Some Shorter Mineral Resource Investigations in Alaska

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Some Shorter Mineral Resource Investigations in Alaska

INTRODUCTION

This circular gives the results of several brief geologic studies on mineral resources in Alaska. These studies were made in 1967 for the Heavy Metals program of the U.S. Geological Survey during the course of more extensive geologic or geophysical research. Each article, however, describes an area favorable for prospecting or gives background data of interest to a prospector or economic geologist.

The first article describes a nickeliferous serpentinite in the Livengood ultramafic trend. The second article is a geophysical study on the depth to bedrock in the Wiseman area. The third article describes a new molybdenum occurrence in the Coast Range batholith near Juneau. This article points out that the Coast Range batholith west of Juneau is a very complex body, not a homogeneous rock unit of one age. This has an important implication, namely that parts of the Coast Range batholith in Alaska need more geologic evaluation before they can be considered unfavorable for ore deposits. The fourth article shows that anomalous amounts of certain elements could serve as geochemical tracers in the area of the White Mountain mercury deposit and summarizes the gold contents of some Alaskan mercury ores. The fifth article describes an area near Sikonsina Pass in the Alaska Range characterized by anomalous concentrations of gold, copper, and lead.

The areas reported on here are widely distributed in Alaska (fig. 1); they were studied by geologists, geophysicists, and chemists all cooperating in the U.S. Geological Survey's Heavy Metals program in Alaska. These individuals were greatly aided in their investigations by many Alaskans, and although it would be difficult to name all those who gave indirect aid, the Geological Survey wishes to acknowledge, specifically, assistance from R. F. Lyman, White Mountain mercury mine, and Andrew Miscovich, Porcupine Creek.

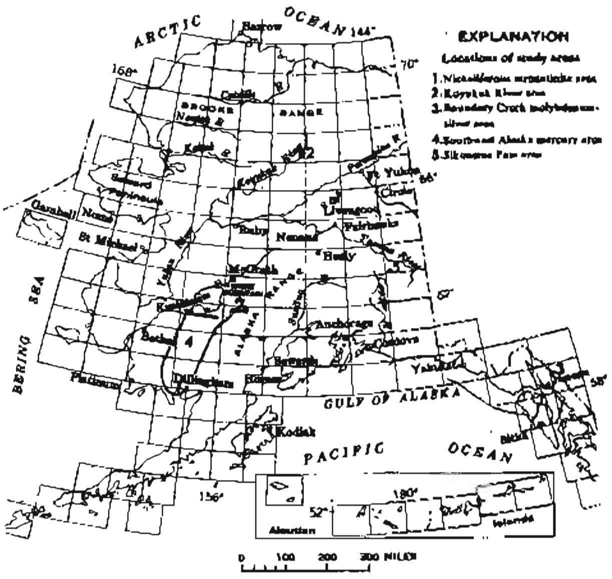


Figure 1.—Index map of Alaska showing locations of study areas.

Nickeliferous Serpentinite Near Beaver Creek East-central Alaska

By R. L. Foster

ABSTRACT

The Beaver Creek alpine-type serpentinite body in the northeastern part of the Livengood ultramafic trend, east-central Alaska, contains nickel concentrations of as much as 0.51 percent and, locally, detectable amounts of platinum and palladium.

INTRODUCTION

An irregular mass of nickeliferous serpentinite approximately 20 miles long, with maximum width of over 1 mile, crops out in the Livengood C–2 and C–3 quadrangles, east-central Alaska. This northeasterly trending alpine-type serpentinite conforms generally to the regional structural grain and is flanked on the southeast by metamorphosed siliceous graywacke clastic rocks and on the northwest mainly by fractured and rehealed chert strata (fig. 2). The analytical results from samples of the ultramafic material collected during reconnaissance geologic examinations along this northeasternmost segment of the Livengood ultramafic trend (Foster, 1967) indicate that these rocks are abnormally nickeliferous as compared to some serpentinites from other parts of the world (table 1).

GEOLOGIC SETTING

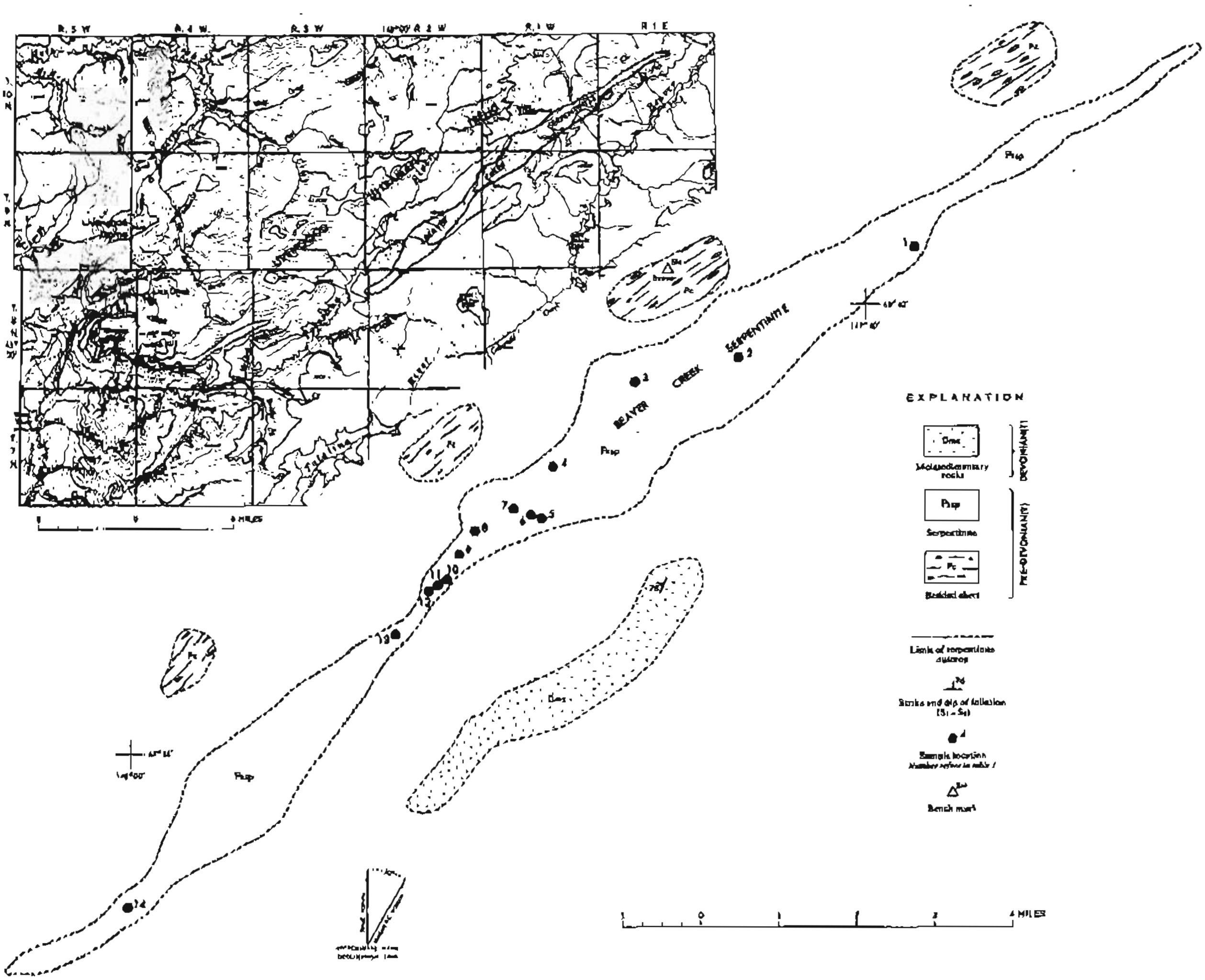
The serpentinite mass forms a conspicuous light-green to brown band which consists of outcrop and rubble and is characterized by sparse vegetation and low rolling hills with isolated pinnacles of more resistant rock. These pinnacles are tectonic inclusions or mafic igneous intrusives within the serpentinite terrane. Southeast of the serpentinite body are contorted Devonian(?) metagraywackes that contain abundant clasts of chert and igneous rock fragments. To the northwest are shattered massive and banded cherts. The juxtaposition of these divergent metamorphic rock types and the nature and geometry of the serpentinite mass suggest tectonic emplacement of the ultramafic material along a major reverse or strike-slip fault.

