STRATABOUND COPPER-GOLD OCCURRENCE, NORTHERN TALKEETNA MOUNTAINS, ALASKA

By Thomas E. Smith, Thomas K. Bundtzen, *and* Thomas C. Trible

DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS – DEPARTMENT OF NATURAL RESOURCES

MISCELLANEOUS PAPER 3

PUBLISHED BY THE DIVISION OF GEOLOGICAL AND GEOPHYSICAL SURVEYS, COLLEGE, ALASKA: 1976

STRATABOUND COPPER-GOLD OCCURRENCE, NORTHERN TALKEETNA MOUNTAINS, ALASKA

by
T.E. Smith, T.K. Bundtzen, and T.C. Trible

ABSTRACT

During the 1973 field season, an occurrence of copper- and gold-bearing volcanic rocks was discovered in low glaciated hills of the northern Talkeetna Mountains.

Metallization is generally confined to a single, near-vertical flow that is discontinuously exposed for over 3,000 feet. Analyses of 10 composite samples over this interval show significant amounts of copper, gold, and silver. Mineralization, although somewhat remobilized, appears stratabound and may well extend beyond the limits of bedrock exposure. Additional exploratory work is recommended.

INTRODUCTION

This brief paper provides preliminary data on an interesting base-metal and precious-metal occurrence identified during the 1973 field season, which was a phase of a reconnaissance geologic mapping and mineral appraisal program carried out by T.E. Smith from 1968 to 1974, under support of the U.S. Geological Survey and the Alaska Division of Geological and Geophysical Surveys (DGGS). A summary of regional geology beyond the limits of figures 1 and 2 in this report is available in the DGGS Annual Report for 1973 (Smith, 1973, p. 3-6).

Copper occurrences and geochemical drainage anomalies are common in Triassic volcanic rocks of the Amphitheater Group (TRa of fig. 1), which are exposed in an elongate belt north of the prospect described here. To the authors' knowledge, however, this mineral occurrence is the first of its type to be reported in the foliated lavas and metasediments of probable upper Paleozoic age that are exposed in a broad belt extending over 70 miles from the northern Talkeetna Mountains to the Richardson Highway. Most of this lowland terrane is discontinuously mantled with surficial deposits, heavily vegetated, and does not lend itself to mineral evaluation by stream-sediment geochemistry. The prospect described here was discovered while examining sparsely distributed bedrock exposures using continuous helicopter support. Surface exposures of sulfide-bearing lavas contrasted strikingly with barren rocks of the Pzv unit in that they were invariably covered with a brilliant orange lichen—hence our informal name *Lichen Prospect*. Its presence of mineralized rocks of the Pzv unit may provide a geobotanical guide for exploration of the remainder of the unit.

REGIONAL GEOLOGY

Bedrock terrane near the Lichen Prospect ranges in age from upper Paleozoic to Cretaceous—including lavas of mafic to intermediate composition with interbedded sediments, pelitic sedimentary rocks, and a variety of intrusive igneous bodies. These are shown on figure 1.

The oldest layered rocks are a deformed sequence of amphibolites with interbedded marbles (Pza) that are in apparent gradational contact with an extensive terrain of mildly schistose lavas of intermediate composition, with minor fine-grained sediments and carbonates (Pzv). Rocks of the Pzv unit form an east-west arcuate belt across the northern part of the Copper River basin. Fossils collected by Csejtey (1973, p. 45) and by Smith and Bundtzen during the 1973 field season in the vicinity of Watana Lake support an age assignment of Upper Paleozoic for this rock sequence. In this area, the Pzv unit is in thrust contact with the Triassic Amphitheater Group, a thick sequence of 1) metabasalts and andesites (TRa) which display both columnar jointing and pillow structures locally, and 2) cherts, argillites, volcaniclastic sediments, and limestones (TRas) which are in part fossiliferous. Fossils collected northeast of the map area from the upper part of the sequence (Moffit, 1912, p. 33) establish an upper Triassic age for the TRa unit. Newer fossil collections made by Smith and Bundtzen in 1973 and Stout (1974, in process) confirm the earlier determination. An upper Jurassic assemblage of sandstones, siltstones, and pebble conglomerates (Js) is in fault contact with the Amphitheater Group in the northwest corner of the map. Most of the lowland areas and stream valleys are covered by Quaternary surficial deposits which were not differentiated during the mapping program.

