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DEPARTMENT OF THE INTERIOR
Geological Survey
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ABSTRACT

Mineral deposits that contain copper, molybdenum, gold, silver, zinc, and iron are exposed near the head of the Nabesna River, on the north side of the Wrangell Mountains in interior Alaska. A mill site and eighteen patented claims covering the deposits are held by the Alaska Nabesna Corporation. Development work consists of open cuts, shafts, fourteen adits aggregating between 250 and 300 feet in length, and 19 diamond drill holes totaling 3,187 feet in length. More than 700 samples have been assayed or analyzed by the Alaska Nabesna Corporation, chiefly for copper, gold, and silver. The deposits were studied by the U. S. Geological Survey during the field seasons of 1942 and 1944 as part of the investigation of strategic minerals in Alaska.

The mineral deposits are near the contact of an intrusive mass of quartz diorite with greenstone, undifferentiated metamorphosed sedimentary rocks and lava flows, and metamorphosed limestone of Permian age. Dikes and irregular bodies of silicic rocks and andesite, dacite, and basalt porphyries cut these rocks.

The quartz diorite and the adjacent limestone have been mineralized with copper, molybdenum, gold, silver, and iron. The limestone has been mineralized also with zinc.

INTRODUCTION

The mineral deposits at Orange Hill are on the north side of the Wrangell Mountains in the Copper River region of Alaska. (See fig. 1.) Orange Hill is on the east side of the Nabesna River and less than half a mile below the foot of the Nabesna Glacier. The claims are about 12 miles south of the Nabesna airfield, which is near the terminus of the Nabesna Road or Abercrombie Trail, a branch of the Richardson Highway. This airfield is about 55 miles up the Nabesna River from the Northway airfield, which is connected with the new Alaska Military Highway by a short branch road.

The Nabesna River is not bridged but may be crossed by boat or on horse-back at some stages of water if appropriate crossings are selected. Travel over the highways is possible throughout most of the year, although parts of the Nabesna Road are subject to frequent washouts and landslides.

Orange Hill lies between Bond and Nikonda Creeks and is only a few hundred feet from the Nabesna River. The hill is roughly elliptical, and its rounded top rises about 600 feet above the terrace level of the river. The north and east boundaries of Orange Hill are marked by a prominent canyon, known as California Gulch. The west side is a bare slope rising abruptly above the river bars and is conspicuous for its yellowish-brown color. The top and southeast side are covered with vegetation which continues eastward across a swamp to a mountain more than 8,000 feet above sea level. Several alluvial fans border the swamp at the base of the mountain, and most of the small streams disappear in them. Although the creek in California Gulch, one of the few east of Orange Hill to reach the terraces of the Nabesna River, is subject to periods of drought and occasional floods, it provides drinking water throughout most of the summer.

An ample supply of spruce is available along the Nabesna River for building material, mine timber, and firewood. Grasses, pea vine, and other plants, which thrive on the low terraces bordering the river, and favorable climatic conditions permit the wintering of horses near Orange Hill.

Patented mining claims with an area of 360 acres and a mill site of 5 acres are held by the Alaska Nabesna Corporation, of which Mr. James C. Dulin, Jr., of Washington, D. C., is president. These claims cover most of the mineralized area. (See pl. 1.) The first two tiers of claims next to the Nabesna River include a large part of the mineralized quartz diorite. The upper claims to the east cover or are adjacent to altered limestone. One of two cabins near the mouth of California Gulch has been destroyed by the stream, and the other has been partly filled with gravel.

Development work by the Alaska Nabesna Corporation includes open cuts, shafts, adits, and diamond-drill holes. The positions of the shafts, adits, and drill holes are shown on plate 1. Most of the open cuts are caved or covered with slide rock. All of the shafts are caved. The combined length of 11 of the 14 adits is 256 feet. Some of these adits are now caved or blocked with ice. Adit E, which is also called the Lemon Tunnel and is located in the Lemon No. 2 claim, is the longest adit, having a length of 73 feet. A total of 19 diamond drill holes completed in 1927 and 1928 have an aggregate length of 3,187 feet. (See table 1.) Of this total, 1,166 feet was drilled in the metamorphosed limestone, and 2,021 feet, in the quartz diorite. More than 700 samples have been assayed or analyzed by the Alaska Nabesna Corporation, chiefly for copper, gold, and silver.

Adits 1 and 2 were driven before the development work by the Alaska Nabesna Corporation was undertaken in 1927 and are now caved. Adit 3, known also as the Sheep Tunnel, is in part a natural cave in the limestone.

Orange Hill is briefly described in five government reports. Mendenhall and Schrader 1/ describe the Monte Cristo diorite of the Orange Hill area, and mention the low copper and gold content of Orange Hill. Moffit and Knopf 2/ give the first description of the porphyry dikes at Orange Hill and report molybdenite in the innumerable quartz veins in the quartz diorite. Pilgrim 3/ describes the mineral deposits at Orange Hill as revealed in the adits, records a few assays and the logs of some of the diamond-drill cores, and briefly mentions the copper showings in the upper claims covering the metamorphosed limestone. Moffit and Wayland 4/ briefly describe the mineral deposits and adjacent rocks at Orange Hill and present a diagram of the mining claims of the Alaska Nabesna Corporation. In 1942 Van Alstine 5/ studied the mineral deposits chiefly in the quartz diorite, prepared a geologic sketch map, and summarized the available information about the tenor and reserves of copper, molybdenum, gold, and silver. Most of the prospects in the five claims covering the metamorphosed limestone were not examined, because their existence was not known at the time. It was stated in 1942 that further investigation was necessary before the commercial value of the material could be demonstrated.

1/ Mendenhall, W. C., and Schrader, F. C., The mineral resources of the Mount Wrangell district: U. S. Geol. Survey Prof. Paper 15, pp. 37-39, 43-45, 1903.

2/ Moffit, F. H., and Knopf, Adolph, Mineral resources of the Nabesna-White River district, Alaska: U. S. Geol. Survey Bull. 417, pp. 45, 58, 1910.

3/ Pilgrim, E.R., Alaska Nabesna Orange Hill copper claims: Report on cooperation between the Territory of Alaska and the United States in making mining investigations and in the inspection of mines for the biennium ending March 31, 1931, pp. 69-74, 1931.

4/ Moffit, F. H., and Wayland, R. G., Geology of the Nutzotin Mountains, Alaska, and gold deposits near Nabesna: U. S. Geol. Survey Bull. 933-B, pp. 103-199, 1943

5/ Van Alstine, R. E., Mineral deposits at Orange Hill, Alaska: U. S. Geol. Survey Preliminary report to war agencies, 1942.