SERPENTINITE

The ultramafic rock is completely serpentinized, has no consistent internal fabric, and varies from a massive blocky variety to highly sheared slickentite. In the massive rocks, serpentine-group minerals occur as fine scaly aggregates in a semiradial distribution as lamellar fibrous scales normal to serpophite "eyes" or opaque veinlets, and as a semidecussate meshwork. The slickentite rocks have these same textures partially or totally modified by shear. Bastite, minor asbestos-fiber veinlets, and primary and secondary spinel group minerals are ubiquitous, whereas only traces of sulfides were recognized.

CONCLUSION

These ultramafic rocks contain concentrations of nickel which justify detailed investigation. Although the detected amounts of platinum, palladium, and rhodium are low, their presence is noteworthy. The possible existence of covered bodies on strike with or parallel to the major ultramafic trend could be tested by magnetometer surveys; coincident anomalies derived from electromagnetic and magnetic surveys could outline additional targets for physical exploration.



Base from U.S. Geological Survey, 1:63,360
Livengood C-3 and C-2, 1951

Figure 2.—Outcrop map of Beaver Creek serpentinite showing sample locations.

Table 1.—*Chemical analyses of Beaver Creek serpentinite*

[Analysts: Spectrographic, Arnold Farley, Jr.; chromium, G. T. Burrow; nickel, E. J. Rowe; palladium, platinum, and rhodium, L. B. Riley, W. D. Goss, and Joseph Haffty. Analyses, unless noted, are semiquantitative spectrographic and are reported in the series 0.1, 0.15, 0.2, 0.3, 0.5, 0.7, 1.0, 1.5, and so on, or by the following symbols: N, not detected; Tr, trace. Results are given in parts per million except for Cr, Ni, Fe, Mg, Ca, and Ti, which are given in percent. Looked for but not detected, limits of determination given in parentheses: Ag (0.5), As (200), Be (1), Bi (10), Cd (20), La (20), Mo (5), Nb (2), Pb (10), Sn (10), Sr (50), W (50), Y (10), Zn (200), and Zr (20); exceptions: Be, 2 ppm in sample 11; La, 30 ppm in samples 4 and 20; and Nb, <20 ppm in samples 7 and 13. Not determined because of interferences: Sn in sample 13 and Zn in sample 5. All samples contain <0.02 ppm Au and <100 ppm Ba. Sample localities are shown in figure 2]

Sample	Cu	B	Co	Mn	Pt[1]	Pd[1]	Rh[1]	Sc	V	Cr[1]	Ni[1]	Fe	Mg	Ca	Ti
1	7	20	150	700	<0.010	<0.004	<0.005	10	30	0.06	0.50	15	>10	<0.05	0.007
2	200	20	100	1,000	<.010	<.004	<.005	7	15	.11	.35	15	>10	.05	.01
3	5	30	100	1,000	Tr	.009	<.005	10	30	.10	.51	10	>10	<.05	.005
4	20	50	70	1,000	.011	<.004	<.005	10	50	.19	.48	7	>10	.1	.007
5	20	200	300	1,000	<.010	<.004	<.005	N	300	12.8	.33	15	5	.07	.07
6	20	70	70	500	<.010	.011	<.005	7	30	.20	.48	10	>10	.05	.015
7	10	20	100	700	<.010	<.004	<.005	15	50	.16	.48	10	>10	.07	.015
8	7	50	100	700	<.010	<.004	<.005	7	30	.15	.49	15	10	<.05	.007
9	100	30	150	1,000	.012	.033	<.005	10	50	.19	.36	15	10	.05	.03
10	7	70	100	700	.014	<.004	<.005	15	50	.13	.47	15	10	.07	<.001
11	15	50	100	700	Tr	.006	.005	15	70	.13	.21	10	10	.05	.03
12	30	70	100	700	.010	.004	.005	15	50	.08	.25	15	>10	.05	.005
13	5	50	150	500	Tr	Tr	.005	N	15	.32	.24	15	>10	.05	.007
14	15	50	150	700	Tr	.005	.005	15	30	.12	.25	15	10	<.05	.007
Limits of determination															
	5	10	5	10	0.01	0.004	0.005	5	10	---	---	0.05	0.02	0.05	0.001

[1] Specific instrumental or chemical method.

Sample	*Description*
1	Grab rock sample; blocky dark-green serpentinite (greenish-brown weathered surface).
2	Grab rock sample; blocky dark-green serpentinite with trace amounts of sulfides (reddish-brown lichen on weathered surface).
3	Selected rock sample; slightly sheared blocky dark-green serpentinite with minor fiber veinlets (light-green on weathered sheared surface).
4	Grab rock sample; blocky dark-green serpentinite (tan on weathered surface).
5	Selected scree rock sample; sheared black chromitite (brownish-white on weathered sheared surface).
6	Grab scree rock sample; dark-green slickentite (dark-green on weathered sheared surface).
7	Grab scree rock sample; dark-green mottled slickentite (olive-green on weathered sheared surface).
8	Grab rock sample; blocky dark-green bastitic serpentinite (green on weathered surface).
9	Grab rock sample; blocky dark-green serpentinite with parallel elongate bluish-gray mottling (greenish-white on weathered surface).
10	Selected rock sample; blocky dark-green serpentinite (rusty-brown on weathered surface).
11	Grab rock sample; blocky dark-green bastitic serpentinite (light-green on weathered surface).
12	Grab rock sample; blocky dark-green serpentinite (light-green on weathered surface).
13	Grab rock sample; blocky dark-green mottled serpentinite (olive-green on weathered surface).
14	Selected rock sample; blocky dark-green serpentinite with pervasive metallic veinlets (greenish-white on weathered surface).

Bedrock Depth by Resistivity Soundings, Middle Fork of the Koyukuk River

By L. A. Anderson and G. R. Johnson

ABSTRACT

Six resistivity soundings were made near the town of Wiseman and Porcupine Creek on the Middle Fork of the Koyukuk River in Alaska. The purpose of the soundings was to evaluate this method as a means of determining bedrock depths in the vicinity of the main stream channel as the first step in appraising the potential of the Middle Fork valley for a gold-dredge operation. Considerable difficulty was met in interpreting the soundings in the absence of detailed geologic control, but a reasonable interpretation of bedrock depth at Porcupine Creek is 60 feet and at Wiseman, 13 miles north, 270 feet. The reason for the rather large difference in bedrock depths at the two locations is unknown.

INTRODUCTION

Placer gold has been obtained by drift mining, caterpillar and dragline operations, hydraulic mining, or various combinations of these from many tributary valleys to the Middle Fork of the Koyukuk River since about the turn of the century. The contribution of gold from the tributaries to the main valley of the Middle Fork suggests that, unless other factors such as glaciation have interfered, the main valley itself should locally be gold bearing. This possibility further suggests that a large-scale dredging operation in the main river channel may be economically feasible, but before such an undertaking can be considered, the thickness of the stream gravels must be known.

The nature of the problem and its possible economic significance was outlined by H. N. Reiser of the U.S. Geological Survey, who accompanied the authors and aided in the investigation. The main purpose of the investigation was to test the resistivity-sounding method as a practical approach for determining bedrock depths at selected locations along the Middle Fork of the Koyukuk River. Four days were allotted to the survey, and in the span of time, a thorough investigation of the bedrock problem was not possible. The data are reported, however, because possibly meaningful depths were obtained at two stations and because considerable experience was gained on the application of the resistivity-sounding method in a complex geologic environment.

The general location of the Middle Fork of the Koyukuk River is shown in figure 1; the locations of the six electrical-sounding stations and the geologic setting near Wiseman and Porcupine Creek are shown in figure 3. The resistivity surveys were made in these areas because of their landing facilities for aircraft. A river boat rented in Wiseman and a tracked vehicle borrowed from Mr. Andrew Miscovich at Porcupine Creek were of considerable help in reducing the travel-time between sounding locations.