At least two ages of igneous intrusive rocks are exposed in the map area. Hornblende quartz diorite (Jqd) of Jurassic age underlies most of the rounded hills

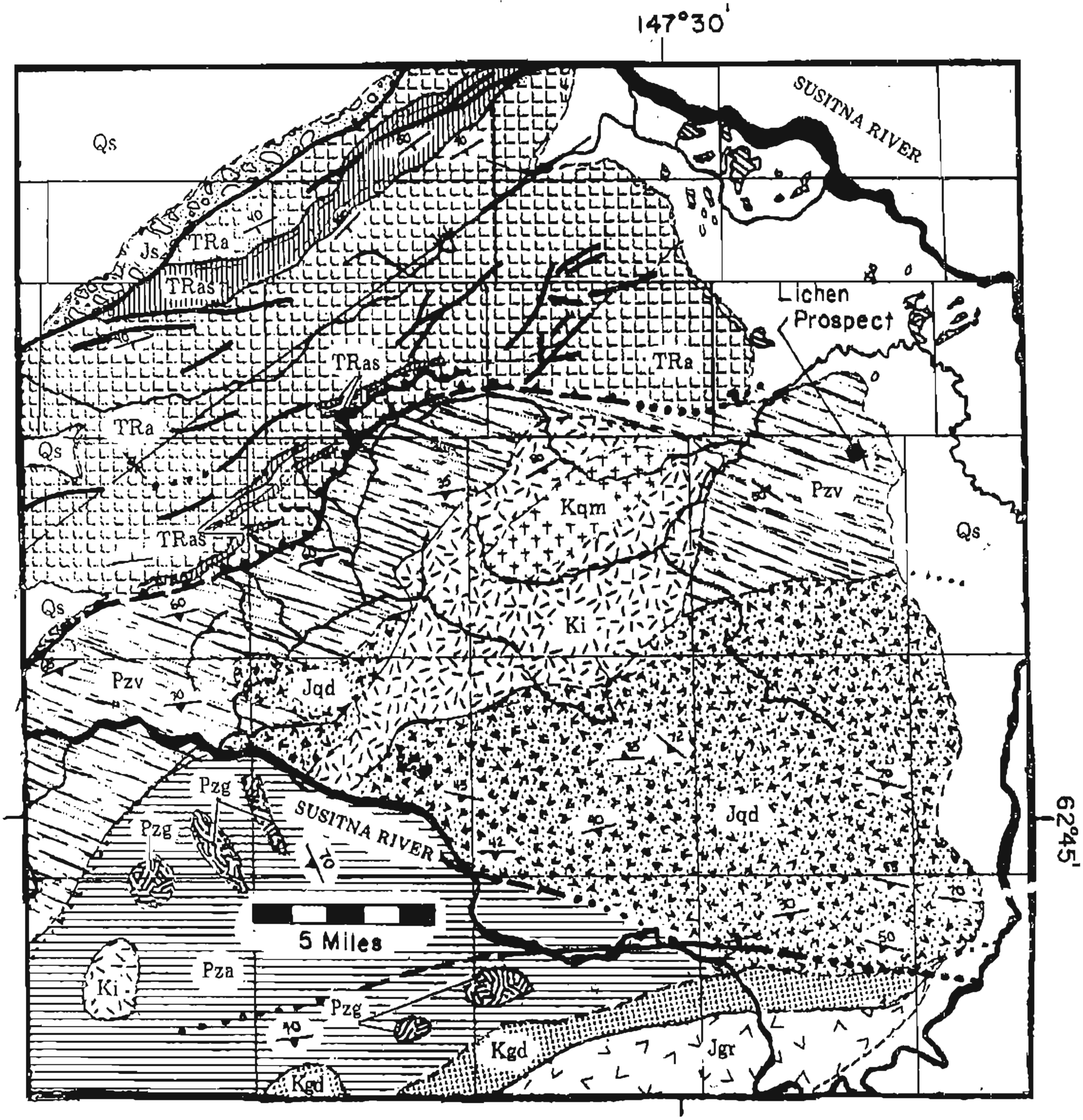

Figure 1. Generalized geologic map of northeast corner, Talkeetna Mountains and southeast corner, Healy 1:250,000 quadrangles. Geology by T.E. Smith, T.K. Bundtzen, and G.L. Kline, 1972-73. Location of prospect indicated in eastern portion of map.

Figure 1 - *continued*

EXPLANATION

LAYERED ROCKS

Quaternary

Qs

Surficial deposits

Jurassic

Js

Conglomerates & sandstone - locally fossiliferous

Triassic

TRa

TRas

Amphitheater Group
TRa, Metabasalts & meta-andesites
TRas, chert, argillite, undifferentiated volcanoclastics, and limestone, locally fossiliferous

Upper(?) Paleozoic

Pzv

Mildly schistose metavolcanics and metasediments

Pza Pzg

Amphibolite terrain includes small bodies of hornblende gabbro, Pzg

INTRUSIVES

Cretaceous

Kqm
Kgd
Ki

Cretaceous intrusives
Kqm, Quartz monzonite-to-granite
Kgd, Granodiorite
Ki, Granodiorite-to-quartz diorite

Jurassic

Jgr
Jqd

Jurassic intrusives
Jgr, Aluminus granite to granodiorite
Jqd, Hornblende quartz diorite

Contact

Thrust fault

High-angle fault

40 67

Strike and dip of beds or foliation