During the field season of 1944 all prospects at Orange Hill were mapped and studied by the writers. A plane table and telescopic alidade were used in making a geologic and topographic map. (pl. 1.) Twenty-six channel samples of mineralized quartz-diorite, silicified alaskite granite, and quartz veins were collected and have been analyzed for copper, molybdenum, gold, and silver. Two channel samples of sphalerite-pyrrhotite-pyrite bodies were analyzed for zinc, copper, iron, gold, and silver. Hand specimens of the sulfide minerals and adjacent rocks were collected, and thin and polished sections were studied. Examination of the quartz diorite and the metamorphosed limestone with a "Mineralite" ultra-violet lamp to determine the presence of scheelite gave negative results. In a few places small quantities of powellite, a mineral composed of calcium molybdenum tungstate, and some calcite fluoresced under ultra-violet rays.

GEOLOGY

The oldest rocks in the vicinity of Orange Hill are thick basic lava flows or greenstone of Permian age. These rocks are overlain by a sequence of sedimentary rocks interbedded with flows of intermediate composition. In this sequence a bed of metamorphosed Permian limestone about 200 feet thick is overlain and underlain by hornfels. A boss of quartz diorite, probably of Jurassic age, forms Orange Hill and is highly altered and cut by innumerable quartz veins. Dikes of alaskite granite cut the quartz diorite and also the greenstone and other rocks east of the hill. Dikes of andesite porphyry and dacite porphyry intrude all of the rocks mentioned above. In the Lemon No. 3 claim, basalt porphyry dikes, possibly Tertiary in age, cut hornfels and Permian limestone. Irregular deposits of glacial till occur on Orange Hill, in the swampy flat to the east, and on the flanks of the adjacent mountains up to an altitude of about 3,850 feet, where they merge with talus accumulations.

Most of the greenstone and succeeding flows or sills are relatively unaltered and are not mineralized. In an exposure south of Orange Hill, however, the greenstone is phyllitic and is cut by many barren quartz veins. The interbedded hornfels at Orange Hill is completely recrystallized and locally grades into tactite zones in the metamorphosed limestone. The hornfels is unmineralized but for a few grains of disseminated pyrite, magnetite, and chalcopyrite and at some distance from Orange Hill grades into argillite.

Contact metamorphism of the limestone resulted in recrystallization and the formation of a marbleized and silicated limestone, or tactite, containing garnet, wollastonite, epidote, diopside, magnetite, hematite, pyrrhotite, pyrite, chalcopyrite, bornite, sphalerite, molybdenite, tetrahedrite, and gypsum. Garnet, the most abundant of these minerals, occurs as banded garnetite replacing the limestone along bedding and as disseminated grains or veinlets in the recrystallized limestone.

The limestone covered by the upper claims is recrystallized completely for as much as a mile from the quartz diorite and is almost devoid of bedding. Evidence from the metamorphosed limestone and from the overlying rocks shows that it trends generally northeast, and with local exceptions dips from 10° to 30° NW. The limestone is of variable thickness in the claims, because the tactite zones in many places grade into the overlying and underlying hornfels, or because intrusions of granitic rocks locally engulfed part of the limestone. The mass of limestone in the Lemon No. 2 claim is regarded as a down-faulted block of the limestone that lies above and to the east. The upper and lower contacts of this down-faulted block are not exposed, and were not found in the adit or in diamond drilling.

The quartz diorite that forms Orange Hill is part of the Monte Cristo granodiorite batholith described by Wayland 6/ and others, and crops out near Monte Cristo and Bond Creeks a few miles below the foot of the Nabesna Glacier. The quartz diorite facies of the batholith is composed largely of quartz, andesine feldspar, and hornblende. Some of the andesine is zoned about cores of labradorite. Augite forms cores in some of the hornblende crystals. Magnetite and biotite are common minerals of the quartz diorite; orthoclase, apatite, and sphene are rare.

The quartz diorite is highly fractured and extensively altered. Silicification is pronounced and takes the form of quartz grains, aggregates, and veins. In many places the feldspar of the quartz diorite is completely altered to sericite, calcite, and quartz, and the hornblende is altered to chlorite. Epidote, kaolin, and leucoxene are common. At Orange Hill the quartz diorite is mineralized with disseminated pyrite, chalcopyrite, and small quantities of molybdenite.

The silicic igneous rocks are chiefly alaskite granite and rhyolite porphyry. They occur as dikes and are commonly pink, but vary from white to red. The textures are fine-grained granitoid to pegmatitic and porphyritic. A study of thin sections under the microscope reveals that the silicic dikes range widely in composition but are composed essentially of quartz, orthoclase, perthite, albite, and oligoclase. Accessory minerals are apatite, muscovite, and in some places biotite. Secondary minerals are calcite, quartz, chlorite, epidote, limonite, and kaolin. Like the quartz diorite, these silicic rocks contain abundant quartz

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6/ Moffit, F. H., and Wayland, R. G., op. cit., 1943 grains, aggregates, and veins. They are mineralized locally with molybdenite, pyrite, chalcopyrite, and magnetite.

The andesite porphyry and dacite porphyry dikes consist chiefly of large white phenocrysts of andesine in a dense gray to brown groundmass composed mainly of plagioclase. The ferromagnesian minerals in some dikes are hornblende, and in others, biotite. Magnetite is a common accessory mineral; apatite is rare. Many of the dikes are altered and contain much chlorite, calcite, epidote, pyrite, limonite, and kaolin. In hand specimens the dacite porphyries are indistinguishable from the andesite porphyries, because the small quantity of quartz in the dacite porphyries is not visible without a microscope. Both of these porphyries cut the mineralized quartz diorite and limestone and were intruded after the mineralization.

Flows of andesite porphyry are exposed at the southwest corner of the Glacier claim. The basal unit of the flows is from 5 to 12 feet thick and is composed of biotite andesite porphyry. It contains numerous inclusions of quartz diorite and rests unconformably upon the weathered crumbly quartz diorite. A flow of hornblende andesite porphyry about 25 feet thich lies above the biotite andesite porphyry. Flow lines in both lava flows are parallel to the contact with the underlying quartz diorite. These andesite porphyry flows are relatively unaltered and are unmineralized.

Basalt porphyry dikes in the Copper King North Extension No. 1 claim near F, G, and H workings closely resemble overlying flows of basalt. The dikes contain dark green to black phenocrysts of hornblende and white phenocrysts of labradorite, and are slightly altered and locally cut by veinlets of sulfide minerals.

MINERAL DEPOSITS

The mineral deposits near Orange Hill are confined almost entirely to the quartz diorite, associated silicic dikes, and the adjacent limestone.

Deposits in the quartz diorite

The mineral deposits in the quartz diorite contain copper, molybdenum, gold, and silver. Copper occurs as chalcopyrite in disseminated grains and in veinlets with quartz, calcite, gypsum, pyrite, and molybdenite. Molybdenite, in addition to being present with the other minerals in the innumerable quartz veinlets, also occurs in the quartz diorite as disseminated grains and as thin films on joint faces and slickensided surfaces. Polished sections of some quartz specimens show that the bluish-gray color and shadowy banding is caused by extremely fine molybdenite flakes scattered irregularly through the quartz or arranged in parallel seams. The gold and silver detected in the assays are probably associated with the sulfide minerals.

