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NICKEL-COPPER PROSPECT NEAR SPIRIT MOUNTAIN COPPER RIVER REGION, ALASKA

BY

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By Jack Kingston and Don J. Miller

ABSTRACT

The Spirit Mountain nickel-copper prospect, near the head of Canyon Creek, 15 miles south-southeast of Chitina in the Copper River region of Alaska, is accessible by boat and trail from Chitina, or by pontoon plane from Chitina or more distant points.

Bedded metamorphic rocks of Carboniferous (Mississippian) age in this area have been intruded by generally concordant igneous bodies including several sill-like masses of sulfide-bearing altered peridotite and pyroxenite. Two of these bodies on the west side of Canyon Creek constitute the principal nickel deposit. Here the sulfide minerals bravoite, pyrrhotite, chalcopyrite, pentlandite, and pyrite are present in the peridotite and pyroxenite as disseminated grains and as massive lenses. The deposit probably is of magmatic origin.

The deposit is estimated to contain about 6,500 tons of material ranging in grade from 0.22 percent of nickel and 0.12 percent of copper for the lowest grade disseminated-sulfide material to 7.61 percent of nickel and 1.56 percent of copper for the massive sulfide material. Because of the small size and almost inaccessible location of the deposit, the authors do not believe that it can be mined profitably, even if the price of nickel should rise considerably above its present level. Additional deposits, if any, would be difficult to find and are not likely to be larger or richer than the known deposit.

INTRODUCTION

Nickel was first reported from this part of the Copper River region about 1907 when an analysis of a sample from a copper prospect about 15 miles south-southeast of Chitina showed its presence. Sixteen claims were staked and consolidated as the Spirit Mountain nickel prospect, under the ownership of B. O. Peterson, Charley Young, and Andrew Halvorsen, and a road was constructed along Canyon Creek from the Copper River to the prospect. Several mineralized outcrops were explored by test pits, and two short tunnels were driven at the base of the most promising outcrop, but no ore was shipped. The prospect was abandoned in 1917. Because of the present strategic position of nickel a detailed examination to determine the size and grade of the deposit was considered desirable.

The authors, accompanied by Neil Finnesand, a camp hand, spent 5 weeks during August and September 1942, in a study of the nickel prospect, but because of transportation difficulties and unfavorable weather only part of this time was available for geologic field work.

The field party was organized and the field work was directed by Fred H. Moffit. The authors acknowledge the helpful criticism and advice offered by Mr. Moffit and John C. Reed during the preparation of this report.

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Moffit[1] has described the regional geology of the area in reports on the Hanagita-Bremner region and the Chitina Valley. A brief description of the nickel prospect is given in the Hanagita-Bremner report,[2] and a more detailed description is given by Overbeck.[3]

GEOGRAPHY

The Spirit Mountain nickel-copper prospect is near the head of Canyon Creek (fig. 3), a small glacial stream which flows in a northeasterly direction from its source to a point near the west end of Summit Lake where it makes a right-angled turn to the left and follows a northwesterly course to the Copper River. The principal deposit is on the west side of Canyon Creek, 1 mile south of the right-angled bend mentioned above and 350 to 750 feet above the valley floor. The nearest settlement, Chitina, is about 15 miles NNW.

The prospect is accessible by boat and trail from Chitina, or by pontoon plane from there and more distant points. Since the abandonment of the Copper River & Northwestern Railroad in 1938, the commonly used route of transportation to Chitina is by way of a branch of the Richardson Highway. A boat for crossing the Copper River to the trails at Taral Creek and Canyon Creek must be obtained at Chitina. The shortest trail to the prospect starts at the junction of Canyon Creek with the Copper River, 11 miles south of Chitina and 12 miles from the prospect, and follows the valley of Canyon Creek. The lower portion of this trail is grown over with brush. A second trail starts at the junction of Taral Creek with the Copper River, 4 miles south of Chitina and 17 miles from the prospect, crosses the divide south of the head of Taral Creek, and joins the Canyon Creek trail near Divide Creek. The field party cleared this trail of brush sufficiently to permit back-packing of supplies from the boat landing at Taral to a camp near the prospect. Summit Lake, 1 mile northeast of the prospect, provides a suitable landing place for a pontoon plane.