within the big bend of the Susitna River. A peraluminous granite series (Jgr), of late Jurassic age, crops out as a linear body in the southeast corner of the map. Hornblende gabbro bodies (Pzg), some of which are too small to be shown on the map, are considered to be of the same age as the amphibolite terrane (Pza) and are probably genetically related to it. Cretaceous magmatism is recorded by a foliated granodiorite (Kgd) in the south and a zoned pluton (Kqm and Ki) in the center of the map. Kqm probably represents a more homogeneous, felsic core of the larger complex plutonic body.

MINERAL OCCURRENCE

Host rocks for mineralization at the Lichen Prospect (fig. 2) consist of metavolcanics, minor detrital sediments, and banded quartzite of probable late Paleozoic age. These rocks (Pzv on fig. 1) have undergone lower greenschist facies metamorphism, and many of the less competent sedimentary beds are recrystallized to greenschists. The sulfide-rich zone, apparently confined to a single volcanic flow, extends along a regional strike of N. 60^{o} W. for at least 3,000 feet. Surficial deposits mantle most of the area, concealing both ends of the metalliferous horizon zone.

Petrographic studies of rocks from the prospect suggest a predominant intermediate composition for the metavolcanics. Although the rocks are locally chloritized and epidotized, varying amounts of biotite, hornblende and quartz are present in the sections. Compositionally they are slightly more felsic than the Amphitheater Group (TRa) to the north; this is true of the entire Pzv unit.