The sulfide minerals in the quartz veinlets and disseminated in the quartz diorite, arranged in decreasing order of abundance and in relative times of formation, beginning with the oldest, are pyrite, chalcopyrite, and molybdenite. Study with the microscope shows that some of the chalcopyrite contains grains of tetrahedrite and sphalerite. The gangue minerals are quartz, feldspar, hornblende, biotite, magnetite, chlorite, sericite, calcite, kaolin, and limonite. In the veinlets cutting the quartz diorite, the gangue minerals are quartz, gypsum, and calcite. The gypsum occurs as a soft, white, fine-grained material and as large plates of selenite as much as 2 inches along an edge. Some of the gypsum was formed later than the molybdenite and some was apparently contemporaneous with it. Molybdite, an earthy canary-yellow oxidation product containing about 40 per cent of molybdenum, forms thin coatings on some of the molybdenite. Films of chrysocolla, malachite, and azurite coat the faces of fractures in many places.

Two prominent systems of molybdenite-bearing quartz veins transect the quartz diorite at Orange Hill. In one system the veins strike N. 5°-30° W. and dip steeply eastward. In the second, the veins strike nearly east and dip steeply northward. The vein systems are exposed especially well in California Gulch and along the west face of Orange Hill.

A typical quartz-molybdenite vein is exposed for 20 feet from a point 17 feet above Adit A in the Nabesna claim. The vein, which strikes N. 5° W. and dips 75° E., consists of three layers. The east layer is 1 to 2 inches thick and is composed of gray quartz with a little pyrite and molybdenite. The central band is 1½ to 3 inches thick and is composed of gypsum, pyrite, and a little quartz. The west band is 4 to 6 inches thick and consists of a gouge of quartz, gypsum, and limonite. The quartz of this band contains a little molybdenite, pyrite, and chalcopyrite. (See table 2, sample 21.) Abundant pyrite and chalcopyrite are exposed in the shattered quartz diorite along the west wall of the vein. Gypsum and greenish alum coat fractures in the country rock.

The six adits in the quartz diorite were driven where azurite and malachite staining, disseminated chalcopyrite, or chalcopyrite veinlets were especially conspicuous. Adit A in the western part of the Nabesna claim was driven S. 48° E. for 52 feet in highly shattered and altered quartz diorite. The adit is inaccessible and almost entirely filled with ice.

Adit B in the western part of the Glacier claim was driven N. 88° E. for 16 feet in jointed and altered quartz diorite. Small quantities of pyrite and chalcopyrite are disseminated in the quartz diorite and in the numerous quartz veins that transect this rock. A few flakes of molybdenite are scattered through the quartz veins. Numerous joint faces are coated with films of gypsum, limonite, and malachite.

In the western part of the California claim, Adit C, now caved, was driven S. 52° E. for 20 feet in weathered and highly altered quartz diorite. The quartz diorite is cut by many quartz veins and is mineralized with a little disseminated pyrite and chalcopyrite and tiny veinlets of pyrite and chalcopyrite. Malachite and gypsum coat fractures in the adit.

In the southeastern part of the California claim, Adit D, which is now caved, was driven S. 16° E. for 10 feet in altered quartz diorite stained with limonite. The quartz diorite and the numerous quartz veins are sparsely mineralized with disseminated pyrite, chalcopyrite, and molybdenite.

In California Gulch near the center of the Camp Bird claim, Adit 1 was driven S. 47° W. for an unknown distance in altered quartz diorite. The adit is now caved but was driven in a fracture zone stained with limonite and malchite.

On the west side of California Gulch and near the center of the California claim, Adit 2, which is also caved, was driven S. 88° W. for about 12 feet in highly altered quartz diorite stained with limonite and mineralized with a little pyrite, chalcopyrite, and molybdenite.

Diamond-drilling of the quartz diorite revealed mineralized rock similar to that exposed in the outcrops and adits. The rock is so highly altered and transected by veinlets, joints, and slickensided surfaces that pieces of quartz diorite core more than 6 inches long were rarely recovered from the drill holes, whereas sections of core of the younger andesite and dacite porphyry, more than a foot long, are common.

Outcrops, adits, and diamond-drilling indicate the absence of any body of oxidized copper ore. Any extensive zones of oxides or secondary sulfides that may have existed in the quartz diorite probably were removed when the Nabesna Glacier rode over Orange Hill. A short distance below the surface of the ground, the temperature of the rock probably has not been above freezing since glacial times, and supergene solutions have had little chance to migrate through the rock and alter the original mineral deposits.

Deposits in the silicic rocks

The deposits in the silicic igneous rocks are similar to those in the older quartz diorite. The mineralization was confined chiefly to the large dike of alaskite granite that crops out at the head of California Gulch. This dike extends southward along the east side of Orange Hill. The deposits of highest grade are exposed at the head of California Gulch, where silicification and accompanying copper, molybdenum, gold, and silver mineralization acted upon the quartz diorite and the alaskite granite.

On the south end of Orange Hill a dacite porphyry dike contains numerous quartz veins bearing pyrite, a little chalcopyrite, but no molybdenite. In alaskite near the greenstone exposed between the two small lakes southeast of Orange Hill, quartz veins contain small quantities of molybdenite. In the upper claims, most quartz veins in the silicic igneous rocks are barren. A little molybdenite was found in one vein.

Deposits in the metamorphosed limestone

The deposits in the metamorphosed limestone are of several types that in general may be classified as contact metamorphic deposits. The sulfide mineral deposits are confined largely to the downfaulted block of limestone in the Lemon No. 2 claim and to the northern part of the main mass of metamorphosed limestone in the Lemon No. 3 and Copper King North Extension No. 1 claims. The three southernmost claims, Copper King, North Star, and North Star East Extension No. 1, are almost barren of ore minerals. In these three claims the upper part of the limestone is metamorphosed to a garnet rock which contains a little gypsum. The rest of the limestone is altered to tactite containing abundant gypsum. The gypsum occurs as veins of very fine crystals and coarse selenite plates, and in the garnet rock as interstitial grains replacing calcite. The tactite and underlying hornfels are cut by many quartz veins, which are more abundant adjacent to the granitic intrusive. Some pink feldspar is associated with the quartz. A few small stringers of bornite and magnetite cut the tactite.

The deposits in the downfaulted block of limestone in the Lemon No. 2 claim contain magnetite, pyrrhotite, pyrite chalcopyrite, sphalerite, and molybdenite, arranged in decreasing order of abundance. Chalcopyrite occurs as veinlets with pyrite, and as disseminated grains in garnetite and magnetite rock. Sphalerite, in general, is scarce and had not been reported from Orange Hill before 1942. One foot of core from a drill hole near Adit E is estimated to contain 90 per cent of sphalerite and 5 per cent each of chalcopyrite and pyrite. A quartz vein bearing a little molybdenite cuts the garnet-magnetite rock above the portal of

Adit E. Garnet and wollastonite are common minerals in the metamorphosed limestone.