The topography in the vicinity of the prospect is very rugged and shows an average relief of about 5,000 feet. The altitude ranges from 400 feet at the Copper River to more than 7,200 feet at a peak near Spirit Mountain. The valley of upper Canyon Creek has a U-shaped profile and hanging tributary valleys, features which are typical of the larger glaciated valleys in the area.

Climatic records at Chitina for the years 1917 to 1923 indicate an annual precipitation of 11.4 inches, about four-fifths of which is snow, and a mean annual temperature of 28.7° F. Weather observations have not been recorded in the vicinity of Canyon Creek. The prospect, somewhat nearer the coast and at a higher altitude than Chitina, has a greater amount of precipitation and a lower mean temperature. There are several small glaciers at the head of Canyon Creek but the prospect is usually free from snow during July, August, and September. Moderate temperature and generally fair weather may be expected during these months.

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[1] Moffit, F. H., Geology of the Hanagita-Bremner region, Alaska; U. S. Geol. Survey Bull. 576, 1914; Geology of the Chitina Valley and adjacent area, Alaska; U. S. Geol. Survey Bull. 894, 1938.

[2] Moffit, F. H., op. cit., pp. 52–53.

[3] Overbeck, R. M., Nickel deposits in the lower Copper River Valley, in Martin, G. C., and others, Mineral resources of Alaska: U. S. Geol. Survey Bull. 712, pp. 91–98, 1918.

