike strikes about N. 65° E. and dips about 75° to the northwest. It appears that the dike is older than the quartz vein and has acted as a barrier to the solutions which deposited the quartz and other minerals. If this interpretation is correct, the ore may not continue on to the south side of the dike.

All of the known ore above the main working level has been mined out on the LeRoy vein. The vein, although fairly strong, appears to be becoming somewhat smaller downward both in lateral extent and thickness and therefore extensive work along this vein should be approached with some reservation.

The area south of the dike is covered on the surface and the positions of veins for several hundred feet south of the dike is completely unknown. Perhaps the vein is present on the south side of the mafic dike but, owing to the fact that the dike appears to have acted as a dam for ore-bearing solutions, the writer feels that it is not likely that the same ore vein continues south of the dike.

A group of small veins lies parallel to the LeRoy vein about 22 feet to the southeast. These veins are not large enough to mine where exposed. They do, however, trend toward the same mafic dike that apparently acted as a barrier to the ore-bearing solutions along the LeRoy vein and the same situation may have developed along these veins as occurred along the LeRoy vein. The LeRoy vein, where exposed at the surface at the discovery, is not very wide and it was only by drifting along the vein toward the dike that the full extent of the ore body was realized. Inasmuch as the small parallel veins are reasonably close to the LeRoy vein it would not be difficult or expensive to explore the possibility that another parallel ore body is there.

Most of the other veins found in the immediate area of the LeRoy mine are small. Probably most are too small to be mined economically although some contain fairly high concentrations of gold. A fairly strong vein which is exposed in the face of the western adit might profitably be further explored.

Incas property

The Incas vein, which was one of the first discovered, was staked by Mr. Joseph Roach in 1924. The vein lies in a fracture zone in the granodiorite on the mountainside facing Reid Inlet at an altitude of

approximately 1,000 feet (figs. 2 and 4). A blacksmith shop and the foundation of one cabin still remained on the property in 1954. A short adit was driven into the mountainside northeast of the cabin for use as a storage depot during the winter months. Ore was removed from the surface workings of the Incas vein by means of an aerial tram.

The Incas vein trends north or northwest and is exposed intermittently through a thin mantle of glacial debris over a distance of nearly 2,000 feet. The country rock has been altered adjacent to the fractured zone for the entire exposed length. The quartz along this altered zone is not continuous, however, but apparently consists of a series of lenticular bodies. All of those quartz bodies found contain some gold.

The main workings are on a vein which on the surface was originally exposed for a distance of approximately 55 feet. The weathered part, which extended for several feet below the surface, has been mined. The trench dug during this mining has caved and the quarts vein, except for several feet on the north end, was covered in 1954.

The tunnel driven to intersect the Incas vein at depth was started at a point approximately 110 feet to the east and at an altitude about 100 feet lower than the surface outcrop of the vein. The tunnel at the portal was driven at a bearing of S. 60° W. for a distance of 75 feet, and was then turned to the northwest and driven 65 feet where it intersected the fault zone at a point below the northern end of the ore vein on the surface. The tunnel was extended to the north along the fault zone but not to the south under that portion which is known to contain

the ore-body on the surface. The portal of the main tunnel is somewhat caved but the underground workings are in good condition.

Several other veins crop out in the immediate vicinity of the Incas vein. One vein lies parallel to it a few tens of feet to the north, and another trending about N. 20° E. and dipping 70° to the west crops out between the tunnel portal and the blacksmith shop. Several other north-trending altered zones and quartz veins crop out between the Incas vein and the beach at an altitude of approximately 600 feet.

The Incas vein, in the writer's opinion, has not been completely explored and its possibilities as a mine remain unassessed. As is mentioned above, the tunnel intersects the vein at a point directly below the northern end of the ore shoot as was found on the surface and exploration was not continued to the south under the area known to contain ore. It would be fairly easy to ascertain if the ore continued to this depth in the area to the south of the point of intersection. For a thousand feet or more to the north of the main prospect, outcrops show that gold-bearing quartz occurs along the altered zone, and although the maximum thickness of quartz found was about 15 inches, it is possible that small ore bodies of minable grade may occur along this portion of the altered fracture zone.