Problems and procedure

The problems met in applying the resistivity method in interior Alaska have been discussed by Joesting (1941) and by Barnes and McCarthy (1964). One problem stems from the fact that permanently frozen ground (permafrost) forms a near-surface highly resistive layer which is very difficult to penetrate electrically. The permafrost can be penetrated if very large separations between current electrodes are used, but the presence of permafrost reduces the resolving power of the method in determining the electrical conductivity of the rock material underlying the permafrost. The permafrost is often laterally discontinuous, which adds to the complexity of the resistivity-sounding curve and makes interpretation more difficult and often unreliable.

Another serious problem in applying any geophysical method in the Middle Fork area is the lack of detailed geologic control, which is essential if a definitive interpretation of the geophysical data is to be made. In the absence of detailed information, it was assumed that the geologic section was relatively simple: sand and gravel resting on a schist bedrock. In order to determine the thickness of the sand and gravel by the resistivity-sounding method, a significant resistivity contrast must exist between the resistivity of the stream gravel and that of the schist. The resistivity ranges of rock materials obtained for interior Alaska by Joesting (1941), our own experience with resistivity

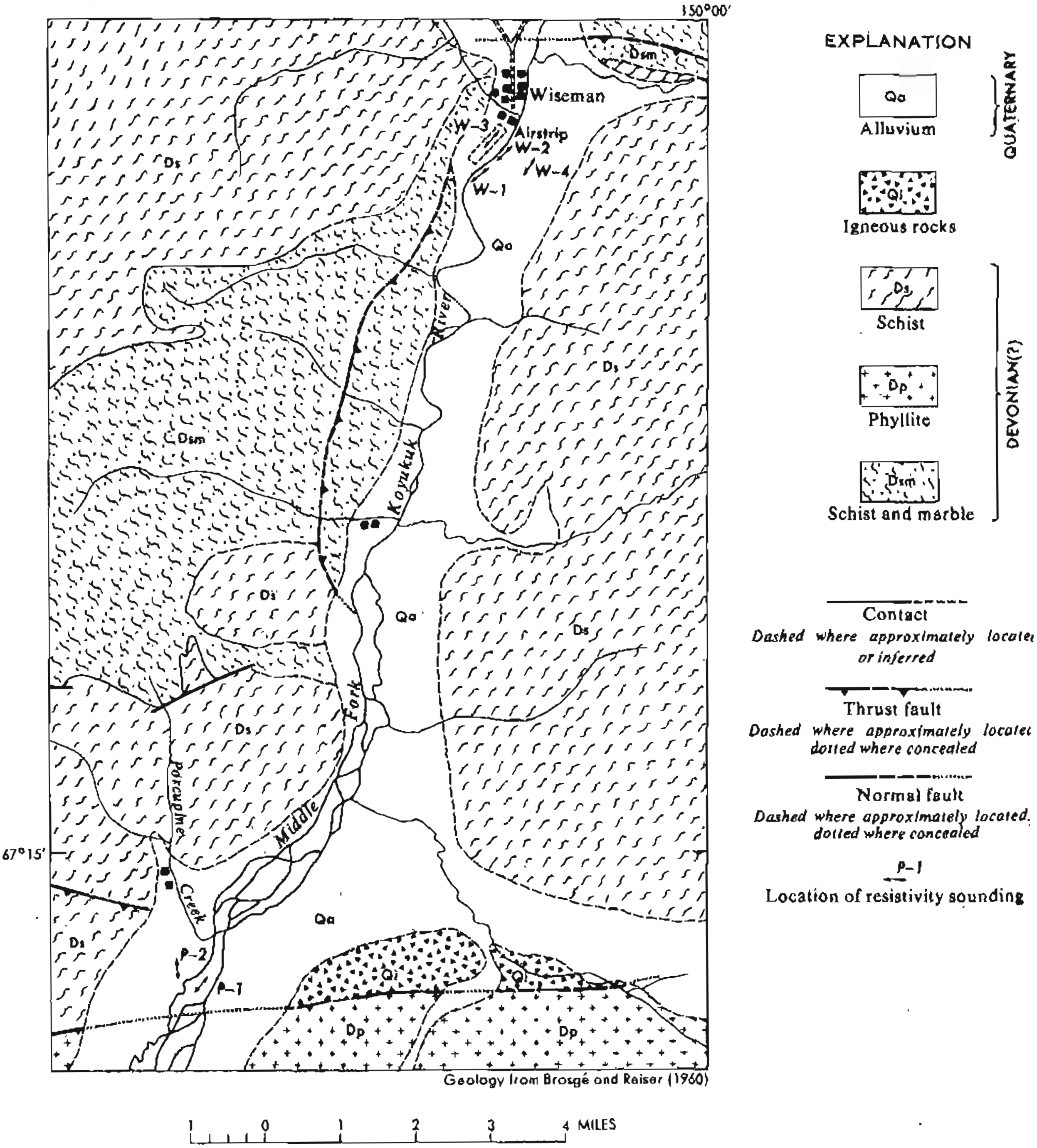


Figure 3.—Map of the Middle Fork of the Koyukuk River showing resistivity-sounding locations and the generalized geology.

soundings in the Fairbanks area, and laboratory measurements on representative samples of the schist from Porcupine Creek were helpful in interpreting the Wiseman-Porcupine Creek resistivity data.

The resistivity surveys were made using the Schlumberger array and the resulting data were interpreted in two steps. First, the album of three-layer Schlumberger theoretical curves (Orellana and Mooney, 1966) was used in conjunction with the auxiliary point diagrams to interpret multilayer curves (Kalenov, 1957; Keller and Frischknecht, 1966; Orellana and Mooney, 1966; and Zohdy, 1965). Second, the geologic section constructed on the basis of the geophysical interpretation was modeled by means of an IBM 360/65 computer to approximate the curve described by the field data. Good agreement between the theoretically computed curve and the field data lends credibility to the original interpretation but does not signify a unique solution.

WISEMAN AREA

Four resistivity soundings were made in the Wiseman area, with the intention of obtaining a bedrock profile starting on the airstrip on the west bank of the river and extending across the stream deposits to a winter trail on the east bank. Two of the soundings (W-1 and W-2, fig. 3) were made on sand and gravel bars in the channel of the Middle Fork.

Only one (W-1, fig. 3) of the two soundings on the river channel deposits was interpreted. Lateral inhomogeneities in the near-surface gravel at sounding location W-2 caused data scatter on the resistivity-sounding curve, and an interpretation was not considered feasible. Sounding W-1, made on a sand lens overlying the gravel, gave a relatively smooth sounding curve (fig. 4). The geologic section interpreted from the curve is indicated in figure 4.

On the basis of laboratory resistivity measurements, the 140-ohm-meter material comprising the uppermost bedrock layer is assumed to be graphitic schist. The geologic map by Brosgé and Reiser (1960) described the schist at Wiseman and black mica and quartz-mica; rocks of this type would be expected to have a resistivity significantly greater than 140 ohm-m. Joesting (1941) reported a range of 200-800 ohm-m for schists from various localities in interior Alaska, and our work near Fairbanks in 1967 suggests a resistivity range of 300-1,000 ohm-m for schist