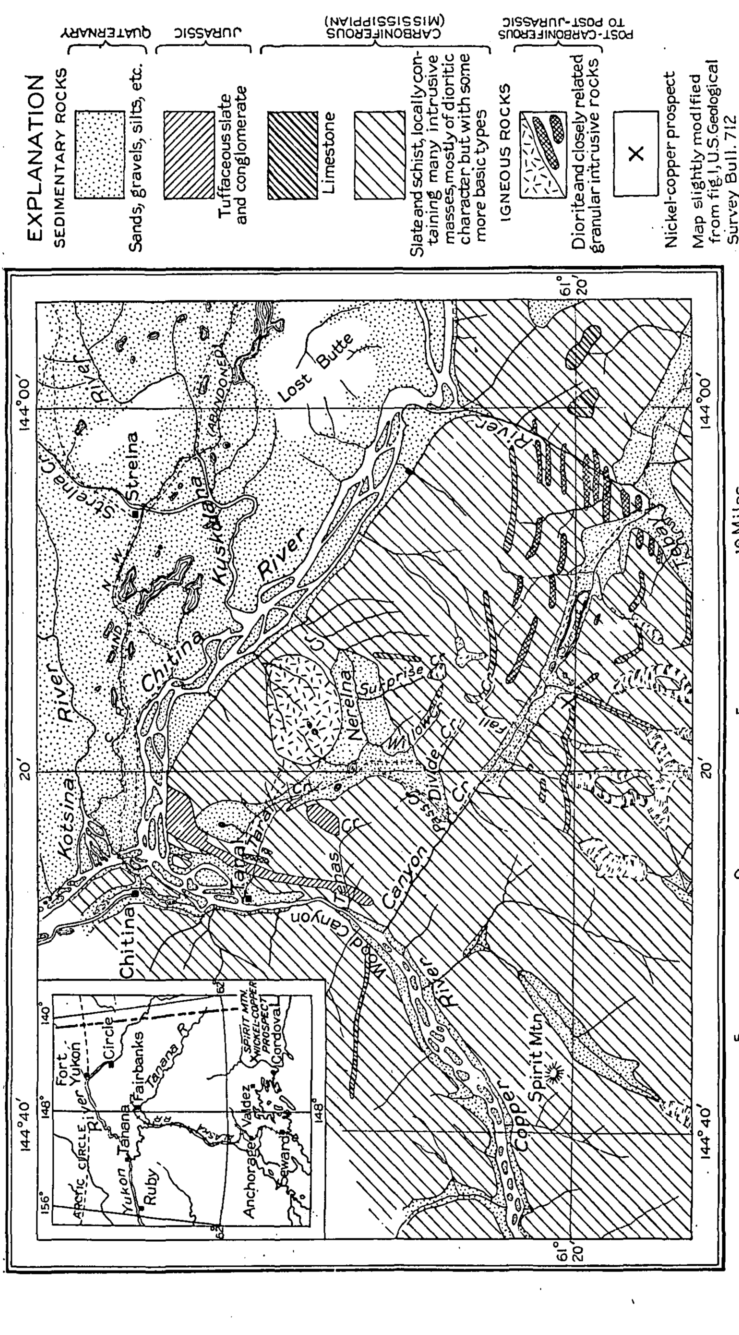

FIGURE 3.—Map of part of the Copper River region, Alaska, showing location and geologic setting of the Spirit Mountain nickel-copper prospect.

The timber line along Canyon Creek follows approximately the 2,500-foot contour. The nearest timber suitable for ordinary mining use is 4 miles northwest of the prospect. Spruce is the most abundant tree.

GEOLOGY

The prevailing country rock in the area represented by figure 3 is a bedded sequence of metamorphic rocks of Carboniferous (Mississippian) age.[4] These metamorphic rocks, predominantly schist, greenstone, gneiss, and recrystallized limestone, are intruded by igneous rocks, which although largely diorite and diabase, include the nickel-bearing peridotite and pyroxenite bodies that constitute the Spirit Mountain nickel-copper prospect. Moffit[5] assigns the igneous rocks in the area between Canyon Creek and the Chitina River to the "older intrusives," which cut Permian and older rocks but are not recognized in the Mesozoic and younger rocks. Tuffaceous slate and conglomerate beds of Middle Jurassic age are exposed near Taral Creek.[6] Slate and graywacke beds of the "Valdez group"[7] of Cretaceous and older (?) age crop out 2 miles south of the head of Canyon Creek but are not exposed in the area represented by figure 3. Quaternary deposits are represented by unconsolidated glacial, fluvial, and residual material.[8]

Several eastward-trending discontinuous peridotite and pyroxenite bodies crop out on both sides of Canyon Creek near its head. These bodies, which are roughly concordant to the intruded beds, may represent discontinuous portions of an eastward-trending sill. Most of the sill-like bodies are sulfide-bearing, but only two, which crop out on the west side of Canyon Creek, contain a significant quantity of nickel. These two bodies constitute the principal nickel deposit of this report. (See fig. 4.) The sill-like bodies intrude Carboniferous beds mapped as limestone on figure 3. This unit includes beds of fine-grained to coarse-grained recrystallized limestone, impure schistose limestone, and slightly calcareous hornblende, biotite, and diopside schists. These metamorphic rocks contain silicious zones and stringers of quartz. Silicification is especially prominent along the upper contact of the intrusive bodies.

The regional trend of the bedded metamorphic rocks is a little north of west. Local variations of as much as 40° from this trend are common. The regional dip is to the north, generally at an angle of from 50° to 85°. Most of the intrusive bodies in the area are roughly conformable to the intruded beds. The sequence of metamorphic rocks is faulted and intensely folded. Part of the discontinuity of the sill-like bodies probably is due to segmentation by faulting, but no evidence of faults of large displacement was found by the writers. Numerous slickensided surfaces along contacts of the intrusive bodies with the wall rock represent adjustment involving only small displacement.

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[4] Moffit, F. H., Geology of the Chitina Valley and adjacent area: U. S. Geol. Survey Bull. 894, p. 24, 1938.
[5] Moffit, F. H., op. cit., pp. 104–105.
[6] Moffit, F. H., op. cit., pp. 63–65.
[7] Moffit, F. H., op. cit., pp. 89–92.
[8] Moffit, F. H., op. cit., pp. 98–103.