Monarch No. 1

The Monarch No. 1 vein is similar in structure and appearance to the Incas vein. It strikes north to northeast and dips steeply to the west. It crops out over a horizontal distance of nearly 400 feet

between the altitudes of 1,875 and 2,000 feet (figs. 2 and 5). The vein is in the same granodiorite body as the Incas vein. The south end of the vein is exposed and is known to pinch out, but the north end is covered by talus and the full length of the vein is unknown. In general, it appears to be somewhat thicker than the Incas vein.

The underground workings at the Monarch mine consist of a tunnel about 225 feet long which follows along the vein for most of its distance only leaving it in places where the ground was too loose to permit drifting along the vein. A small area was stoped about 55 feet from the entrance to the tunnel and another area about 110 feet in from the portal appears to have been mined upward for a distance of 15 or 20 feet. The tunnel extends to the south beyond this mined portion but in the rest of the tunnel the quartz is too lean to be ore.

During the period in which the development work was in progress, an aerial tram extended from the portal of the tunnel eastward to the road at an altitude of about 1,900 feet. The oxidized outcrops along the vein were mined and the ore transported by aerial tram to the road, and thence southwestward on the road to a second aerial tram which passed directly over the Incas mine to the beach.

Other veins found near the Monarch No. 1 vein also contain some gold. One vein found a few hundred feet to the west of the Monarch No. 1 crops out for a length of about 100 feet and is exposed in several pits near the northern end of the body. The maximum width exposed in 1936 was about 12 inches but the vein appears to be widening where it passes under cover. The vein strikes north to northeast and has a steep dip. Some mining has been done on the partially decomposed

weathered material above the vein. A smaller vein about 6 inches wide, which contains abundant pyrite and several percent of galena, was found several hundred feet due west of the south end of the Monarch vein. Undoubtedly the stringer is very rich but it is probably too small to be mined profitably.

Apparently the Monarch No. 1 vein was prospected as much as was deemed advisable and probably it was felt that the body was either too small or too low grade to be mined profitably. The vein continues southward beyond the end of the tunnel for at least another 100 feet, but its width at the surface is less than it is in the area directly over the tunnel and possibly would be no thicker underground than it is on the surface. The writer feels that the chance of finding a larger ore body beyond the end of the tunnel, although possible, does not appear to be very likely.

Monarch No. 2

The Monarch No. 2 vein is poorly exposed on the surface and can be followed over a distance of about 80 feet. Over in the area beyond the ends of the vein is thin and the vein probably does not extend much beyond the last outcrop. The vein strikes north to northwest and dips steeply to the east. The maximum amount of quartz found on the surface consisted of an 8-inch quartz vein found near the southernmost outcrop of the vein. At other places the vein was 2 to 6 inches thick but is not present over the entire 80 feet. The workings on the Monarch No. 2 consist of a tunnel approximately 100 feet long which starts at an altitude of 1,400 feet at a point about 1,000 feet northeast of the

Monitor No. 1 portal (figs. 1 and 2). The fault along which the vein lies was intersected in the tunnel at a distance of about 75 feet from the portal and was followed for a distance of 15 feet. Over this distance a few lenticular masses of quartz occur that showed, upon panning, a few small flakes of gold. According to Mr. Jones, another vein apparently of somewhat similar appearance crops out in the area now covered by the fill from the tunnel. This vein was reported to contain some galena and free gold and to dip steeply to the north.

This vein is poorly exposed on the surface and the southern end passes under cover but outcrops of bedrock a few tens of feet farther south fail to show the continuation of the vein. The vein apparently does not extend much farther north than the last outcrop. The vein, where exposed both on the surface and underground, does not appear to be of economic importance for future work. At no place has as much been found nor does there seem to be any reason to believe that one lies concealed beneath the talus beyond the last outcrop. Future work on this vein should be undertaken cautiously inasmuch as no ore is in sight.

Rainbow mine

The Rainbow mine is the only mine other than the Leroy mine from which an appreciable amount of ore has been mined. The Rainbow vein crops out at sea level in the cliff facing the western shore of Prince Ruy about 4,000 feet northeast of the entrance to Reid Inlet (fig. 2).

Mining on the Rainbow vein was started by the Lesley Mining Company in about 1936. The ore mined from the tunnel was loaded directly on a barge and towed to Hunnewell Creek and there transported to the mill on the Lesley Mining Company's property. According to the report given the writer, a large amount of high grade ore was removed from this vein, apparently at a profit to the Lesley Mining Company.