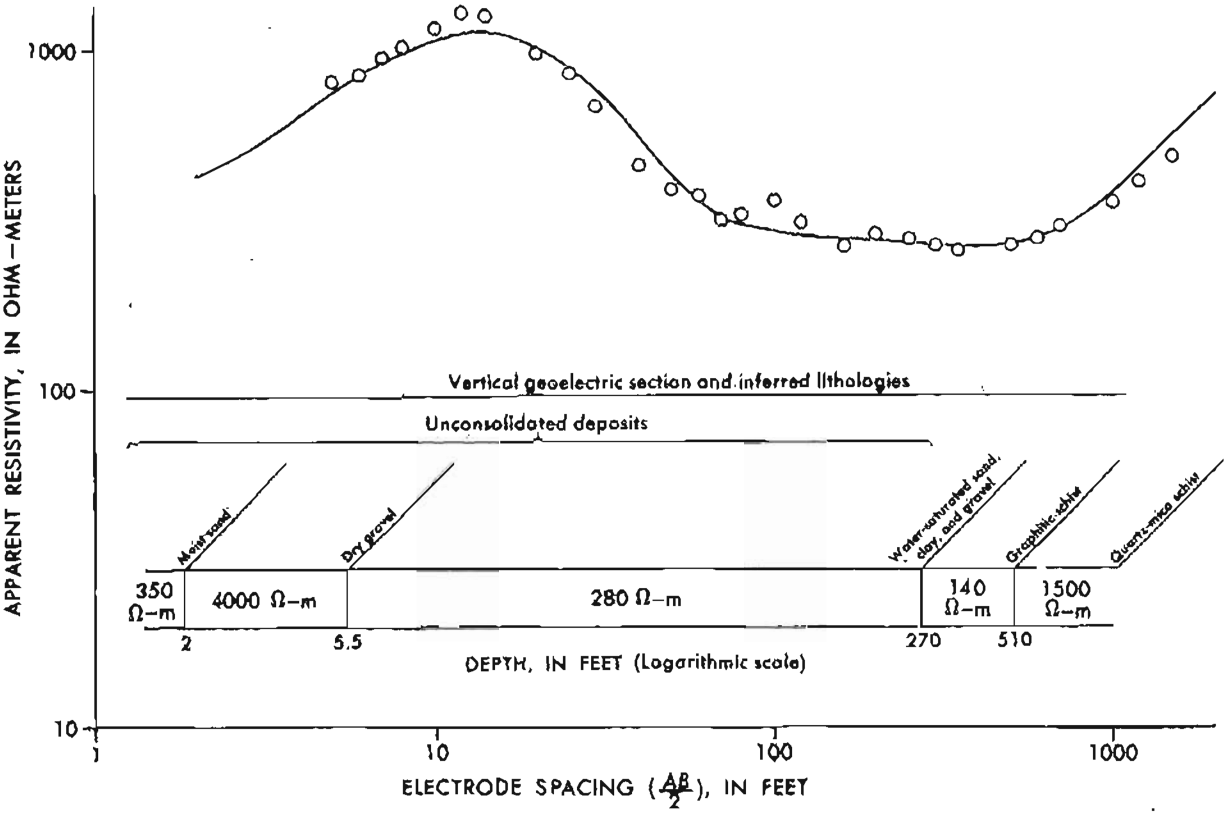


Figure 4.—Resistivity sounding (W-1, fig. 3) made adjacent to the main stream channel near Wiseman. The circles are the field data from which the vertical geoelectric section was determined. The solid line is a theoretical curve computed using the geoelectric section as a model. The electrode-spacing axis is also the depth axis for the inferred geologic column in which the values of resistivity are indicated.

containing little or no graphite. For sections of schist near Fairbanks suspected to be graphitic, values of resistivity as low as 30 ohm-m were obtained. Laboratory measurements on the Porcupine Creek schist samples show the resistivity to be less than 200 ohm-m. To gain some assurance that the low resistivity was caused by graphite, a total-carbon analysis and an X-ray pattern were obtained on concentrates from one of the samples. Both methods verified the existence of graphite, although not any large amount. However, a slightly graphitic schist can provide innumerable conduction paths along which current can easily flow, thereby reducing the resistivity of the rock below that measured on small rock samples.

The possibility exists that a layer of schist, electrically indistinguishable from the stream gravel, overlies the graphitic schist unit. If this were true, the depth to bedrock would obviously be less than the 270-foot figure determined from the sounding interpretation. On the other hand, if the 140-ohm-m layer, thought to be graphitic schist, was actually clay-rich gravel, the bedrock surface would be at a depth in excess of 500 feet. The valley configuration is not consistent with a gravel thickness of this magnitude, and therefore it is felt that 270 feet is the maximum depth to bedrock.

The curve of the resistivity sounding (W-3) made on the airstrip (fig. 5) could not be interpreted in its entirety because the second maximum on the curve cannot be matched to a curve describing a laterally homogeneous layered section. The interpreted part of the curve indicates a soil cover less than 2 feet thick underlain by dry gravel which extends down to 12 feet, the probable level of the water table. The third layer is water-saturated sand, clay, and gravel. This unit has electrical properties which suggest that the top of a lenticular body of permafrost exists at a depth of about 88 feet from the surface. The resistivity of the permafrost is extremely high and has been assigned a value of infinity in the vertical geoelectric section

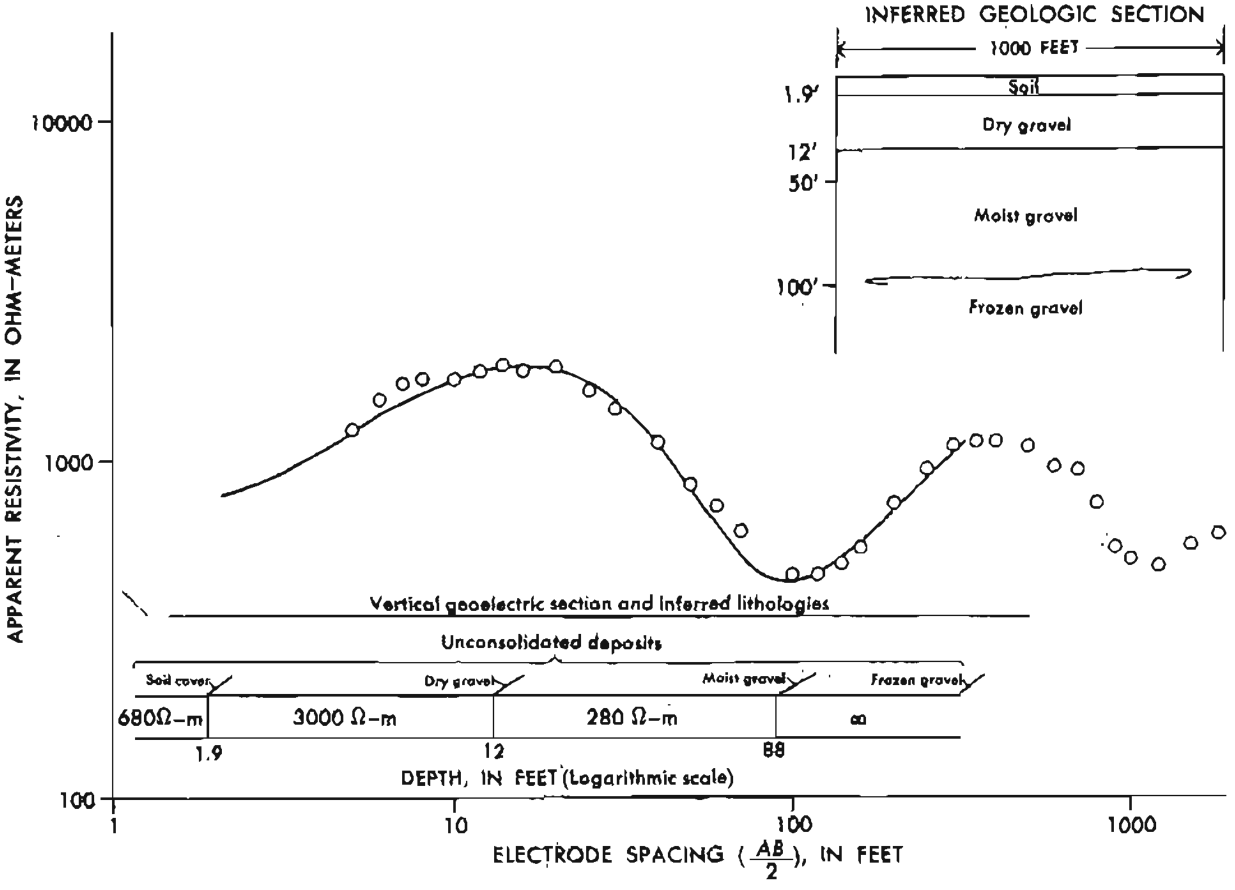


Figure 5.—Resistivity sounding made on the Wiseman airstrip (W-3, fig. 3). The circles are the field data from which the vertical geoelectric section was determined. The solid line is a theoretical curve computed using the geoelectric section as a model. The electrode-spacing axis is also the depth axis for the inferred geologic column in which the values of resistivity are indicated. The vertical geologic section in which a permafrost lens is included is, in part, inferred from the uninterpretable part of the field curve.

shown in figure 5. The observed rapid decrease in the apparent resistivity at *AB*/2 spacings (half the distance of the current-electrode separation) between 400 and 1,200 feet is apparently a result of the horizontally discontinuous nature of the permafrost body.