NICKEL DEPOSIT

DESCRIPTION

The principal nickel deposit is on the glacier-steepened west wall of Canyon Creek Valley and includes two irregularly shaped intrusive bodies which strike nearly east and dip steeply to the north. (See fig. 4.) The larger body consists of lenses and stringers of highly altered, coarse-grained peridotite in which the olivine has altered to hydrous silicates and magnetite and the pyroxene has altered to hornblende. In a thin section of rock from the center of the largest exposed lens the original olivine crystals are represented by rounded masses of antigorite with serpentine-chlorite veinlets and magnetite. The original matrix of pyroxene is entirely replaced by tremolite, which in turn, is partially altered to talc. The chlorite-talc content increases outward from the center of the intrusive mass. Near the contacts of the larger altered peridotite lenses and throughout smaller lenses the rock is almost completely altered to talc and chlorite, and no relict olivine structure is evident.

The intrusive rock in the smaller body is partly altered pyroxenite in which the pyroxenes, augite and enstatite are partially altered to hornblende and talc. There is no evidence in thin sections that olivine was a primary constituent of this rock. The similarity of the sulfide minerals in the two bodies suggests a common magma source despite the difference in mineral composition. This difference may be due to a greater amount of reaction of the wall rock with the magma in the smaller body.

The intrusive rock contains sulfide minerals as interstitial grains and as massive lenses. The interstitial sulfides are rather evenly disseminated, though more abundant in the coarser-grained facies. The lenses of massive sulfides are found only along the lower contact of the larger body. Overbeck [9] reported the principal sulfide minerals to be pyrrhotite, chalcopyrite, and an unidentified nickel-iron sulfide, later identified as bravoite by Buddington.[10] The following metallic minerals, listed in order of their probable age, beginning with the oldest, were identified from polished sections by the writers:

1. Pyrite.
2. Pyrrhotite ($Fe_{n-1}S_n$).
3. Pentlandite ($(Fe, Ni)_9S_8$ and bravoite $(Ni, Fe)\ S_2$).
4. Chalcopyrite.
5. Sphalerite.
6. Magnetite.
7. Limonite.

The primary silicates, olivine and pyroxene, apparently are older than any of the metallic minerals.

The character and relationship of the sulfide minerals is similar in polished sections from different parts of the intrusive bodies, but the ratios of the relative amounts of the most abundant sulfides varies from about eight pyrrhotite; four bravoite; one chalcopyrite in the massive sulfide lenses, to about six pyrrhotite; five bravoite; nine chalcopyrite in disseminated sulfides in the smaller body at the west end of the deposit. Pyrite is believed to be the earliest mineral. It is present in

[9] Overbeck, R. M., Nickel deposits in the lower Copper River Valley, in Martin, G. C., and others, Mineral resources of Alaska: U. S. Geol. Survey Bull. 712, pp. 96–98, 1918.
[10] Buddington, A. F., Alaskan nickel minerals: Econ. Geology, vol. 19, pp. 524–527, 1924.

