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UNITED STATES
DEPARTMENT OF THE INTERIOR
J. A. KRUG, SECRETARY

BUREAU OF MINES
R. R. SAYERS, DIRECTOR

REPORT OF INVESTIGATIONS

EXPLORATION OF SPIRIT MOUNTAIN NICKEL PROSPECT
CANYON CREEK, LOWER COPPER RIVER REGION, ALASKA

BY

HAROLD C. PIERCE

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By Harold C. Pierce[2]

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INTRODUCTION

During the years 1941 to 1945, the United States produced less than one-half of one percent of all primary nickel, whereas the nation's consumption of the metal amounted to nearly three-fourths of the world's supply. Although postwar nickel consumption probably will be less than wartime consumption, trade estimates for the next 10 years are well above the average established during the 1930-1940 decade. The greatest consumption is expected in nickel alloys, particularly nickel-alloy steels.[3] The greater use of nickel cast irons and nickel-clad metals also signifies an expanding nickel market.

1/ The Bureau of Mines will welcome reprinting of this paper provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Report of Investigations 3913."

2/ Assistant mining engineer, Bureau of Mines, Fairbanks, Alaska.

3/ Engineering and Mining Journal, "Metals for the Alloy Steels": Vol. 145, No. 2, February 1944, p. 84.

In anticipation of the postwar demand for nickel, and realizing the seriousness of the "have not" position of the United States with respect to this metal, the Bureau of Mines, sent an engineer[4] into the lower Copper River region of Alaska during the summer of 1944 to investigate the nickel deposits near the head of Canyon Creek. Samples from the Spirit Mountain nickel prospect were sufficiently encouraging to justify more intensive exploration. As a result, a program of surface trenching, systematic sampling, and detailed mapping of the property was adopted and directed by a Bureau of Mines engineer[5] in the summer of 1945.

ACKNOWLEDGMENTS

In its program of exploration of mineral deposits, the Bureau of Mines has as its primary objective the more effective utilization of our mineral resources to the end that they make the greatest possible contribution to national security and economy. It is the policy of the Bureau to publish the facts developed by each exploratory project as soon as practicable after its conclusion. The Mining Branch, Lowell B. Moon, chief, conducts preliminary examinations, performs the actual exploratory work, and prepares the final report. The Metallurgical Branch, R. G. Knickerbocker, chief, analyzes samples of ore and performs beneficiation tests. Both these branches are under the supervision of Dr. R. S. Dean, assistant director.

With respect to this report, special acknowledgment is due to Robert S. Sanford, acting chief, Alaska Division, Mining Branch, and to Lowell B. Moon, chief, Mining Branch, Washington, D. C., for their help in supervising and revising this report.

LOCATION AND ACCESSIBILITY

The Spirit Mountain nickel prospect is situated about 15 airline miles south, 22° east from Chitina, Alaska, at the approximate latitude 61° 19' N. and longitude 144° 16' W. This prospect, 12 miles east of Spirit Mountain, from which it derives its name, is near the head of Canyon Creek, a westerly flowing tributary of the Copper River. Canyon Creek heads in a glacier 2 miles south of the nickel prospect and flows northeast for 3½ miles to a point where it makes a right angle turn. From there it maintains a northwest course for 9 more miles to its confluence with the Copper River, about 9 miles below the town of Chitina. Figure 1 is an index map of Alaska showing the general location of the deposit. Figure 2 is a map of the area south of Chitina showing the location of the mineralized exposures sampled in the Canyon Creek area.

The deposit is now virtually inaccessible except by air transport. Summit Lake, 2 miles from the property, is 2½ miles long and large enough for float planes in summer; when frozen, it could be used by planes equipped with skis.

4/ Norman, Ebbley, Jr., mining engineer.
5/ Harold C., Pierce, mining engineer.