To illustrate the effects of a horizontally discontinuous resistive layer at some depth on the shape of the sounding curve, two diagrams have been taken from Alfano (1959) (fig. 6*A* and *B*). The characteristics of the modeled structures are indicated in the sketches adjacent to the vertical electric-sounding curves. In these sketches the midpoint of the sounding is represented by a center line, ℄, and the sounding direction is represented by the arrows. The resistivity contrast, $\rho_2 : \rho_1$, between the second and first layers is 19 to 1; the third-layer resistivity is equal to ρ_1. Layers 1 and 2 are equal in thickness, and layer 3 is infinite in thickness.

In figure 6*A*, the sounding curve for a horizontally homogeneous three-layer medium (dashed line) is compared with the sounding curve obtained when the second layer is truncated some distance τ from the center of the sounding array (solid line). The deviation from the standard curve caused by the truncation of the second layer can be erroneously interpreted by assuming a greater resistivity contrast between the second and third layers than actually exists and by interpreting the descending part of the curve in terms of more than one layer decreasing monotonically in resistivity with depth. However, it is not quite possible to match theoretical curves describing a layered condition with a field curve in which one layer is discontinuous without subjecting the field data to some degree of smoothing. In figure 6*B*, the standard curve for a horizontally homogeneous three-layer condition (dashed line) is compared with the curve obtained when the second layer is truncated at both ends (solid line). The descending part of the curve falls off so rapidly that an interpretation by curve matching with curves for horizontally homogeneous media is impossible.

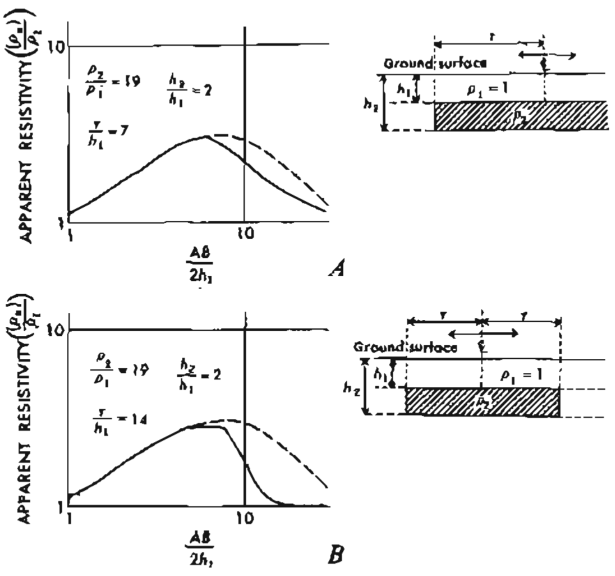


Figure 6.—Comparison of resistivity curves for a horizontally layered section of infinite lateral extent (dashed lines) with: *A*, The resistivity curve obtained when the second layer is semi-infinite in horizontal dimension (solid line). *B*, The resistivity curve obtained when the second layer is finite in horizontal dimension for the indicated conditions (solid line). Modified from Alfano (1959).

The decrease in the apparent resistivity (fig. 5) following the second maximum most nearly corresponds to the effects noted for the two-dimensional body of finite lateral extent. The maximum resistivity value on the solid curve shown in figure 6*B* occurs at a spacing approximately equal to one-half of the distance τ; therefore, it may be reasonable to assume that the permafrost layer at the Wiseman airstrip pinches out approximately 800 feet from the midpoint of the sounding array.

The effect of the resistive schist at depth can be observed in figure 5 at electrode spacings greater than *AB*/2=1,000 feet, but the existence of graphitic schist within the section cannot be ascertained. The distortion of the sounding curve due to the permafrost lens makes it of little value in determining the depth to bedrock except to say that the bedrock surface must be deeper than 88 feet.

The resistivity sounding (W–4) made on the east bank of the river is shown in figure 7. The sounding data were not interpreted because the curve could not be matched with the standard theoretical three-layer curves for horizontally homogeneous media. The field curve rises rapidly, presumably sensing the near-surface permafrost, and at *AB*/2 spacings greater than 200 feet, the apparent resistivity decreases at a rate greater than possible for a horizontally layered condition. The decrease in the resistivity values is probably caused by lateral effects as described by Alfano (1959) and as illustrated in figure 6, although similar effects from other lateral conditions are possible.

PORCUPINE CREEK AREA

Weather conditions and local flooding limited the number of soundings to two near Porcupine Creek; one on the stream gravel and the other on the west bank of the Middle Fork of the Koyukuk River. The sounding on the west bank proved to be extensively underlain by permafrost and was not interpreted.

The sounding on the stream gravel (P–1) is shown in figure 8. The geologic section interpreted from the curve is indicated in figure 8.

The resistivity change within the upper sand and gravel at 7.5 feet is probably due to the influence of the water table at that level. The 260-ohm-m section

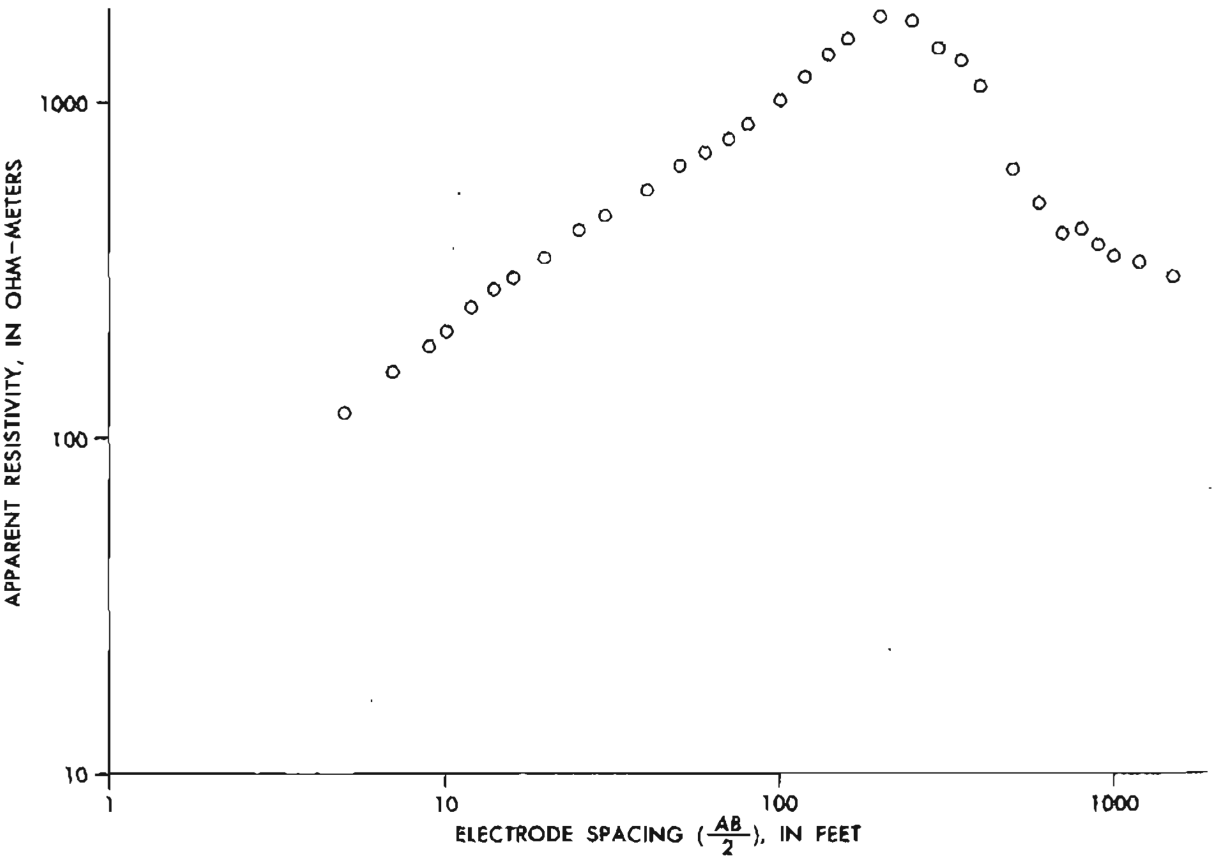


Figure 7.—Resistivity sounding (W-4, fig. 3) made along winter trail, east bank of the Middle Fork of the Koyukuk River near Wiseman.

from 30 to 60 feet correlates well with the 280-ohm-m sand, clay, and gravel detected near Wiseman. The bedrock, having a resistivity of 130 ohm-m and thought to be graphitic schist, is very similar to that at Wiseman and is interpreted to be 60 feet below the surface. The graphitic schist(?) unit appears to become more conductive with depth at this site, whereas, in the Wiseman area it is rather thin and underlain by a resistive rock unit. The fact that the supposed graphitic schist at Porcupine Creek is almost 1,000 feet thick precludes any identification with a clay-rich stream deposit and is accordingly thought to constitute the bedrock layer here and at Wiseman.