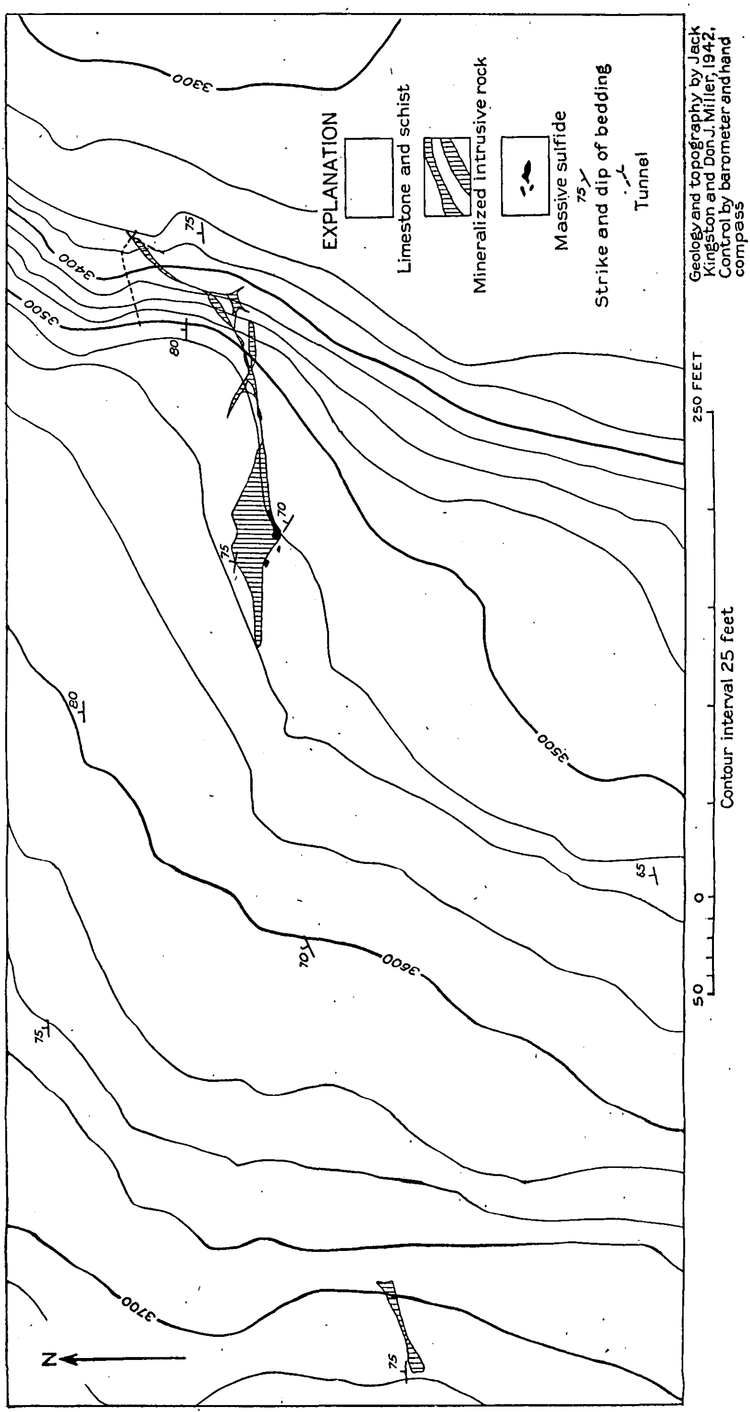

FIGURE 4.—Geologic and topographic sketch map of the principal deposit of the Spirit Mountain nickel-copper prospect, Copper River region, Alaska.

small euhedral grains in one polished section. Pyrrhotite, the most abundant sulfide, is in anhedral grains up to several millimeters in diameter. Bravoite blebs and veins are in part interstitial to pyrrhotite grains and in part replacements of pyrrhotite. Some of the bravoite has well-developed crystal outlines against pyrrhotite. Bravoite in this deposit is believed to be a primary mineral rather than a replacement of pentlandite. A few small grains of pentlandite present in a polished section of disseminated-sulfide minerals from the largest altered peridotite lens show no replacement by bravoite. Chalcopyrite apparently replaces the earlier sulfides in part and is in part interstitial to them. Sphalerite veins replace the earlier sulfide minerals along fractures and planes of cleavage in a section from one of the massive-sulfide lenses. Magnetite, in the form of small crystals in the relict olivine grains, and limonite, along fractures in the massive-sulfide lenses, are secondary minerals.

This nickel deposit probably is of magmatic origin. Most of the original silicate minerals crystallized before the sulfide minerals, holding them as interstitial blebs between the framework of silicate crystals. The lenses of massive sulfides may have formed by gravitative settling of part of the sulfide melt or by ejection of part of the sulfide melt because of distorting pressure on the nonrigid framework of silicate crystals. The sulfide-bearing basic magma itself probably differentiated from a more silicic magma at depth and was intruded into previously metamorphosed beds.

RESERVES

Only the two mineralized bodies on the west side of Canyon Creek are considered in estimating the reserves of the Spirit Mountain nickel-copper prospect. Other exposed parts of the discontinuous sill-like intrusive, though as much as 75 feet thick, do not contain a significant quantity of nickel.