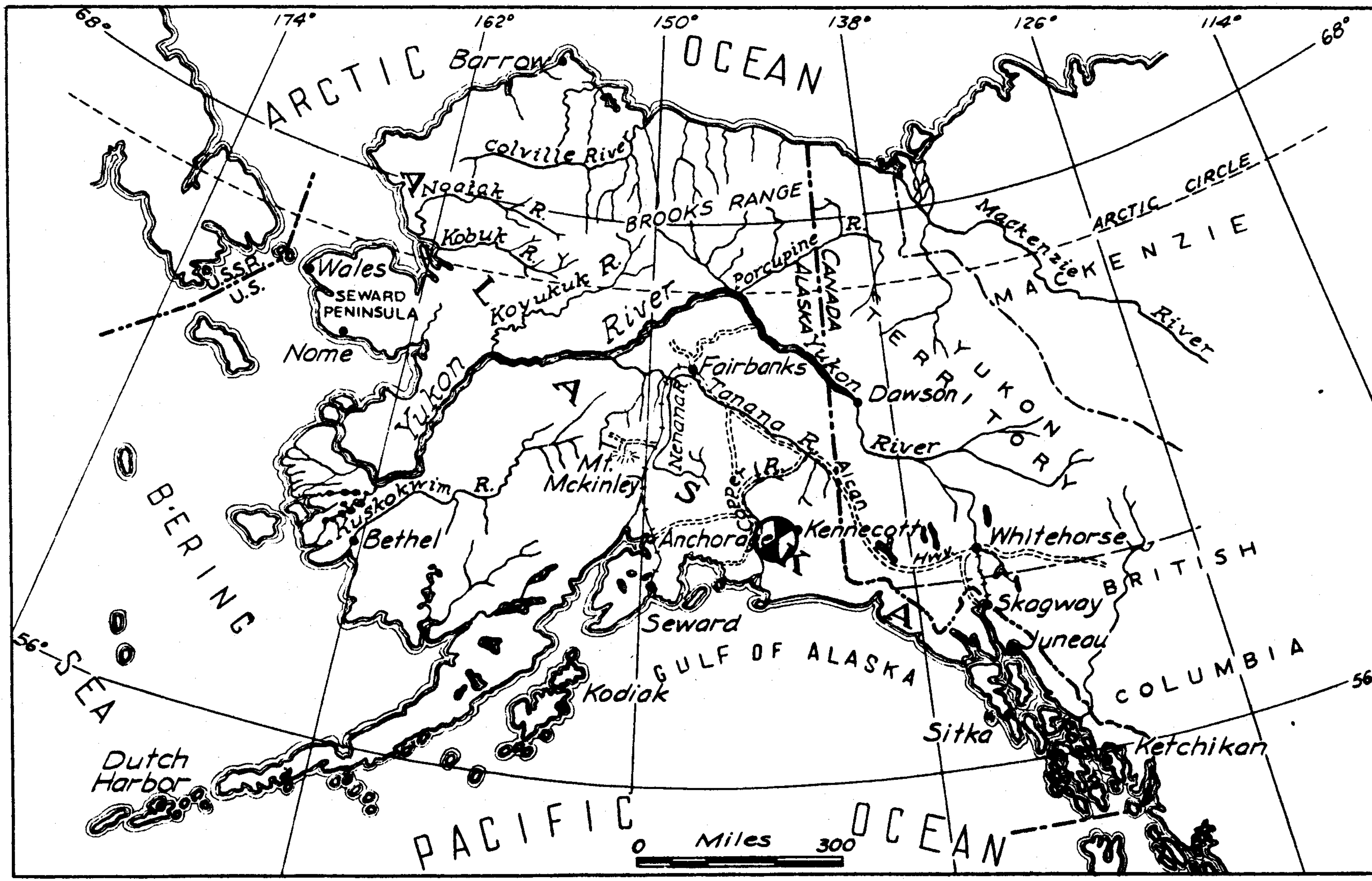

FIG. I INDEX MAP SHOWING LOCATION SPIRIT MOUNTAIN PROSPECT

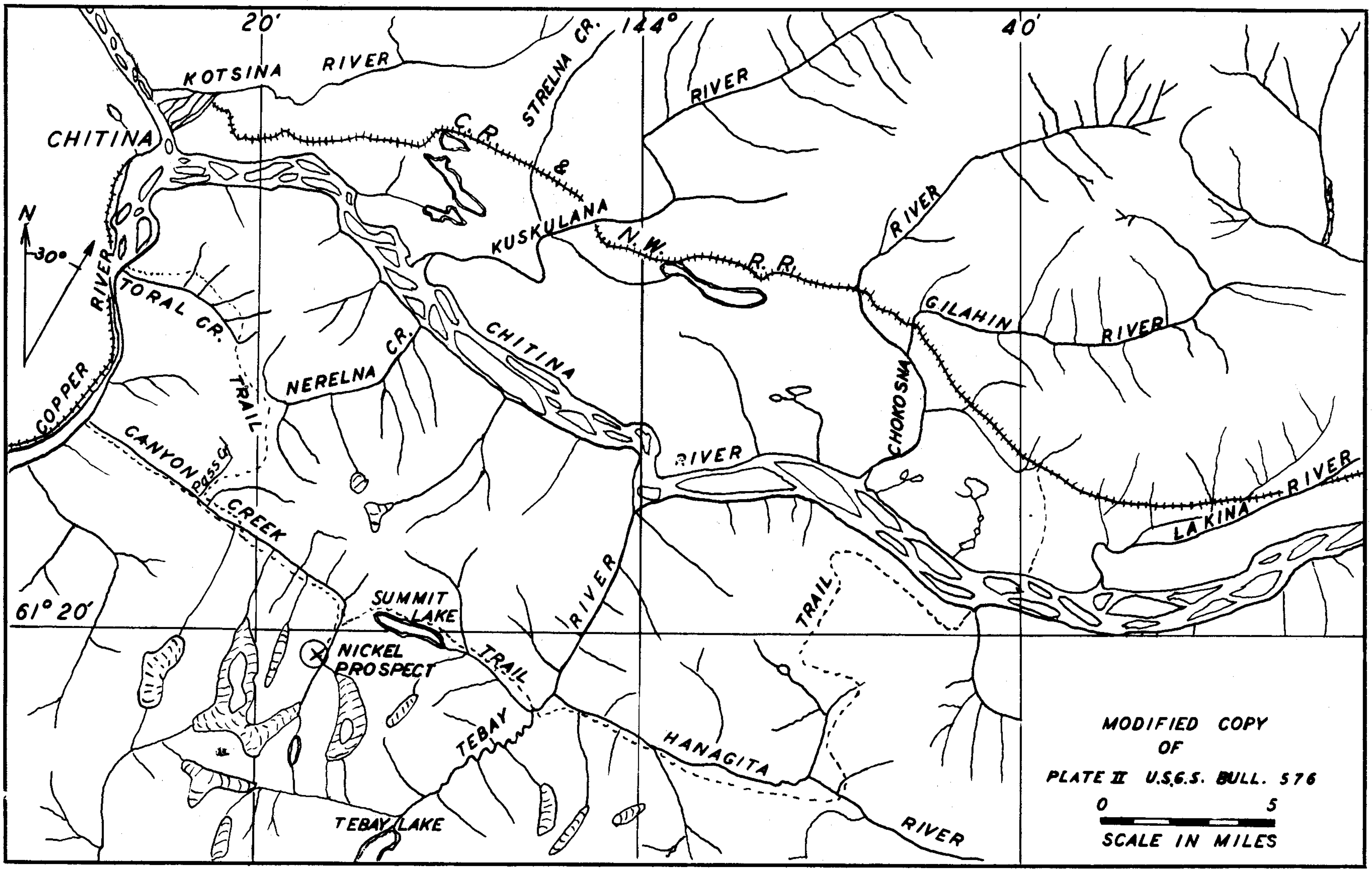

FIG. 2 AREA SOUTH OF CHITINA

About 35 years ago considerable work was done in this area. Two "double ender" trails were built from Copper River up Canyon Creek to the property. One, originating near the mouth of Canyon Creek, took a course along the south-west side of the creek all the way to the property. The other, beginning at Taral, 4 miles below Chitina, led up Taral Creek, over the divide, and down Pass Creek to Canyon Creek, where it joined the first trail. Both of these trails are in extremely poor condition, being virtually impassable because of willows and alders. By either trail it is necessary to cross the Copper River, a particularly fast and treacherous stream. Power boats capable of making the trip from Chitina to Taral or Canyon Creek and return were not available in Chitina, when the examination was made.