SUMMARY AND CONCLUSIONS

In the absence of certain geologic information, the assumption was made that graphitic schist with a resistivity of 130–140 ohm-m is the local bedrock in the Wiseman and Porcupine Creek sounding areas. If this assumption is valid, the resistivity data indicate a rather large discrepancy between the bedrock depths at sounding W–1 near Wiseman (270 feet) and P–1 near Porcupine Creek (60 feet). The interpreted 210-foot difference in bedrock depths at the two survey locations may possibly be explained by the much broader valley of the Middle Fork of the Koyukuk River at Porcupine Creek. The inferred bedrock depth of 60 feet at Porcupine Creek is within reach of a large dredge. On the other hand, the inferred 270-foot-bedrock depth at Wiseman is well beyond reach of any known dredge. The sounding on the Wiseman airstrip (W–3) supports the impression that bedrock is deeper in this area than at Porcupine Creek.

Additional resistivity soundings should provide additional information on bedrock depth, especially if it is possible to avoid permafrost areas by working on the sand and gravel bars adjacent to the present-day stream channel. However, the uncertainties involved in correlating the geoelectric section with the geology would still be a significant shortcoming in this approach to the problem. A series of gravity profiles across the valley coupled to bore holes drilled for control might be more effective because the entire valley configuration could then be established without regard to the limitations imposed on the resistivity method by permafrost.

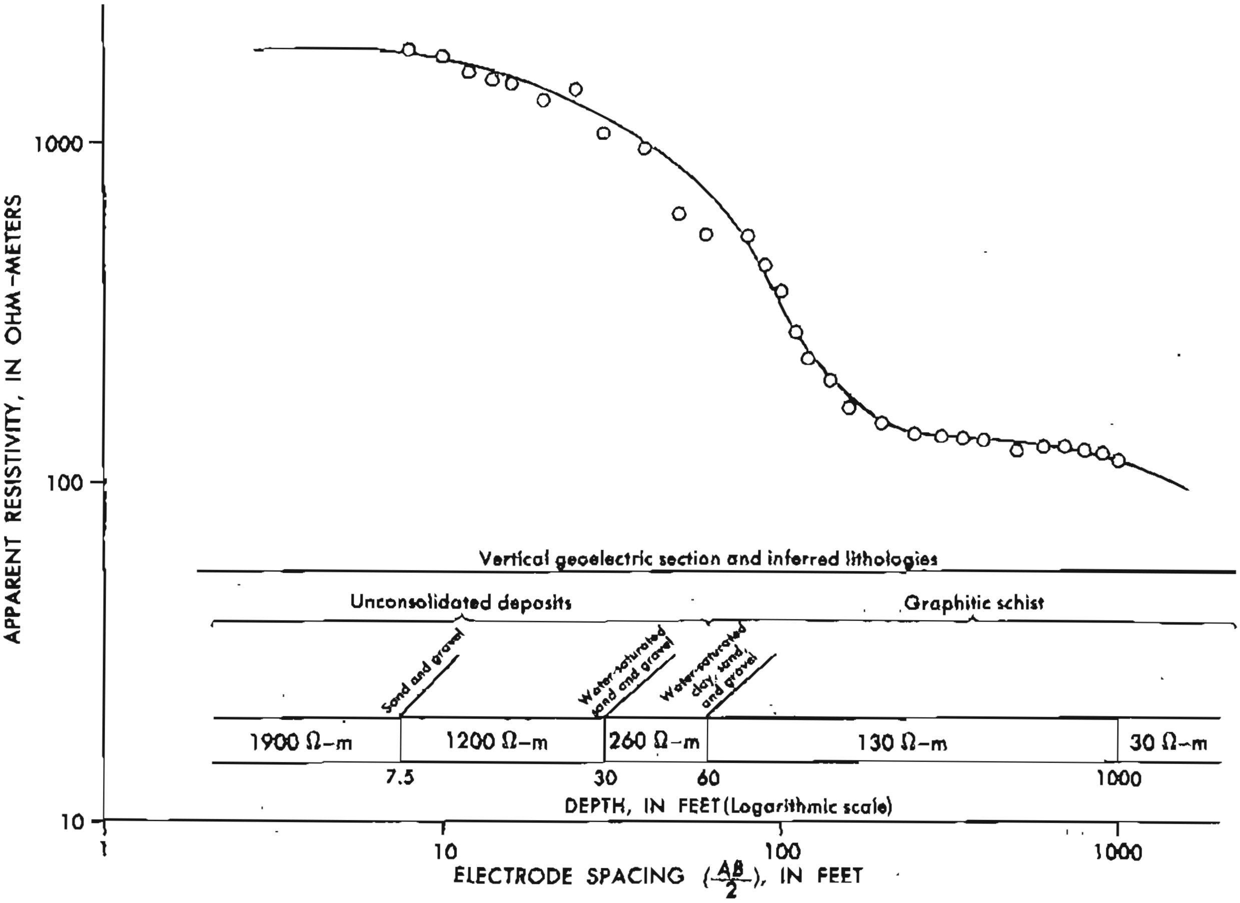


Figure 8.—Resistivity sounding made near Porcupine Creek (P-1, fig. 3). The circles are the field data from which the vertical geoelectric section was determined. The solid line is a theoretical curve computed using the geoelectric section as a model. The electrode-spacing axis is also the depth axis for the inferred geologic column in which the values of resistivity are indicated.

Boundary Creek Molybdenum-silver Occurrence

By David A. Brew and A. B. Ford

ABSTRACT

Two molybdenite occurrences with local anomalous concentrations of silver were found in a dikelike body of iron-stained granodiorite and aplite; the body is more than 2 miles long and at least 2,000 feet thick. The Tertiary(?) granodiorite-aplite body cuts tonalite and related rocks of Cretaceous(?) age approximately 10 miles north of the Taku River and 5 miles west of the United States-Canadian border.

INTRODUCTION

A previously unreported occurrence of mineralized rock with unusually high molybdenum and silver content was found during geologic field studies in the Juneau Icefield area on August 5, 1967. The mineralized rock is well exposed in a recently deglaciated cirque at the headwaters of Boundary Creek and consists of intensely iron-stained aplite with locally visible molybdenite. The complete extent of the mineralized area is not known, but the dikelike granodiorite and aplite host unit is at least 2 miles long, is exposed for 2,000 vertical feet, and has several prominent iron-stained zones within and near it. Two samples contain 1,000 ppm (parts per million) molybdenum each, 300 ppm and 7 ppm copper, and 9.6 ppm and 0.9 ppm silver, respectively.

Location

The Boundary Creek molybdenum-silver occurrence is on the eastern periphery of the Juneau Icefield (figs. 9 and 10) about 31.5 miles northeast of Juneau in southeastern Alaska (fig. 9). The sampled occurrence is 4,450 feet above sea level near the north end of the crest of the southeast-facing cirque that contains the headwaters of Boundary Creek, a stream that joins the Taku River about half a mile west of the United States-Canadian border. The cirque face is partly covered by an icefall which is a remnant of the glacier that once filled the valley of Boundary Creek. Northwest of the crest the glacier joins the Hades Highway Glacier of the Juneau Icefield.