The sulfide minerals are generally disseminated or are concentrated in small quartz-feldspar-epidote veinlets averaging less than 1 centimeter thick. Both the veinlets and disseminations are restricted to a zone about 5 feet wide; they seem to be confined to a single volcanic horizon that strikes N. 60^{o} W. and dips nearly vertical. Chalcopyrite ($CuFeS_2$) and bornite (Cu_5FeS_4) are the most obvious economic sulfides, but under the ore microscope, chalcopyrite, bornite, minor covellite (CuS), digenite (Cu-S), and an unusual mineral, probably idaite (Cu_6FeS_5), have been identified. The idaite is perhaps an alteration product of the bornite. Covellite and digenite veinlet systems cut the bornite and chalcopyrite, and supergene malachite is abundant. No native precious metals or precious metal sulfides were recognized. The mineral source of the silver and gold values present in the analyzed samples was not recognized, although higher silver values seem to correlate with the higher copper values (table 1).

A conspicuous bright-orange lichen is invariably associated with the sulfide-bearing material and actually aided the field party in deliniating the extent of the mineralized zone. The lichen is actually the free-living plant *Trentepohlia aurea*, an alga which is a common component of the lichen genus *Ionaspis*. The identification was made by Dr. William Weber of the University of Colorado museum in Boulder (written comm., 1974), who stated that the lichen commonly grows on spruce twigs in a locally humid environment, but has also been found on rocks in Europe. A search in several USGS publications on the subject revealed no mention of the plant being associated with other mineral deposits in the state.

The association of ore minerals with a single stratum of volcanic flow rock suggests a primary volcanogenic source may best explain its occurrence. Hutchinson (1973, p. 1229), in his classic paper on volcanogenic ore deposits, describes a "cupreous-pyrite" type of massive sulfide deposit with high ratios of gold to silver, but containing virtually no lead or zinc. These are usually associated with mafic-to-intermediate tholeiitic volcanic rocks. Felsic volcanics are usually absent, and sedimentary assemblages are volumetrically insignificant, but usually include siliceous ironstones and radiolavian cherts. Mineralization is usually irregularly distributed in the flows in pillows, pillow matrices, and breccias. The volcanic hosts are usually interpreted as being the results of deep-water quiescent fissure eruptions on the sea floor.

At the Lichen Prospect, several lines of evidence support the assignment of this prospect to this category of volcanogenic deposit:

1) Mineralization seems to be confined to a single volcanic unit of intermediate composition that extends for several thousand feet.
2) Sediments do not make up a significant percentage of the total rock exposed at the prospect; however, a quartzite band possibly representing a metachert or siliceous metasediment is present near the mineralized zone.
3) Felsic volcanics are absent.
4) Lead and zinc are not present in significant amounts in the samples. Copper analyses average 2.48 percent.
5) The average silver-to-gold ratios of the analyzed samples is 4.6 to 1. This is much lower than ratios reported for deposits in Hutchinson's other categories and agrees with his "cupreous-pyrite"-type deposit.
6) The nature of the mineralization seems to suggest that the sulfides before metamorphism were irregularly distributed through the volcanic horizon and did not constitute a uniform sheet of massive sulfides.

RECOMMENDATIONS

Analyses of several composite and grab samples taken along the length of the exposure show copper values ranging to 4.5 percent and gold values to 16 parts per