Adit E, or the Lemon tunnel, trends S. 56° E. for 25 feet, S. 71° E. for 18 feet, and S. 76° E. for 30 feet to the face. Weathering of the sulfide bodies produced considerable limonite, which stains the rock near the adit a deep yellowish brown. An examination of the walls of the adit, beginning at the portal, gave the following sequence:

feet	
0 -20	garnet rock with very small quantities of chalcopyrite and pyrite
20-33	magnetite rock with pyrrhotite, pyrite, chalcopyrite, and scarce bands of garnet
33-61	alternating magnetite rock with abundant sulfide minerals and garnet rock containing small quantities of sulfide minerals
61-67	fault zone of barren rock, composed chiefly of limonite, garnet, and epidote
67-73	magnetite rock containing pyrrhotite, pyrite, and chalcopyrite

The Alaska Nabesna Corporation completed several diamond-drill holes, totaling 684 feet, near this adit. In one place it was proved that the metamorphosed limestone continues to a depth of at least 102 feet below the portal. An open cut about 50 feet above the portal exposes similarly metamorphosed limestone with abundant magnetite, pyrrhotite, pyrite, and chalcopyrite. Unmineralized hornfels and a sill of rhyolite porphyry are exposed a few feet northwest of Adit E.

The part of the main mass of limestone near Adits F, G, and H is extensively metamorphosed and mineralized with magnetite and sulfide minerals. Several basalt porphyry dikes as much as 70 feet wide, which cut the altered limestone and underlying hornfels, are cut by veins of sulfide minerals. In some places the recrystallized limestone contains irregular veins and patches of garnet and epidote. The outcrops are stained with abundant limonite and coated with alum and gypsum.

Adit F was cut for 5 feet in the northern part of a sulfide-magnetite body east of the body at Adit G. On the surface the sulfide body is about 30 feet long, 8 feet thick at the north end, 4 feet thick at the south end, and about 3 feet thick in the center. The ore body replaces recrystallized limestone and is underlain by tactite. The eastern extent of the ore is not known. The ore body is composed chiefly of pyrite, lesser quantities of magnetite and sphalerite, and a little chalcopyrite. The chalcopyrite occurs as microscopic blebs and veinlets in sphalerite, which cuts the pyrite. The presence of sphalerite at Adits F and G was first detected in 1944.

Adit G was driven for 10 feet in the southwestern part of a lenticular body of sulfide minerals and magnetite, which replaced the limestone near the contact with the underlying hornfels. The lens has a maximum thickness of 15 feet on the surface and extends up the slope for 30 feet. The base of the deposit is covered by talus that in places is cemented with limonite. The ore body is composed of pyrrhotite, sphalerite, pyrite, chalcopyrite, and magnetite, arranged in decreasing order of abundance. Most of the pyrite is earlier than the other sulfide minerals, but a few pyrite veinlets transect all other minerals. Large grains of pyrrhotite and sphalerite are intergrown, and many microscopic inclusions of pyrrhotite occur as blebs in the sphalerite. Study with a microscope shows that chalcopyrite occurs in the sphalerite as rods oriented along cleavage planes and as veinlets and irregular blebs. About 8 feet southwest of Adit G a fine-grained offshoot from a large dike of basalt porphyry forms a dike one foot thick and cuts the recrystallized limestone. This narrow dike is cut by tiny veins bearing pyrite, chalcopyrite, and sphalerite.

Near Adit H the altered limestone contains several veinlets of magnetite with a little pyrite and chalcopyrite. The veinlets cut the bedding and locally spread out along the bedding planes for a few feet. Adit H was started on a vein of magnetite from 4 to 15 inches thick that parallels the banding in garnet-epidote rock near the base of the altered limestone. Study with a microscope shows that platy magnetite cuts pyrite and is intergrown with chalcopyrite and cut by it.

Adit I in the Copper King North Extension No. 1 claim extends N. 80° E. for 20 feet in garnet rock and marble, about 10 feet above the contact with hornfels. Sulfide mineralization in the adit and near it was apparently confined to very small grains and veinlets of chalcopyrite. Stains of azurite and malachite are conspicuous but not abundant.

Adit J in the Copper King North Extension No. 1 trends N. 50° E. for 20 feet in marble and garnet rock. Pink fibrous wollastonite is common in the marble. In the northwest wall of the adit and about a foot from the face, a vein of bornite, chalcocite, and chalcopyrite strikes N. 10° E. and dips 30° W. The vein is irregular and ranges in thickness from 1 to 5 inches. About 10 feet from the face of the adit and in the southeast wall, an irregular vein of bornite from 2 to 4 inches thick cuts the marble.

The vein trends approximately N. 35° E. and dips steeply northwest. Some of the irregular patches of garnet rock in the adit contain specks and small patches of molybdenite and tiny grains of chalcopyrite.

An open cut 50 feet long extends southwest from Adit J. The cut is chiefly in garnet rock that contains tiny grains and veinlets of bornite near the portal of the adit and a few grains of chalcopyrite farther from the portal. A few patches of molybdenite less than half an inch in diameter are in the cut about 10 feet from the portal. According to data supplied by the Alaska Nabesna Corporation, samples from the 50-foot cut assayed 8 percent of copper.

Scattered flakes of molybdenite occur in garnetite about 150 feet northwest of Adit J in the southeastern part of the Copper King North Extension No. 1 claim. The molybdenite occurs between grains of garnet and cuts them in a garnetite band $1\frac{1}{2}$ to 4 feet thick.

Adit K in the southeastern part of Copper King North Extension No. 1 claim was driven S. 40° E. for 25 feet in recrystallized limestone. In the adit some garnet rock in the limestone contains small bunches and disseminated grains of bornite. Two irregular bunches of bornite and a little chalcocite, 2 to 3 inches thick, are exposed along the southwest side at sites 1 and 2 feet from the portal.

RESERVES

The Alaska Nabesna Corporation has made available the results of several hundred assays of samples from outcrops, open cuts, adits, and drill cores. A large part of the sampling and assaying for copper, gold, and silver was done by H. V. Redmond and Carlyle Weiss, assayer-engineers for the Alaska Nabesna Corporation. Some sampling was done by Robert H. Sayre, consulting mining engineer, and the results of assays of the samples were incorporated in a report to the Corporation. Many other assays are available in the published literature. The assays of samples collected by the writers are presented in table 2.