The icefall has receded in recent years and is not as extensive as shown on the Taku River C-6 quadrangle (U.S. Geol. Survey, 1:63,360 topographic map series) which provided the contours and glacier limits shown in figure 10. The deglaciation has exposed bedrock for at least 2,000 vertical feet on the north side of the cirque. Although steep, the cirque wall is quite easily accessible from the top and the bottom.

The area is most easily reached by air. Helicopters can land easily on the cirque crest, cirque floor, and elsewhere in the vicinity. Ski-wheel aircraft can land on the gently sloping glacier surface northwest of the crest. The area can be reached on foot from either the icefield side or via Boundary Creek. The latter would involve a laborious hike of about 11 miles up the brushy valley of the creek from Taku River. The former would involve a glacier traverse of much greater length.

GEOLOGIC SETTING

The oldest rocks in the vicinity of the Boundary Creek molybdenum-silver occurrence are schistose biotite hornfels, hornblende hornfels, calcsilicate hornfels, and minor marble (fig. 10). These metamorphic rocks are folded about north- to west-trending axes and are locally cut by abundant small dikes of fine-grained leucocratic granodiorite. These rocks are tentatively correlated with rocks of Mesozoic age just across the United States-Canadian border (Kerr, 1948; Forbes, 1959).

The hornfelses are cut by two groups of igneous rocks—an older group dominated by tonalite (quartz diorite), and a younger group dominated by granodiorite. The molybdenum-silver occurrences are in aplite or altered granodiorite of the younger group. The tonalite group is composed of hornblende tonalite, hornblende tonalite gneiss, and intrusion breccia with

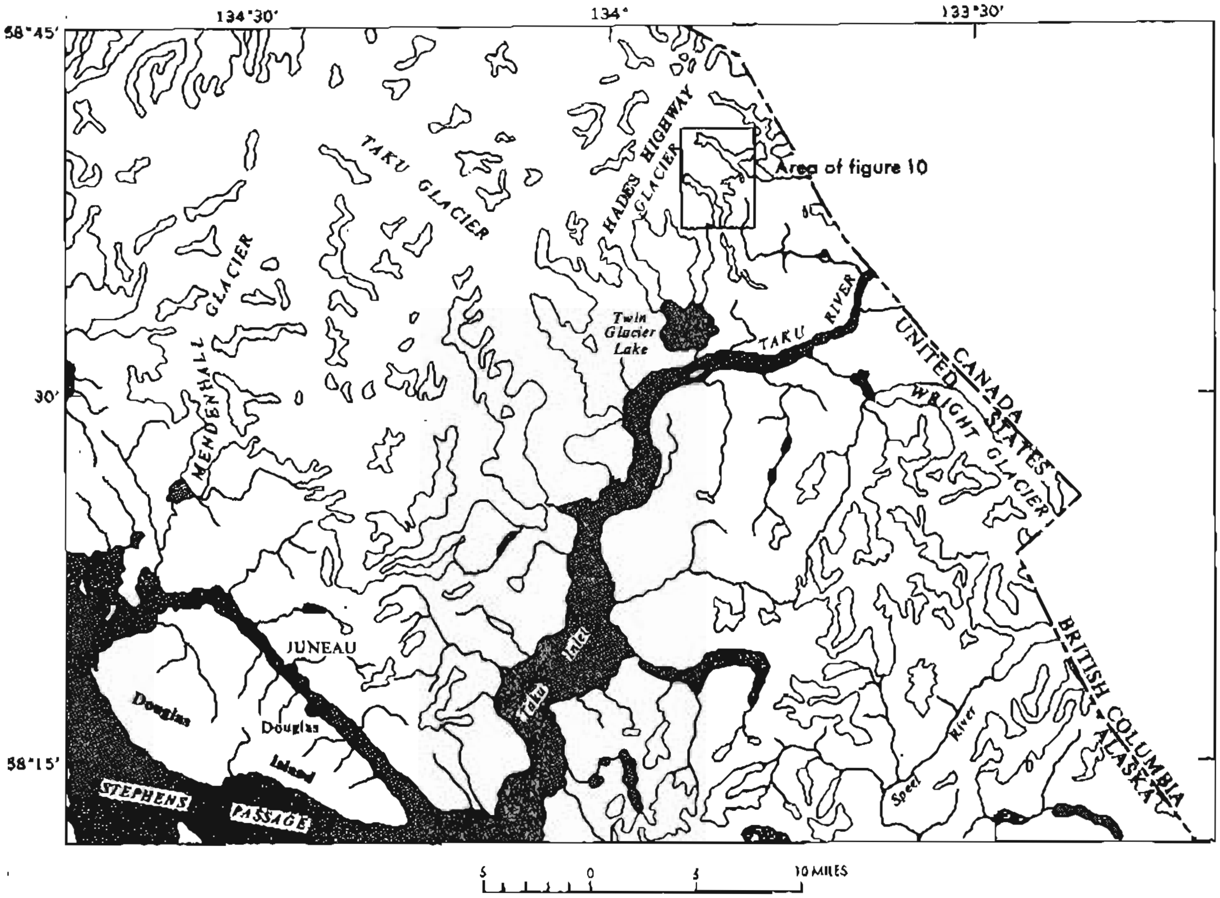
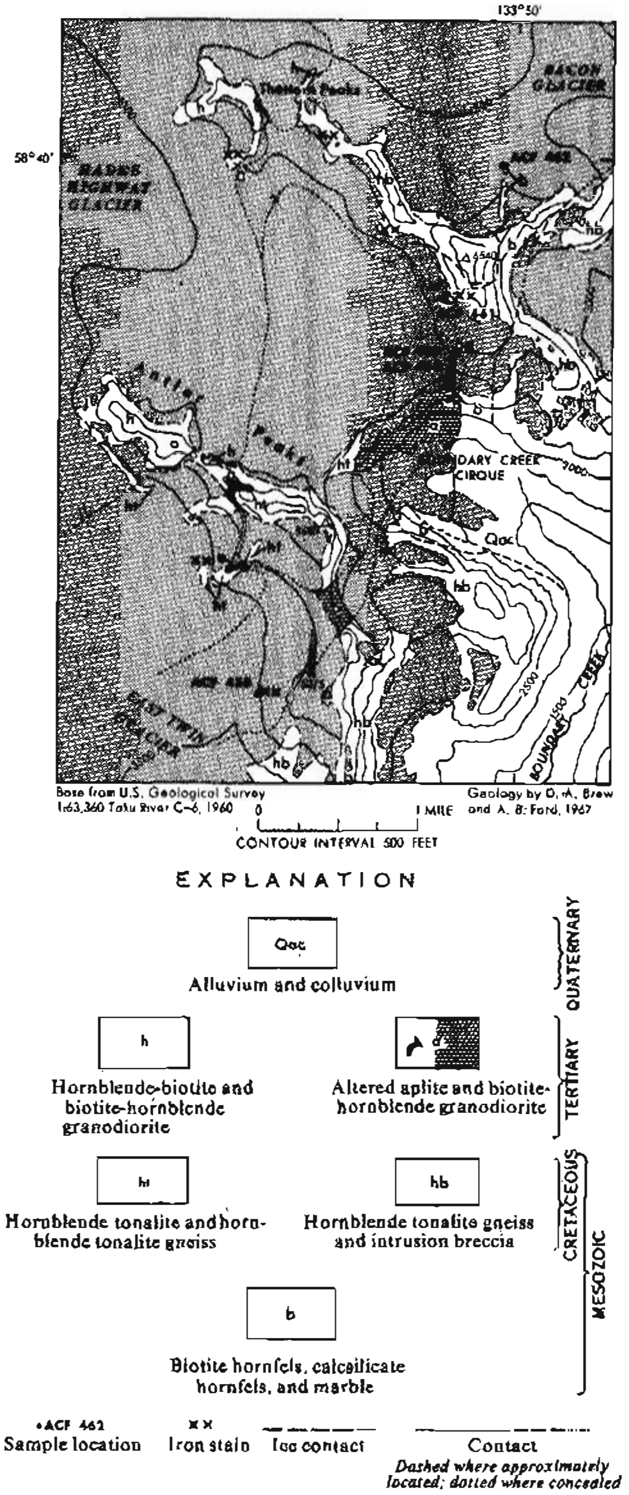


Figure 9.—Index map showing Juneau and vicinity and the area of figure 10.

a matrix of hornblende tonalite. The tonalite and tonalite gneiss, mapped as a separate unit from the breccia (fig. 10), consists of foliated sphene-bearing hornblende tonalite and local zones of migmatitic gneiss. The intrusion breccia unit is similar in that it also contains homogeneous tonalite gneiss but in small amounts. It is dominatly a complex breccia of dark fine-grained mafic-rich fragments in a matrix of foliated tonalite. To the south beyond the map area this unit becomes more uniform and more like the tonalite and tonalite gneiss unit. These rocks are inferred to be Cretaceous in age on the basis of their similarity to Cretaceous igneous units elsewhere in northern southeastern Alaska (Brew and others, 1966; Loney and others, 1967).