The irregular shape of the two mineralized bodies that constitute the nickel deposit and the lack of mining development prohibit accurate calculation of the volume of the deposit. The eastern 100 feet of the larger body (fig. 4), which is 200 feet long, consists of irregular stringers and lenses ranging in thickness from less than 1 inch to 5 feet and extending through a vertical distance of 150 feet. The total volume of these lenses is estimated to be 7,500 cubic feet. The western 100 feet of the larger body is an irregular lens of altered peridotite having a maximum thickness of 22 feet near the middle. The largest of 3 massive-sulfide lenses exposed along the footwall of the larger body measures 3 feet by 12 feet. The smaller sulfide lenses are 1½ by 2½ feet. A fourth lens, formerly exposed in a pit at the west end of the larger body, is now covered and its dimensions are not known. If it is assumed that the large peridotite lenses and the massive-sulfide lenses decrease in size downward as abruptly as they do laterally the volume of the peridotite lens may be estimated at 57,500 cubic feet and the volume of the sulfide lenses at 120 cubic feet.

The smaller mineralized body has a length of 45 feet and an average width at the surface of 3 feet; it tapers out to a thickness of less than 6 inches at a depth of 10 feet. The estimated volume is 670 cubic feet.

Assuming a specific gravity of the material containing disseminated sudfides such that 10 cubic feet equals 1 ton and a specific gravity of the massive-sulfide material such that 7 cubic feet equals 1 ton, the eastern 100 feet of the larger body contains 750 tons of disseminated sulfide material, the western 100 feet of the larger body contains 5,750 tons of disseminated-sulfide material and 17 tons of massive-sulfide material, and the smaller body contains 67 tons of disseminated-sulfide material.

A specimen and four channel samples from the principal deposit on the west side of Canyon Creek and a specimen from the most highly mineralized outcrop of the sill-like bodies east of Canyon Creek were analyzed quantitatively for nickel and copper with results shown below. The massive-sulfide material also was analyzed quantitatively for cobalt and qualitatively for metals of the platinum group and silver.

Nickel-copper content of samples and specimens from the Spirit Mountain nickel-copper prospect, Alaska

[F. S. Grimaldi, analyst]

Body and sample or specimen	Nickel (percent)	Copper (percent)
Eastern 100 feet of larger body:		
Sample from channel 3.5 feet long, north wall of tunnel	0.22	0.12
Sample from channel 2.5 feet long, roof of tunnel	.29	.24
Western 100 feet of larger body:		
Sample from channel 22.5 feet long across widest part of body; 2.7 feet of the channel is across massive-sulfide lens	1.44	1.40
Sample [1] of largest massive-sulfide lens	7.61	1.56
Smaller body: Sample from channel 4 feet long, west wall of prospect pit	1.03	1.42
Body east of Canyon Creek: Specimen of most highly mineralized material	.09	.06

[1] Contains about 0.18 percent of cobalt. Tests for metals of the platinum group and silver were negative.

The samples from the tunnel, the sample from the prospect pit, and the specimen of the largest massive-sulfide lens probably represent approximately the average grade of the material in the eastern 100 feet of the larger body, the smaller body, and the massive-sulfide lenses, respectively. The sample across the widest part of the larger body is believed to have a nickel content considerably higher than the average nickel content of the material in the western 100 feet of the larger body, because the sample probably contains a larger proportion of massive-sulfide material than that part of the larger body.

ECONOMIC CONSIDERATIONS

The tonnage of the mineralized material exposed at the nickel-copper prospect is too small to be mined profitably, even if the price of nickel should rise considerably. The almost inaccessible location of the prospect makes transportation costly and difficult. It is not likely that other exposed bodies of similar or higher grade will be found in the vicinity. Other bodies may exist down the dip below the exposed deposit, but the irregular shape and discontinuity of the intrusive bodies makes their discovery costly and uncertain. If further prospecting is attempted the most promising location is along the footwall of the larger body near the massive-sulfide lenses.

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