Chitina, the supply center for most of the Copper River and Chisana Districts, receives freight from Valdez by truck at a cost of $15 a ton.

PHYSICAL FEATURES AND CLIMATE

Topographically, the Canyon Creek area is one of considerable relief. The altitude of Copper River at the mouth of Canyon Creek is about 400 feet, although Spirit Mountain rises to an altitude of 7200 feet in the distance of a few miles. The altitude of the nickel deposits is about 4,000 feet, whereas adjacent peaks rise abruptly to 6,000 and 7,000 feet.

Vegetation on upper Canyon Creek is predominantly of stunted willows and alders. These are of sufficient size and quantity to supply fuel for a small exploration party for a month or more. Spruce timber suitable for wood and mine timber can be obtained 3 miles from the property down Canyon Creek as well as about 1 mile east of Summit Lake. Saw timber is available along the lower portions of Canyon Creek. Ample summer forage for horses can be found in the vicinity near the nickel property.

No data are available regarding the climate of this section. However, summers are short and cool and winters are long and cold and accompanied by severe storms. The ice usually melts on Summit Lake late in July, and the first snow can be expected about September first. Although this area is only 60 airline miles from the coast, it is protected by the high Chugach Mountains to the south, so that the area receives only a moderate amount of precipitation, most of which falls during the winter in the form of snow.

HISTORY

During the period between 1907 and 1917, the Chitina and Copper River areas experienced a period of active prospecting stimulated by the development of the rich Kennecott copper deposits and by building of the Copper River & Northwestern Railroad. When no new high-grade deposits were found, interest gradually subsided, and since abandonment of the railroad in 1938 there has been very little activity in this area.

The Canyon Creek deposits were first located as copper prospects, locally known as the Peterson property. The first published report was made by Fred H. Moffit,[6] and a second investigation was made in 1917 by R. M. Overbeck,[7] who examined the prospect for its nickel content. The property was examined in 1942 by Jack Kingston and Don J. Miller of the Federal Geological Survey and again, in 1944, by Norman Ebbley for the Bureau of Mines.

Between 1907 and 1911 sixteen unpatented claims were staked and consolidated into one group. By 1915 a large open cut had been opened on the outcrop and several small test pits put down in an unsuccessful attempt to trace the outcrop on the surface. About this time a 50-foot adit was driven under the outcrop but failed to expose the deposit at depth.

ORE DEPOSITS

The following notes on the geology of the deposits are abstracted from or quoted from the Geological Survey Reports by Moffit and Overbeck.

The general geology of the area is described by Moffit[8] as follows:

> Two groups of sedimentary rocks occupy most of the area under consideration. The oldest consists of schists, slate, and limestone, which form the chief rocks of the mountains between Hanagita Valley and Chitina River and of those south of the Hanagita Valley eastward from the Copper River for nearly 30 miles. These sedimentary beds are folded, faulted, and much metamorphosed. Furthermore, they are intruded in a most complicated manner by igneous rocks and sills, which are chiefly dioritic but include granitoid rocks of a more basic kind.
>
> The second group of sedimentary beds consists of interstratified slate and graywacke, here classed as early Mesozoic (?) (Valdez group). It adjoins the first group mentioned on the south.***. These sedimentary rocks are folded and faulted but are less metamorphosed than the schist and limestone beds bounding them on the north. They are cut by numerous light-colored dikes of quartz monzonite.

The following notes on the geology of the Canyon Creek deposit are taken from a report by R. M. Overbeck.[9]

> The country of the Canyon Creek valley is schist of probable Carboniferous age. The numerous bodies of igneous rock that have intruded the schist are conspicuous because of their

6/ Moffit, Fred H., Geology of the Hanagita-Bremner Region, Alaska; Geol. Surv. Bull. 576, 1914, 56 pp.

7/ Martin, G. C., and others, Mineral Resources of Alaska, Report on Progress of Investigations in 1918: Geol. Surv. Bull. 712, 1920, pp. 91-98.