The vein is in rhyolite along a small fault which trends about N. 40° E. and dips 70° to 80° southeast. The vein is traceable on the surface above the mine for several hundred feet and the attendant altered zone can be traced to the southwest, with some interpretation across covered intervals, for a distance of about 2,000 feet. Over most of this distance the quartz vein is missing but the fault zone is traceable through the presence of the altered rock, which is a bright rust-red color on weathered outcrops. At the southwest end, at an altitude of [illegible] feet, a quartz vein crops out which is known as the Upper Rainbow vein. The weathered portion of this upper vein has been mined and the gold recovered.

The tunnel which makes up the workings of the Rainbow vein extends along the vein for a distance of about 200 feet, and the vein has been stoped for an unknown distance above this level. The Rainbow vein is so poorly exposed in the tunnel that worthwhile geologic mapping could not be done underground. The tunnel was driven southwest in the cliff face a foot or so above high tide. The vein for much of this length either has been mined out or is covered by mine timbers so that at only one or two places was it visible. The face of the tunnel in 1941 was concealed by loose material which filled the end of the

tunnel for several tens of feet.

The writer does not know much about the reserves in the Rainbow vein and little can be given in the way of recommendation for future work. Apparently the vein continues down below the main working level but inasmuch as this is very nearly at sea level, future mining operations downward must be done by downward extention. Because the face of the tunnel is concealed it is not known whether ore is present in the tunnel farther to the south or not. The presence or absence of ore at the face can be ascertained at practically no expense, however, by simply removing the loose material from the end of the tunnel. Inasmuch as the vein and altered zone can be traced on the surface for a considerable distance to the southwest, exploration in this direction may be justified but this can best be determined after the face of the tunnel is examined. The ore body at the upper Rainbow adit appears to be rather small. It crops out over a distance of approximately 75 feet and has an average width of about 10 to 15 inches. The body appears to be too small to merit extensive exploratory work.

Sentinel vein

A small gold-bearing hydrothermally altered zone known as the Sentinel vein (fig. 5), crops out on the side of the mountain facing Glacier Bay at an altitude of about 1,400 feet. The Sentinel ore body is the only one in the area not associated with quartz, which has yielded gold in any significant quantity. The ore occurs along a minor fault and consists of altered granodiorite impregnated by galena and other sulphides. The vein is exposed over a vertical distance of about 50 feet and a horizontal distance of about the same length. The

northernmost extension is covered by talus but the southern end pinches out a few feet above the main workings. The gold-bearing zone is 6 to 18 inches wide. When the deposit was first discovered by Mr. Ibach, a cavity a few feet long existed in the lower part of the ore-bearing zone. The floor of the cavity, Mr. Ibach reports, was covered with a red oxidation product from the vein, which apparently was mainly lead oxide. This material was reported to contain a high concentration of gold. The ore from this prospect was carried and dragged by hand to the beach and thence transported to Mr. Ibach's home on Lemesurier Island where the ore was milled. The Sentinel vein has been largely mined out.

Highland Chief claims

The Highland Chief claims are near the southern edge of the mapped area just south of Ptarmigan Glacier (fig. 2). The veins crop out between the altitudes of 2,500 and 2,800 feet. The main vein is exposed in a gulch, but was not visible to the writer during his examination in August 1948 because of snow cover. Mr. Ibach reports the vein to be as much as 6 feet wide and to contain a considerable amount of free gold. Apparently the vein is somewhat lenticular in habit. J. C. Reed visited this property in 1936, and states in his notes that the vein feathers out to the north but disappears under a small glacier to the south.

Several other veins crop out on the side of the ridge to the east of the main ore vein at an altitude of about 3,000 feet. Most of these veins are parallel, trending northeast and dipping steeply to the northwest.

They appear to be somewhat thicker and more continuous than do those found near the entrance to Reid Inlet. The veins in places are as much as 2 feet thick and can be traced laterally over a distance of approximately 700 feet. They pinch out to the north but disappear under cover to the south and their total length is therefore unknown. All of the veins contain some gold, and in several, a considerable number of specks of free gold could be seen even while making a rather cursory examination of them. Other than the veins at the Leroy mine, those veins on the Highland Chief claims are the only ones found in the sedimentary rocks. One vein was noted which penetrated the graphitic schist for a few tens of feet.