The quartz diorite along the west face of Orange Hill, from Adit C southward to Adit B, has been sampled by Redmond, at intervals of approximately 50 feet. The assays of these samples are incorporated in table 3 and may be compared in table 2 with those of samples 2 to 12, collected by the writers. The average copper content of 42 samples (see table 3) collected along the west face of Orange Hill, as sampled by Redmond, is 0.25 percent of copper. Chip samples 2 to 12, collected by the writers, contain on the average 0.2 percent of copper and 0.036 percent of molybdenum. Samples 1, 2, and 3 (see table 2) suggest that the content of copper decreases southward. Diamond drill holes 1, 2, 3, 8, and 19 along the west face of Orange Hill aggregate 1,123 feet, of which a total of 835 feet has been assayed by Redmond or Weiss. (See table 1.) Assuming each weighted average percentage of copper to be representative of each drill core, the weighted average for the five holes is 0.24 percent of copper. Drill hole 7 has an unusually low content of copper and was not included in the composite percentage of copper. An 8-foot channel sample along both sides of Adit B, collected by Sayre, has 0.55 percent of copper, 0.02 ounces of gold to the ton, 0.10 ounces of silver to the ton, and no molybdenum. Three channel samples taken by Redmond along the walls of Adit B contain 0.2, 0.3, and 0.6 percent of copper. The dump of Adit A was sampled by Sayre and contains 0.50 percent of copper, 0.04 ounces of gold to the ton, 0.06 ounces of silver to the ton, and no molybdenum. The face of Adit C as sampled and assayed by Weiss contains 0.77 percent of copper. A 6-foot channel sample by Redmond along the north side of Adit C and 12 feet from the portal contains 0.7 percent of copper. Mendenhall and Schrader 7/ report that samples from the upper west face of Orange Hill contain 0.02 ounces of gold to the ton.

Six channel samples of quartz diorite collected and assayed by Redmond from Adit 1 in the north end of California Gulch and from surface outcrops near the adit each contain 0.2 percent of copper. Redmond also sampled the surface outcrops in California Gulch from diamond-drill hole No. 4 and No. 5 (see table 4) and obtained an average copper content of 0.05 percent for 21 channel samples. Samples 14 through 20 (see table 2) collected from California Gulch by the writers have an average of 0.16 percent of copper and 0.027 percent of molybdenum. Diamond-drill hole No. 5, driven eastward in California Gulch, is barren of copper, gold, and silver values beyond 7 feet. Diamond-drill holes Nos. 4 and 6, driven westward in California Gulch, aggregate 655 feet and have a weighted average of 0.24 percent of copper. A composite sample made in 1942 on miscellaneous drill cores of quartz diorite with disseminated pyrite and chalcopyrite contains 0.69 percent of copper, 0.002 ounces of gold to the ton, and no silver (S. H. Cress, analyst, U. S. Geol. Survey). A trench 12 feet long was cut at a place above Adit C and on the slope toward California Gulch. A channel sample collected from this trench by Sayre contains 0.35 percent of copper, 0.01 ounces of gold to the ton, a trace of silver, and no molybdenum. A dozen samples or specimens of molybdenite-bearing quartz veins in the quartz diorite were

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7/ Mendenhall, W. C., and Schrader, F. C., op. cit., p. 44.

analyzed by the Alaska Nabesna Corporation, and showed a molybdenum content ranging from a maximum of 0.08 percent to none. A specimen taken from one of the quartz veins in California Gulch in 1942 was analyzed by the Geological Survey (S. H. Cress, analyst) and contains 0.67 percent of molybdenum, 0.1 ounces of silver to the ton, and a trace of gold. This molybdenum content is believed to indicate the grade of the quartz veins containing conspicuous molybdenite. A composite sample made in 1942 from miscellaneous drill cores of the quartz diorite with disseminated pyrite, chalcopyrite, and molybdenite contains 0.11 percent of molybdenum, 0.31 percent of copper, and no gold or silver (S. H. Cress, analyst, U. S. Geol. Survey). Six samples of material from drill holes and channel samples in the quartz diorite were submitted in 1943 to the Geological Survey by the owners of the property. These samples contain molybdenum ranging from 0.036 percent to none (Cyrus Feldman, analyst, U. S. Geol. Survey). North of Adit D, a thin vein sampled by Sayre assayed 0.10 percent of copper, 0.04 ounces of gold to the ton, 0.14 ounces of silver to the ton, and no molybdenum. At Adit D, a 6-inch channel sample collected by Sayre from a quartz vein contains 0.20 percent of copper, 0.02 ounces of gold to the ton, and 0.14 ounces of silver to the ton. Part of this sample was submitted to the Geological Survey and was found to contain 0.036 percent of molybdenum (Cyrus Feldman, analyst, U. S. Geol. Survey).

From a consideration of the preceding assay data the area of quartz diorite showing the most extensive copper and molybdenum mineralization, as outlined on plate 1, contains about 0.2 percent of copper and 0.03 percent of molybdenum. According to Mr. James C. Dulin, Jr., president of the Alaska Nabesna Corp., a check of the copper values determined by Redmond was made by two independent sources upon a quartered fraction of some of the original samples, and it was found that Redmond's assay values for copper are about 50 percent too low. The additional assay data indicate that the copper content is about 0.3 percent. Gold and silver assays made at various times on the mineralized quartz diorite range from 0.0 to 0.04 ounces of gold and from 0.0 to 0.18 ounces of silver to the ton. The average tenor of these metals in the outlined area is considered to be less than 0.01 ounces of gold and 0.01 ounces of silver to the ton. North and south of this area the quartz diorite apparently contains only traces of copper. The gravels of the Nabesna Valley mark the west edge of the outlined area, and alaskite granite and swampy ground with a light covering of vegetation limit it on the east.

The volume of material within the outlined area above an altitude of about 3,250 feet was calculated by drawing vertical profiles at intervals of 300 feet, measuring the area of each profile, and then applying Simpson's rule for volumes. The volume thus obtained is about 1,100,000,000 cubic feet. The quantity of overburden is negligible in almost all this area, so that no account is taken of it in the calculation As one ton of quartz diorite has a volume of about 11 cubic feet, the weight of rock for the calculated volume amounts to 100,000,000 tons. Every additional 10 feet of depth below the 3,250-foot contour in the outlined area adds 3,465,900 tons to the tonnage given above. No observations were made which indicate that the tenor of metals will change within a short distance below the 3,250-foot level.

Metalliferous deposits in the silicic igneous rocks are confined apparently to the large alaskite granite dike that extends along the east side of Orange Hill. Exposures containing conspicuous molybdenite and chalcopyrite are most abundant in the section of the dike at the head of California Gulch. On the flat above Adit D, Sayre collected a 40-foot trench sample from the alaskite, which contains 0.02 ounces of gold to the ton, a trace of silver, a trace of copper, and no molybdenum. Samples 23, 24, and 25, collected near the head of California Gulch contain an average of 0.017 percent of copper, 0.033 percent of molybdenum, and no gold or silver (see table 2). Sample 26, taken near the south end of Orange Hill contains 0.06 percent of copper, 0.04 ounces of gold to the ton, 0.04 ounces of silver to the ton, and 0.02 percent of molybdenum. The extent and tenor of the mineralization in the silicic igneous rocks are not known.

The known reserves in the metamorphosed limestone consist of several small irregular bodies of copper, gold, and silver, and two bodies of unknown size which contain zinc in addition to these metals. These reserves are smaller than the reserves in the quartz diorite, although in the limestone, small pockets of bornite and chalcopyrite commonly have a higher content of copper, gold, and silver than the average of the mineralized quartz diorite. As far as is known, the reserves of copper in the limestone are limited to the down-faulted block in the Lemon No. 2 claim; to the limestone in the vicinity of Adit J in the Copper King North Extension No. 1 claim; and with zinc sulfide to the limestone in the vicinity of Adits F and G in the Lemon No. 3 claim. Tactite zones in the metamorphosed limestone were examined with the aid of ultra-violet rays from a "Mineralite" lamp, but no scheelite was found.