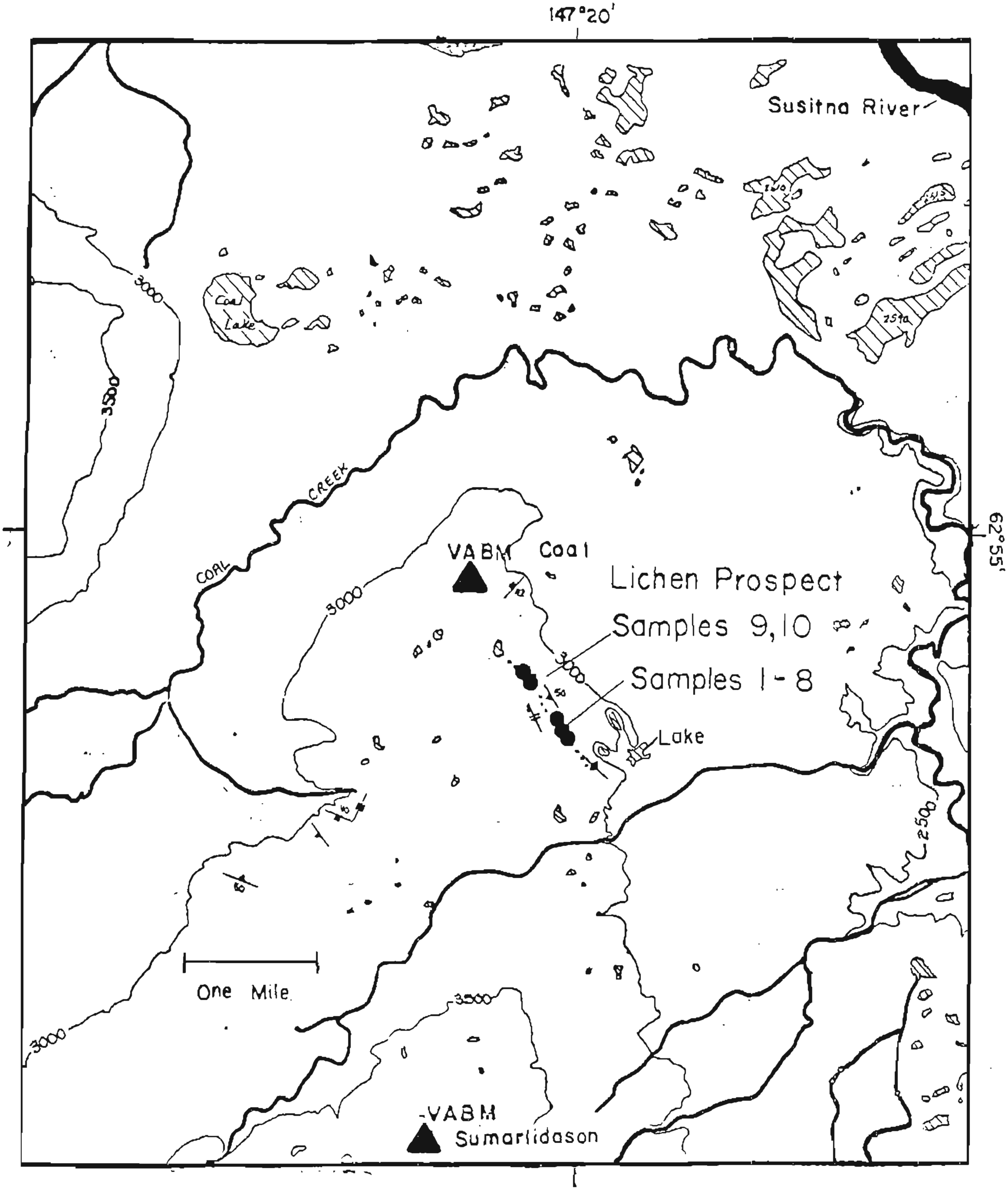

Figure 2. Detailed location of Lichen Prospect. Base from Talkeetna Mountains D-1, 1:63,360 quadrangle, northwest corner.

Table 1. Atomic Absorbtion Spectrophotometric Analyses of Samples from Lichen Prospect[2]

Sample	Cu (%)	Pb (ppm)	Zn (ppm)	Ag (ppm)	Au (ppm)	Ni (ppm)	
1	4.50	46	102	33	16	42	Composite of three samples; gossan-stained massive metavolcanic
2	3.75	42	57	68	6	ND[1]	One sample; massive metavolcanic with malichite stain
3	0.62	17	98	6	6	53	Composite of three samples; sulfide-bearing schistose greenstone
4	1.68	32	91	24	6	43	Composite of three samples; sulfide-bearing massive metavolcanic
5	1.16	24	28	10	5	46	Composite of three samples; sulfide-bearing chloritized greenstone
6	3.27	48	119	58	15	35	Composite of three samples; massive metavolcanic with malachite stain
7	3.18	37	110	27	5	45	One sample; schistose metavolcanic
8	2.66	44	60	45	6	52	One sample; schistose metavolcanic
9	0.79	78	50	16	5	ND[1]	One sample; chloritized greenstone
10	3.24	36	43	35	5	31	One sample; gossan-stained metavolcanic of intermediate composition