8/ Footnote 6, pp. 17-18.

9/ See footnote 7.

rusty-looking croppings. The shapes of these bodies are irregular, but the irregularity is probably due in part to faulting which took place after intrusion. The slickensided surfaces found along the contact between schist and igneous rock indicate that such faulting has occurred, and a fault trace shows prominently on the face of a cliff on the west side of Canyon Creek. The intrusive bodies range from acidic rocks, such as quartz monzonite, to basic rocks, such as peridotites. Quartz stringers are also rather abundant in the schist.

The country rock in which the nickel-bearing body occurs is light-gray limy and quartzose schist, striking N. 84° W. and having a vertical dip, into which peridotite has been intruded. The peridotite is rather strongly mineralized in places with sulphides, and it is with these sulphides that the nickel is associated. This schist, which is a recrystallized impure limestone, is seen under the microscope to consist chiefly of coarse calcite crystals separated by flakes of biotite, chert, hornblende, muscovite, and zoisite. Along the hanging wall of the ore body lies a light-colored igneous rock that may represent an acidic differentiation product of a magma of which the nickel-bearing basic rock along the footwall is the other extreme. This acidic rock is very light-colored and medium-grained and contains a few scattered garnets. A thin section shows that it consists chiefly of quartz, orthoclase, and altered plagioclase. The quartz and orthoclase together are about equal in amount to the altered plagioclase. Some garnet and a few flakes of biotite and muscovite are present. The altered feldspar has been so far changed that its original composition could not be determined, although traces of plagioclase twinning can still be detected in some of the crystals. The alteration product of the feldspar is very fine-grained and can not be determined definitely, but a considerable part of it seems to be sericite. The quartz and orthoclase are closely intergrown and in some parts of the slide show graphic intergrowth. Attention is called to this graphic intergrowth because, although it is extremely common in the acidic rocks, it has been noted at a number of places where nickel ores are associated with extremely basic igneous rocks. Relatively, the rock is not greatly altered, nor does it show the effects of having undergone any intensive squeezing. As the specimen was taken from a surface outcrop, much of the alteration may be due to weathering. Stringers of chlorite are rather common, but these, too, may be the result of weathering.

The quartz stringers, which are fairly abundant near the outcrop of the basic rock, may represent products of differentiation - a step farther than that of the acidic dike.

The rock in which the nickel-bearing sulphides occur is a highly altered coarse-grained peridotite. It appears to have consisted originally of olivine and pyroxene, but it has been so greatly altered that none of the olivine and almost none of the pyroxene remains. The olivine has been altered with characteristic mesh structure to serpentine, talc, and opaque minerals. The pyroxene is now hornblende. Some epidote and several large flakes of biotite were noted. Stringers of carbonate that may be in part calcite and in part magnesite are very abundant in the slide. Chlorite is present in considerable quantity. The rocks as a whole, however, have been so greatly altered that only a part of the minerals can be definitely determined. The opaque sulphide minerals in the slide occur partly as grains and partly as stringers that cut across the silicates. Although the sulphides seem to be later than the silicates, their deposition seems to have been controlled to some extent by the presence of the silicates. In other words, they are for the most part interstitial between the grains of the silicates and to a rather minor extent cut across the grains. Although the type of rock is different from that of the southeastern Alaska nickel deposit, the texture of the polished surface of the ore rock is very similar in appearance. Chalcopyrite and pyrrhotite can be recognized in a thin section of the ore rock.

The more heavily mineralized portion of the dike is along its footwall side. In places the mineralized rock is massive sulphide, but at most places where it has been mineralized the sulphides are interstitial in the coarse-grained igneous rock. The minerals in the massive ore have been acted on extensively by the weather and now represent rather an agglomeration of original minerals and minerals that are the result of weathering. The only mineral that can be definitely determined on a polished surface of the ore is chalcopyrite. The section is cut by numerous stringers of a bluish mineral that may be in part chalcocite and in part hematite. The most abundant minerals in the slide have some resemblance to pyrrhotite, but comparison with polished surfaces of known pyrrhotite show there is a decided difference in color. The most abundant mineral, next to pyrrhotite, in most of the specimens is light-colored and has roughly equidimensional surfaces that show cubic cleavage. This mineral occurs also in slender stringers cutting though the pyrrhotite. The pyrrhotite is very strongly magnetic; the unknown mineral is nonmagnetic.