As blocked out by diamond drilling, the reserves of copper ore in the down-faulted block of limestone in the Lemon No. 2 claim are less than 2,000 tons. Assays of 375 feet of core from drill holes 9, 10, 11, 16, 17, and 18, in the vicinity of the adit, indicate a weighted average of 0.495 percent of copper. (See table 1.) The assays of 12 channel samples taken by Redmond from along the walls of Adit E are given in table 5, and are considered to indicate minimum values. The weighted average content of copper and iron in these samples is 0.49 percent and 24.1 percent, respectively. The results of assays of channel samples taken by

Sayre from along the walls of the adit indicate a weighted average of 0.71 percent of copper, 0.024 ounces of gold to the ton, 0.66 ounces of silver to the ton, and no tungsten or molybdenum.

Less than 1,000 tons of copper and zinc ore is exposed in the sulfide bodies in the metamorphosed limestone at Adits F and G, although the actual reserves are not known. The outcrops of ore are on nearly vertical cliffs, no drilling of the deposits has been done, and Adits F and G together aggregate only 15 feet in length. Samples from the walls of Adit F, collected and assayed by Weiss, contain 0.37 percent of copper. Picked samples taken in Adit F by Sayre contain 4.10 percent of copper, 0.02 ounces of gold, 0.20 ounces of silver, and no tungsten or molybdenum. An 8-foot channel sample taken in 1944 by the Geological Survey and cut vertically across the ore body at Adit F contains 38.84 percent of iron, 0.32 percent of copper, 6.12 percent of zinc, 0.08 ounces of gold to the ton, and a trace of silver (see table 2, sample 27). Samples from the walls of Adit G, collected and assayed by Weiss, contain 0.44 percent of copper. Picked samples taken in Adit G by Sayre contain 0.7 percent of copper, 0.04 ounces of gold to the ton, 0.15 ounces of silver to the ton, and no molybdenum or tungsten. A 7-foot channel sample cut in 1944 vertically across the ore body at Adit G contains 38.32 percent of iron, 0.18 percent of copper, 9.13 percent of zinc, and a trace of gold and silver (see table 2, sample 28).

An 8-foot channel sample was taken by Sayre from Adit I in the limestone and found to contain 0.60 percent of copper, 0.01 ounces of gold to the ton, 0.09 ounces of silver to the ton, and no tungsten or molybdenum.

The reserves of copper in the vicinity of Adit J in the limestone are probably small and of relatively low grade. Drill holes 12, 13, 14, and 15 aggregate 482 feet in length, but drill logs were kept only of holes 14 and 15, which aggregate 121 feet (see table 1). In Adit J an 8-foot channel sample by Sayre assayed 1.55 percent of copper, 0.04 ounces of gold to the ton, 0.26 ounces of silver to the ton, and no tungsten or molybdenum. The outcrop south of Adit J as sampled and assayed by Weiss, for 50 feet contains 8.0 percent of copper, 2.10 ounces of silver to the ton, and 0.24 ounces of gold to the ton. A 15-foot channel sample taken by Sayre near the portal contains 0.55 percent of copper, 0.06 ounces of gold to the ton, 0.44 ounces of silver to the ton, and no tungsten or molybdenum.

Table 1. Summary of drill-

Hole No.	Claim	Chief type of rock	True bearing	Dip angle	Length in ft.	Percent of core recovered	Ft. of core assayed	Weighted avg. % of copper
1	Glacier	quartz diorite	S.80°E.	-3°35'	175	83.0	63	0.22
2	Glacier	"	S.80°E.	-57°	110	52.0	79	0.20
3	Nabesna	"	S.41°E.	-44°10'	237	70.0	170	0.31
4	Camp Bird	"	N.75°W.	-44°35'	241	71.5	172	0.27
5	California	"	S.85°E.	-21°35'	151	68.3	103	trace
6	Camp Bird	"	N.86°W.	-1°15'	414	73.0	302	0.22
7	California	"	S.44°E.	-7°55'	92	78.0	72	0.08
8	Nabesna	"	N.88°E.	-16°30'	391	53.5	311	0.18
9	Lemon No. 2	lime-stone	S.88°E.	-26°35'	128	78.0	68	0.11
10	"	"	S.72°E.	-11°30'	112	---	88	0.10
11	"	"	S.81°E.	-33°	188	---	72	1.23
12	Copper King N. Ext. No. 1	"	S.61°E.	-60°	65	---	---	*
13	"	"	S.61°E.	-12°	296	---	---	*
14	"	"	N.69°E.	+5°	93	---	83	1.47
15	"	"	S.81°E.	+8°	28	---	28	1.62
16	Lemon No. 2	"	N.29°E.	-40°	135	---	30	0.22
17	"	"	S.47°E.	-40°	61	---	57	0.25
18	"	"	S.24°E.	-44°	60	---	60	1.00
19	Orange Hill	quartz diorite	S.79°E.	-41°	210	---	210	0.30

*See remarks for each drill-hole.

hole data, Orange Hill, Alaska.

Max. range of copper percentage	Oz. of gold per T.	Oz. of silver per T.	Copper Assayer	Percent of molybdenum analyses by U.S.G.S.	Remarks
0.1-0.4	0.01*	0.02*	Redmond	0.0 from 124-133 ft.	weighted average of all core assayed.
0.1-0.4	0.01*	0.02*	"	0.013 from 102-110 ft.	weighted average of all core assayed.
trace-0.6	0.01*	0.06*	"	---	avg. value of drill sludge.
0.0-0.5	0.004*	0.03*	"	---	avg. value of drill sludge.
0.0-0.2	---	---	"	---	0-7 ft. of core has 0.2% of copper; rest of hole is barren.
0.12-0.60	0.005*	0.055*	"	---	assay of a composite sample of all core.
0.0-0.6	---	---	"	---	first 20 ft. in talus and not assayed.
0.0-0.70	0.001*	0.044*	"	---	assay of composite sample of all core.
0.0-0.87	0.11*	0.02*	"	---	avg. of two assays.
0.0-0.72	0.025*	0.1*	"	---	avg. of two assays.
0.3-3.8	0.037*	0.89*	Weiss	0.0-composite sample of core.	three assays totaling 20.5 ft. of core. Composite sample of core - 0.95% of copper.
---	---	---	"	---	avg. of core as received, 0.18% of copper.
trace-0.8	---	---	"	0.0 composite sample of core.	avg. of core as received, 0.27% of copper.
0.0-9.5	0.067*	0.516*	"	0.01 from 84-88 ft.	weighted avg. of five assays totaling 15 ft. of core.
0.51-4.25	0.16*	2.00*	"	---	one assay of 6½ ft. of core.
trace-1.3	0.02	0.80*	"	---	one assay of 5 ft. of core.
0.0-1.0	0.02*	0.40*	"	---	one assay of 10 ft. of core.
trace-6.2	0.04*	1.60*	"	---	one assay of 10 ft. of core.
0.06-0.84	0.02*	trace*	"	0.025 from 160-175 ft.	composite sample of all core.