The system of parallel veins on the Highland Chief property appears to be the most extensive of any in the area between Reid Inlet and Lamplugh Glacier. They crop out somewhat over a mile from tidewater at an altitude of about 3,000 feet. Undoubtedly, these veins would have undergone more mining activity except for their inaccessibility. For a large part of the year, the veins at the Highland Chief claims are covered by snow and mining operations would either have to cease or be carried on only with added difficulty and expense.

Rambler claims

A group of veins which is included within the Rambler group of claims crops out on the mountain facing Lamplugh Glacier about 2 miles due south of Mt. Parker. The main vein found in the area is known as the Rambler vein. This vein was discovered by Mr. Ibach sometime before 1910 but it was not known whether it was discovered in 1924 before

the Monument was closed to prospecting or after the Monument was again opened in 1936.

The area in which these veins occur has not been examined in detail by the writer. Probably veins exist in this area which are not shown on the geologic map. Most of the veins strike northeast and are nearly vertical. The Rambler vein, however, strikes almost due east. It lies in the granodiorite which is probably part of the same granodiorite mass that crops out immediately west of Reid Inlet. The Rambler vein itself is the largest vein known to exist in the area. In places it is 3 feet thick but it appears to vary markedly in thickness along the outcrop length. At the western end near Lamplugh Glacier, the vein is covered; to the east it apparently pinches out within a few hundred feet, although its eastern end was not seen by the writer. The vein where examined contains considerable pyrite but no galena. However, some float in the creek bed in which the Rambler vein crops out contains abundant galena, sphalerite, and a considerable amount of free gold. This float has a slightly different appearance than the rock in the Rambler vein at the places where it was examined and may well have come from some other higher vein or from some part of the Rambler vein not seen by the writer.

Other veins

Another vein was noted along a fault zone on the west side of Ptarmigan Creek about 3,000 feet southeast of Mt. Parker. This vein has an exposed length of about 200 feet but appears to be rather

discontinuous and lenticular along its outcrop. No free gold was found in the quartz but the vein does contain some sphalerite, arsenopyrite and pyrite. Galena appears to be lacking. Prospectors who have examined the vein in the past have noticed that it contains a dark colored mineral which they suspected might be ferberite--an iron tungstate. This mineral has been identified by the writer as iron-rich sphalerite. The fault along which this vein lies can be traced for 4,500 feet to the southwest. The wall rock is altered along its outcrop length and possibly may contain other quartz veins.

A fairly large and continuous vein is reported to crop out in the mountain about 1 mile southeast of Mt. Parker at an altitude of approximately 3,000 feet. This vein was not found by the writer.

Two claims were staked on two veins in the area east of Reid Inlet. These, called the Whirlaway and Hopalong veins, contain some free gold and on both some of the weathered surface material has been mined and sluiced and the gold recovered. These veins were not visited during 1954. They are reported to crop out high on the side of the mountain and apparently are in a crystalline rock with a granitic texture.

A few other gold-bearing veins have been prospected in adjacent areas. One of these crops out on the side of the mountain east of Reid Inlet at an altitude of about 700 feet. The vein is in highly shattered rock of sedimentary origin. The vein itself, at least on the surface, is also highly shattered. The shattering has affected all of the rock along the side of the mountain for several miles; it does not appear to be part of a major fault zone and the cause of the shattering is not known. Generally the vein is covered by slumped

debris from the shattered country rock and is difficult to find. Reportedly the vein continues along the side of the mountain for several thousand feet, and in places contains some gold. In one locality about due east of the Incas property, the vein is reported to contain some scheelite but apparently the amount of scheelite is too small to be of any economic importance.

Mr. Ibach found a small 1-inch vein of material he believes to be native arsenic in limestone which crops out on the eastern beach of Reid Inlet about due east of the Incas mine. A small specimen of this material was shown the writer and although the material was not identified it certainly contains considerable arsenic. Both the writer and Mr. Ibach searched for the vein during the summer of 1954 but could not find it. Mr. Ibach reported that at the time he found the vein it cropped out in the roof of a small wave-cut cavern in the limestone. Since that time, the outcrop has changed considerably and several of the caverns that existed in that area have collapsed. This may be the reason why the vein could not be found. It is also possible that the arsenic is soluble and has dissolved away since the time of discovery, which was shortly after the vein was uncovered by the recession of Reid Glacier.