The best exposures of the nickel-bearing peridotite are on the west side of Canyon Creek, about 500 feet above the valley floor. The largest of these exposures has a maximum width of 25 feet and a possible length of 200 feet. It is exposed on the face of a vertical cliff and on the surface at the top of the cliff (fig. 3).

Another small exposure outcrops about 400 feet farther up the hill, but prospecting has failed to show any continuity between the two exposures.

At the foot of the cliff, a 50-foot tunnel has been driven in an attempt to undercut the deposit. The tunnel was driven on a fault striking N. 64° E. and dipping about 45° to the northwest. A brecciated zone about 1 foot wide

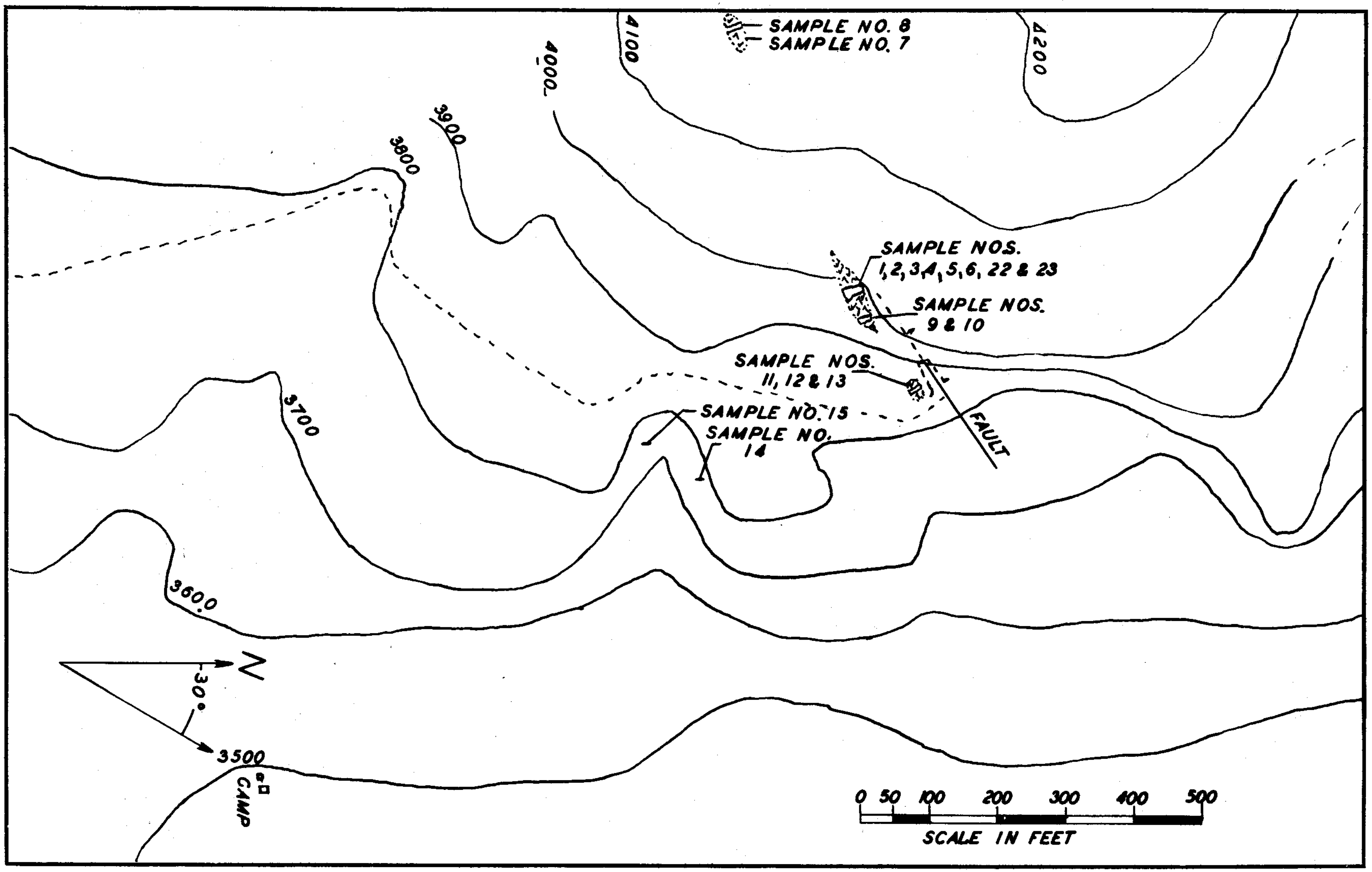

FIG. 3 TOPOGRAPHIC MAP, SPIRIT MOUNTAIN NICKEL PROSPECT

is exposed in the tunnel and can be traced up the face of the cliff about 75 feet, where it cuts the peridotite exposure on the cliff. The crushed material along the fault contains some mineralized basic rock showing slickensides. No evidence of mineralization was observed in the footwall of the fault.

SAMPLING AND ASSAYING

Three trenches were sunk on the largest outcrop on the west side of Canyon Creek, and 10 samples were taken from these trenches. Three samples were cut across the outcrop on the face of the cliff, and 10 samples were collected from other exposures of rocks showing sulfide mineralization. A list of samples taken and a description of each are given in table 1.

Analyses of samples taken from other intrusive exposures do not indicate the existence of other ore shoots in the vicinity.

In evaluating the results of the sample analyses, care should be taken not to place too much weight on samples 2 and 6, as they were taken across an irregular lens of massive sulfide. Subsequent trenching has proven these lenses to have little extension either laterally or vertically.

TABLE 1. - Sample data

Sample No.	Location	Width, inches	Remarks	Analysis, percent Ni.	Cu
1	4 feet below surface in trench No. 1...	14	Country rock showing green stain in joints and cracks..................................	1.08	0.11