Table 2. Assays of samples collected in 1944 by the U. S. Geological Survey, Orange Hill, Alaska

The sample localities are shown on plate 1. Each sample of the quartz diorite and silicified alaskite is a chip sample totaling at least 10 pounds in weight, and was taken over a circular area with a radius of at least 5 feet.

Ref. No.	Description	Assays by S. H. Cress, analyst, U. S. Geological Survey. Percent of Cu	Au (oz./ton)	Ag (oz./ton)	Percent of Mo
1	Very dark fine-grained diorite, highly weathered, seamed with many apparently barren quartz veins. The quartz diorite is mineralized with a little disseminated pyrite and less chalcopyrite. A few veinlets of magnetite cut the quartz diorite. Limonite and gypsum coat fractures.	0.02	none	none	trace*
2	Very fine-grained silicified quartz diorite, relatively unweathered, cut by many quartz veins as much as 2 feet wide, which carry a little pyrite and chalcopyrite. Very small quantities of pyrite and chalcopyrite are disseminated in the quartz diorite. Several small faults contain 1 to 3 inches of gouge, stained with limonite and gypsum.	0.10	none	none	0.01
3	Altered fine-grained quartz diorite stained with limonite and cut by veins of magnetite and quartz. Pyrite is disseminated and forms veinlets in the quartz diorite.	0.17	none	none	trace*
4	Weathered medium-grained quartz diorite stained with limonite, alum, gypsum, malachite, and azurite. Many small quartz veins bearing some pyrite, chalcopyrite, and traces of molybdenite. Pyrite and chalcopyrite form veinlets and are disseminated in the quartz diorite.	0.21	none	none	0.03

Ref. No.	Description	Percent of Cu	Au (oz. ton)	Ag (oz. ton)	Percent of Mo
5	Relatively unaltered quartz diorite stained with limonite and malachite. Pyrite and chalcopyrite are disseminated and form tiny veinlets in the quartz diorite. A few quartz veins as much as $\frac{1}{4}$ inch in thickness carry traces of molybdenite, and stains of malachite are common in the vicinity of this site.	0.26	none	none	0.05
6	Weathered quartz diorite coated with gypsum. Pyrite and chalcopyrite are disseminated and form veinlets in the quartz diorite. Quartz veins are numerous but only a few carry molybdenite.	0.38	none	none	0.03
7	Altered quartz diorite with disseminated pyrite and chalcopyrite, a few small veinlets of pyrite and chalcopyrite, and one small quartz vein bearing molybdenite. Malachite stains the surface of fractures.	0.07	none	none	0.04
8	Weathered quartz diorite coated with much limonite and a little gypsum. Disseminated pyrite and chalcopyrite in the quartz diorite are common; veinlets of pyrite and chalcopyrite are rare. A few small veins of quartz bear molybdenite.	0.27	none	none	0.04
9	Altered quartz diorite with disseminated pyrite and chalcopyrite and tiny veinlets of pyrite and chalcopyrite. Quartz veins bearing molybdenite are rare. Malachite stains the rock in places.	none	none	none	0.06
10	Weathered quartz diorite stained with limonite. Several veinlets of pyrite and chalcopyrite, a few veins of quartz bearing molybdenite, and a little disseminated pyrite and chalcopyrite occur in the quartz diorite.	0.21	none	none	0.03

Ref. No.	Description	Percent of Cu	Au (oz., ton)	Ag (oz. ton)	Percent of Mo
11	Highly altered and weathered quartz diorite stained with limonite and very little malachite. A few veinlets of quartz carry pyrite, chalcopyrite, and molybdenite. Small quantities of pyrite and chalcopyrite are disseminated in the quartz diorite.	0.15	none	none	0.03
12	Highly altered and weathered quartz diorite stained with limonite and malachite. Disseminated pyrite, chalcopyrite and molybdenite and tiny veinlets of pyrite and chalcopyrite occur in the quartz diorite. The quartz veins are barren.	0.35	trace*	trace*	0.08
13	Highly altered and deeply weathered quartz diorite stained with limonite. Pyrite and traces of chalcopyrite and molybdenite are disseminated in the quartz diorite.	0.03	trace*	trace*	0.03
14	Highly altered and weathered quartz diorite stained with limonite and a little malachite and azurite. Some pyrite and chalcopyrite are disseminated in the quartz diorite. Sample taken 5 feet above Adit 1.	0.32	none	none	0.09
15	Relatively unaltered quartz diorite cut by numerous quartz veins and stained slightly with malachite.	0.25	none	none	0.03
16	Altered quartz diorite cut by numerous quartz veins and mineralized with small quantities of pyrite and chalcopyrite.	0.14	none	none	0.01
17	Relatively unaltered quartz diorite cut by numerous quartz veins. both with a little pyrite. Stains of malachite are rare.	0.08	none	none	0.01

Ref. No.	Description	Percent of Cu	Au (oz. ton)	Ag (oz. ton)	Percent of Mo
18	Altered quartz diorite stained with limonite and cut by numerous quartz veins bearing pyrite and molybdenite. Part of the sample was cut on a quartz vein, 2 to 3 feet thick, that carries pyrite and a little chalcopyrite and molybdenite.	0.13	none	none	0.01
19	Altered quartz diorite stained with considerable limonite, and cut by a few quartz veins carrying pyrite and a little molybdenite.	0.14	none	none	0.01
20	Altered quartz diorite with much hornblende, cut by numerous quartz veins containing pyrite, chalcopyrite, and molybdenite.	0.09	none	none	0.03
21	Channel sample across a quartz-molybdenite vein in altered quartz diorite. For a description of the vein see p. 7.	0.20	none	none	0.17
22	Channel sample across a $2\frac{1}{2}$-foot quartz vein in the altered quartz diorite. The vein carries considerable pyrite and some molybdenite. Several other similar veins occur in the vicinity.	0.02	none	none	0.03
23	Silicified alaskite mineralized with pyrite, chalcopyrite, and molybdenite and stained with limonite and a little manganese.	0.01	none	none	0.03
24	Silicified alaskite mineralized with pyrite, chalcopyrite, and molybdenite and stained with considerable limonite.	0.02	none	none	0.03
25	Silicified alaskite mineralized with pyrite, chalcopyrite, and molybdenite.	0.02	none	none	0.04
26	Silicified alaskite mineralized with pyrite, chalcopyrite, and a trace of molybdenite. The alaskite contains small inclusions of quartz diorite.	0.06	0.04	0.04	0.02

Ref. No.	Description	Percent of Cu	Au (oz./ton)	Ag (oz./ton)	Percent of Zn	Percent of Fe
27	Channel sample 8 feet long cut vertically across the sulfide body at Adit F.	0.32	0.08	trace*	6.12	38.84
28	Channel sample 7 feet long cut vertically across the sulfide body at Adit G.	0.18	trace*	trace*	9.13	38.32

* "Trace" means that the sample ran less than 0.01 percent of molybdenum or less than 0.01 oz./ton in gold and silver.