Conclusion

The area between Reid Inlet and Lamplugh Glacier contains a large number, perhaps as many as several hundred, zones along which alteration of the wall rock, and gold mineralization have taken place. The rocks in the area are well exposed and probably most of the important veins

have already been discovered. The chief factor which has inhibited continued prospecting and mining in the area seems to be the small size and discontinuous character of the veins. In many of the prospects on which tunnels were driven to reach the ore at depth, the vein or altered zone when reached, was of considerably lower grade than was found on the surface. Probably several factors have been influential in bringing about the belief that the vein decreased in gold content downward from the surface. One factor is that the ore in the weathered zone has undergone an appreciable enrichment as the quartz and sulphides weathered away and the gold was concentrated on top of the underlying vein. This has given rise to some increase in assay values at the surface. The fact that less quartz is found in some of the tunnels underground than is found on the surface is probably attributable to the tendency of the veins to be lenticular in shape, both horizontally and vertically. There is no sound geologic reason for believing that the lenticular veins might not occur at any place along the altered fault zone below the surface as commonly as they do at the surface. Because the workings are limited in extent, they may have, by coincidence, passed under most of the quartz bodies that they were intended to intersect.

The system of veins at the Highland Chief claims appears to be the strongest and most promising of any found in the mapped area and may some day prove to be the focal point of mining activities. Their inaccessible location, both from the standpoint of their location within their area and their distance from timber and other inhabited areas where supplies can be obtained will be a strong factor deterring their development.

[illegible] MINERALIZED AREA NEAR [illegible]

The following notes are included [illegible] the attention of prospectors [illegible] mineralized area [illegible]. The mineralized area consists mainly of hydrothermally altered rock [illegible] was found [illegible] gold and silver. The mineralization was first discovered [illegible] and [illegible] prospect [illegible] in the area. During [illegible] body of [illegible] samples [illegible] show that [illegible] the hydrothermally altered rock [illegible] that in a few places [illegible] small amount of gold [illegible].

The rocks in the area include [illegible] sedimentary [illegible] Mesozoic age [illegible] hydrothermally altered rock [illegible] and sedimentary rocks of Mesozoic age.

In outcrop, the altered rock has a clay-like [illegible] and is commonly reddish-yellow. Generally [illegible] for this reason [illegible] found in stream banks or stream bottoms or in small gullies [illegible]. The material is [illegible] weak and where oversteepened [illegible] tends to form small landslides.

The main area of alteration is in the drainage basin of [illegible] and [illegible] headwaters of [illegible] Creek and McBride [illegible] similar

rock in the upper part of the Topsy Creek drainage.-/ The locations of those outcrops of hydrothermally altered rock known to the writer are shown on figure 7, but certainly many others are present in the same general area. Possibly hydrothermally altered rock extends beyond the area mentioned.

-/ Personal communication 1954

The results of the assays of samples of the altered rock are shown on figure 7. The highest assay value (0.24 oz. per ton) was from an outcrop on the south fork of Fall Creek. It is not known if the gold is free milling so its presence can be detected by panning. Gold recovered from the gravels of Mudslide Creek probably came from the altered zone at the head of the stream. If the altered rock contains free gold, the best way to prospect might be to pan samples from either the outcrops or from areas where streams have concentrated heavy minerals from the altered zones. The writer examined only a small fraction of the total number of altered zones exposed in the area south of Lituya Bay; careful prospecting might possibly disclose some material of economic grade.

REFERENCES CITED

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

Miller, D. J., 1951, Preliminary geologic map of Tertiary rocks in the southeastern part of the Lituya district, Alaska: Open-file Rept. One map and one sheet of correlated columnar sections.

Reed, J. C., 1938, Some mineral deposits of Glacier Bay and vicinity: Ec. Geol., v. 33, no. 1, p. 57-80.

Reed, J. C., and Dorr, J. V. N., 2d, 1942, Nickel deposits of Bohemia basin and vicinity, Yakobi Island, Alaska: U. S. Geol. Survey Bull. 931-F, p. 105-138.