2	do....................	82	Massive sulfide and 1 foot of limestone next to footwall................................	1.44	2.95
3	do....................	74	Jointed and blocky; peridotite with some sulfides..................................	.49	.48
4	do....................	48	Peridotite..................................	.57	.43
5	do....................	66	Light-colored acidic rock next to hanging wall	.56	.33
6	7 feet below surface in trench No. 1...	84	Stringers of sulfides next to footwall........	1.70	.90
7	Bottom of test pit, 400 feet west of trench No. 1..............................	60	Country rock and 1 foot of crushed peridotite.	.16	.14
8	Surface near test pit above............	36	Peridotite..................................	.20	.34
9	Trench No. 2............................	76	Peridotite next to hanging wall..............	1.08	1.00
10	Trench No. 2 next to footwall..........	36	Blocky; peridotite and small sulfide stringers	.49	.78
11	Outcrop on face of cliff...............	60	Peridotite, quartz stringers, little sulfide..	.31	.24
12	do....................	138	Blocky peridotite, small quartz stringers, little sulfide..............................	.30	.36
13	Outcrop on face of cliff...............	54	Peridotite; little sulfide..................	.05	0.10
14	See figure 3............................	144	Mineralized outcrop..........................	Tr.	Tr.
15	do..............................	120	do..............................	Tr.	0.05
16	Small pit on east side of Canyon Creek.	24	....	Tr.	0.05
17	do....................		Hand-picked best material....................	Tr.	0.05
18	East side of Canyon Creek..............		Mineralized outcrop..........................	Tr.	Tr.
19	East side of Canyon Creek 2 miles south of adit..........................		North end of mineralized outcrop..............	Tr.	Tr.
20	do....................		Central part of mineralized area above........	Tr.	Tr.
21	do....................		South end of mineralized outcrop above........	Tr.	Tr.
22	9 feet below surface in bottom trench No. 1................................	60	Peridotite and some sulfides.................	1.34	.63
23	do....................	66	Peridotite next to hanging wall..............	.55	.66