Table 3. Assays of samples collected by H. V. Redmond, along the west face of Orange Hill, Alaska.

All samples are channel samples at least 6 feet long and cut at approximately 50-foot intervals between Adit B and Adit C.

Sample No.	Location Distance in feet south of Adit C	Percent of copper
71	50	0.4
72	100	0.3
73	150	0.4
74	200	0.2
75	250	0.3
76	300	0.2
77	350	0.0
78	400	0.0
79	450	0.0
80	500	0.3
81	550	0.2
82	600	0.3
83	650	0.3
84	700	trace
85	750	0.3
86	800	0.4
87	850	0.2
88	900	0.2
89	950	0.2
90	1,000	0.2
91	1,050	0.1
92	1,100	0.2
93	1,150	0.3
94	1,200	0.2
95	1,250	0.2
96	1,300	0.3
97	1,350	0.3
98	1,400	0.2
99	1,450	0.2
100	1,500	0.6
102	at diamond-drill hole No. 3	0.0
	Distance in feet south of Hole No. 3	
106	50	0.38
107	100	0.50
108	150	0.22
109	200	0.20
110	250	0.20
111	300	0.30
112	350	0.20
113	400	0.80
114	450	0.30
115	500	0.29
116	550, and 50 feet north drill holes Nos. 1 & 2.	0.24

Table 4. Assays of samples collected by H. V. Redmond in California Gulch, Orange Hill, Alaska.

All samples are channel samples at least 6 feet long and cut at approximately 50-foot intervals from a point near diamond-drill hole No. 4 to a point near diamond-drill hole No. 5.

Sample No.	Location	Percent of copper
34	Open cut above drill hole No. 4	0.2
	Distance in feet south of drill hole No. 4	
35	100	0.2
36	150	0.0
37	200	0.1
38	250	0.1
39	300	0.0
40	350	trace
41	400	0.0
42	450	0.0
43	500	trace
44	550	0.0
45	600	trace
46	650	trace
54	700	0.1
55	750	trace
56	800	trace
57	850	0.1
58	900	0.0
59	950	0.1
60	1,000	0.0
63	1,050	trace

Table 5. Assays of samples collected by H. V. Redmond from Adit E, or the Lemon Tunnel, Orange Hill, Alaska.

All samples are channel samples cut along the adit, starting from the portal.

Distance from portal (feet)	Percent of copper	Percent of iron
0 - 5	0.0	9.5
5 -10	0.0	8.0
10-15	0.0	12.0
15-20	0.87	28.0
20-25	0.39	33.0
25-32	0.24	21.5
32-38	0.24	29.0
38-44	0.36	38.5
44-50	0.19	29.0
50-56	2.80	25.0
56-62	0.10	16.5
62-70	0.56	32.0

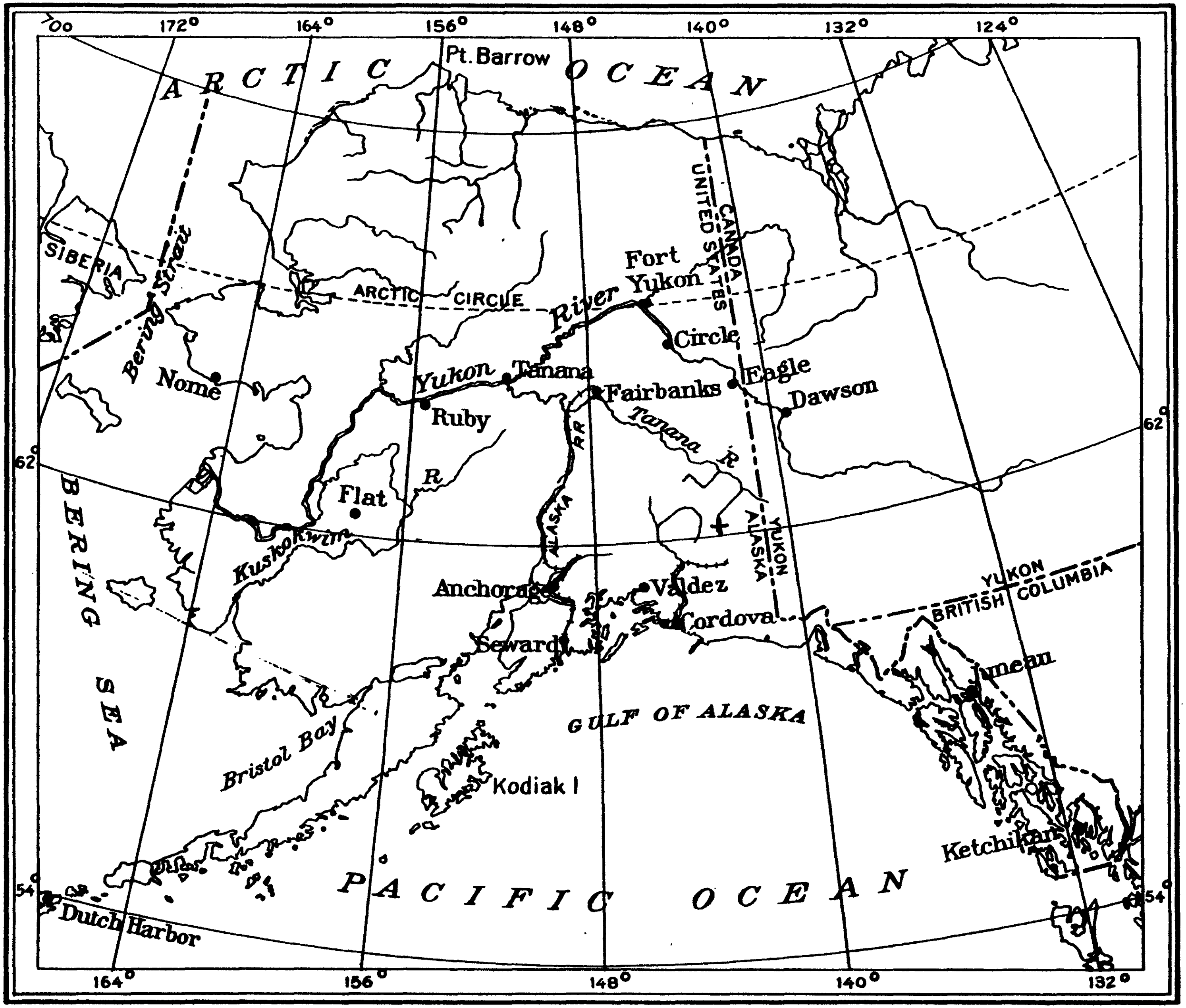

FIGURE 1.- INDEX MAP SHOWING THE LOCATION OF ORANGE HILL (+).

Interior—Duplicating Section, Washington, D. C. 87756