[1]ND—Element looked for but not detected.
[2]Elemental analysis was performed by T.C. Trible at the Mineral Analyses and Research Laboratory in College, Alaska. The atomic absorbtion analysis was carried out by taking a 10-gram sample and digesting it in an appropriate amount of aqua-regia. The digestate was diluted to 100 ml with distilled water and centrifuged. The elements copper, lead, zinc, silver, and nickel were aspirated directly into an air-acetylene flame while gold was determined following a DIBK/Aliquot 336 solvent-solvent extraction.

Table 2. Semiquantitative Emission Spectrographic Analyses of Samples from Lichen Prospect[2]

Sample	Cr (ppm)	Sr (ppm)	Co (ppm)	Sc (ppm)	Mo (ppm)	V (ppm)	Mn (ppm)	B (ppm)	Ba (ppm)	Nb (ppm)	Sb (ppm)	Mg (%)
1	120	100	20	80	4	130	350	5	50	10	ND[1]	2.0
2	230	750	25	90	5	130	500	ND[1]	20	10	100	2.5
3	275	250	40	70	7	100	500	ND[1]	20	10	100	3.5
4	200	200	35	70	5	130	750	ND[1]	20	15	ND[1]	3.0
5	200	600	35	100	7	100	350	ND[1]	20	10	150	2.5
6	250	500	25	65	5	130	500	ND[1]	50	10	100	1.5
7	120	150	25	40	2	100	350	ND[1]	20	10	ND[1]	1.5
8	250	125	35	65	7	125	500	ND[1]	70	10	ND[1]	4.0
9	320	300	25	80	5	130	500	10	20	10	ND[1]	2.5
10	200	750	25	80	8	130	350	ND[1]	20	10	100	2.5

[1]ND—Element looked for but not detected.
[2]Emission spectrographic analyses were performed using the "six-step procedure." The values are reported on three-step series 1.2, 5, 10, 20, 50, 100, 200, etc. in ppm or percent. A reported value of 100 ppm identifies the concentration as nearer 100 than 50 or 200. Approximately 95% of the values fall within plus- or minus-one reporting interval. Be, Sn, W, and As were looked for but not detected.

million (tables 1 and 2). Outcrops are limited at the prospect; thus a high probability exists for extensions of the mineralized zone under surficial deposits of the area, as well as for the presence of other metalliferous strata in the flow sequence. The Lichen Prospect could represent the distal edge of a larger deposit. Further examination should include induced polarization surveys to delimit the extent of disseminated sulfide mineralization.

REFERENCES CITED

Csejtey, Bela Jr., 1973, Paleozoic island arc in Talkeetna Mountains *in* United States Geological Survey Programs, 1973 [abs.]: U.S. Geol. Survey Circ. 683, p. 45.

Hutchinson, R.W., 1973, Volcanogenic sulfide deposits and their metallogenic significance: Econ. Geology, v. 68, no. 8, p. 1223-1246.

Moffit, F.H., 1912, Headwater regions of Gulkana and Susitna Rivers, Alaska: U.S. Geol. Survey Bull. 498, 81 p.

Smith, T.E., 1973, Regional geology of the Susitna-Maclaren River area *in* Alaska Div. Geol. and Geophys. Surveys ann. rept., p. 3-6.

Stout, J.H., in process, Geology of the Eureka Creek area, east-central Alaska Range: Alaska Div. Geol. and Geophys. Surveys Geol. Rept. 46, 32 p.