The tonalite-rich sequence is intruded by leucocratic hornblende-biotite granodiorite, biotite-hornblende granodiorite, and aplite. These rocks are shown in figure 10 as two separate units on the basis of the presence or absence of alteration and of aplite, but they probably are part of the same intrusive complex and thus connect beneath the glaciers and to the southwest of the area shown in the figure.

In the northwestern part of the mapped area the unit is a locally foliated, light-yellowish-gray-weathering hornblende-biotite granodiorite which grades imperceptibly into biotite-hornblende granodiorite. It is part of the large granodiorite batholith which underlies much of the eastern Juneau Icefield. The dikelike unit which trends north-northeast through the center of figure 10 is the host rock for the Boundary Creek molybdenum-silver occurrence. Where exposed on the east side of East Twin Glacier the unit is medium- to coarse-grained biotite-hornblende granodiorite with less than 10 percent ovoid inclusions of hornblende tonalite. Northeast-striking joints there are locally intensely iron stained. On the crest of Boundary Creek cirque the unit consists of intensely iron-stained, creamy-weathering aplite. The relationship between the aplite and the granodiorite to the south is not known, but the aplite is inferred to be near the top of the dikelike body. These leucocratic bodies are correlated with the granodiorite at Turner Lake near Taku Inlet, which is Tertiary in age (M. A. Lanphere, oral commun., 1965).



Base from U.S. Geological Survey 1:63,360 Taku River C-6, 1960

Geology by D. A. Brew and A. B. Ford, 1967

Figure 10.—Geologic sketch map of the Boundary Creek molybdenum-silver occurrence and vicinity.

MOLYBDENUM-SILVER OCCURRENCE

The intensely iron-stained altered aplite exposed near the cirque crest (fig. 10), samples ACF459 and ACF460) contains local concentrations of visible pyrite and molybdenite. Analysis of sample ACF459 (table 2) represents a composite chip sample of iron-stained rock with little visible molybdenite. Sample ACF460 is a grab sample of rock with readily visible molybdenite. The intensely iron-stained area is at least 100 feet wide and is exposed over a slope distance of at least 300 feet. Distant observations indicate that this area probably extends well down the cirque wall. The sampled area with readily visible molybdenite is at least 6 feet wide and is exposed for a vertical distance of at least 12 feet.

Apophyses of the dikelike mass of aplite and granodiorite extend into the overlying metamorphic rocks. Sample ACF461 (table 2) is of iron-stained hornfels from an area of abundant aplite dikelets 500 vertical feet above the main aplite body. Other iron-stained zones noted in the north and south are shown in figure 10. One of these zones in recently deglaciated (still shown on base map as glacier-covered) granodiorite near the East Twin Glacier, is represented by sample ACF458 (table 2). Another, in sulfide-bearing dike rock which cuts hornfels near the Bacon Glacier, is represented by sample ACF462 (table 2).

The analyses show that molybdenum, silver, and copper are present in markedly anomalous amounts in the intensely iron-stained aplite near the crest of the cirque. Other elements which are also anomalously high in some samples include manganese, beryllium, bismuth, niobium, lead, mercury, and tin. Anomalously low elements are barium, strontium, and vanadium. These comparisons are based not only on the analyses given in table 2 but also on analyses of similar rocks beyond the limits of figure 10.

CONCLUSIONS

The available data are insufficient to adequately appraise the economic potential of the Boundary Creek molybdenum-silver occurrence. The potential size of the occurrence and the anomalously high analytical values of molybdenum, mercury, and copper suggest that further, more detailed, study is warranted, including mapping and sampling of the iron-stained and visibly molybdenite-bearing zones on the cirque wall.

Table 2.—*Analyses of molybdenite-bearing and associated rocks, Boundary Creek area*

[Analyses by semiquantitative spectrographic methods except analyses for Ag and Au, which are by atomic absorption and for As, Hg, and Sb, which are special analyses by a quantitative or semiquantitative method. Results are reported in parts per million, except for Mg, Fe, Ca, and Ti, which are reported in percent. Analyses by G. W. Sears, Jr., G. T. Burrow, E. J. Fennelly, and W. W. Janes. N, not detected; L, detected but below limit of determination; ---, not looked for; elements looked for but not detected: Cd, Pd, Pt, Ta, Te, W, and Zn, with the exceptions that Pd, Pt, Ta, Te, and W were not looked for in sample ACF462]

Sample No.	ACF458	ACF459	ACF460	ACF461	ACF462
Field No.	67ABd126	67ABd138B	67ABd138D	67ABd139B	67AFd206
Ag	<0.2	9.6	0.9	0.6	1.6
As	<10	<10	<10	<10	---
Au	<.02	<.02	<.02	<.02	<.02
Ba	1,500	150	30	2,000	1,000
Be	N	3	3	N	1
Bi	N	300	10	N	L
Co	N	N	N	30	L
Cr	2	1	1	10	L
Cu	1.5	300	7	150	30
Hg	<.01	<.01	<.01	<.01	.13
La	N	N	N	N	30
Mo	N	1,000	1,000	3	N
Mn	100	15,000	1,000	1,500	150
Nb	N	15	20	N	10
Ni	N	N	N	7	L
Pb	30	150	70	30	15
Sb	2	4	2	2	---
Sn	N	15	N	N	N
Sr	100	30	15	1,500	500
V	15	15	7	150	20
Y	N	70	20	20	20
Zr	150	200	10	100	150
Mg	.07	.07	.02	3.0	.15
Fe	1.5	5	.7	7	1
Ca	.07	.5	.5	7	.7
Ti	.1	.07	.07	.7	.15

Geochemical Data on the South Ore Zone, White Mountain Mine and on the Gold Content of Other Mercury Ores Southwestern Alaska

By C. C. Hawley, E. E. Martinez
and John Marinenko

ABSTRACT

Mercury ores of southwestern Alaska generally contain only trace amounts of gold or they are gold free. Gold was detected (0.03 ppm) in one new sample from the South ore zone, White Mountain mercury mine, and it exists in near crustal-background amounts to anomalous amounts in at least six other prospects widely scattered in southwestern Alaska that had been sampled previously. Only one sample (Cinnabar Creek mine) contained more than 0.10 ppm gold, and gold was absent or below detection in three samples from the Red Devil mine, the most productive mercury deposit of the region.

Although ore at the White Mountain mine is characterized by a sparsity of trace elements except mercury, the fault gouge in the main vein, South ore zone, is characterized by anomalous amounts of Ti, As, Sb, B, Cr, and Zr. Similar compositions of fault gouge elsewhere in the region may be a guide to mineralized areas.

INTRODUCTION

Mercury is widespread in southwestern Alaska and has been mined at several localities (Sainsbury and MacKevett, 1965). Cinnabar is associated with southwestern Alaska gold deposits in the Flat district and at Donlon and Little Creeks (fig. 11). Mercury is also associated with some gold deposits elsewhere, notably at the Getchell mine in Nevada (Erickson and others, 1964) where trace amounts of mercury, arsenic, and tungsten characterize the gold ore. Therefore, it seems worthwhile to gather data on the gold content of mercury ores in conjunction with the search for gold deposits. As an initial step in the accumulation data, samples were collected at one part of the White Mountain mine by C. C. Hawley during a brief visit in 1967. The results for gold at the South ore zone, White Mountain mine, were almost negative as gold was detected in only one of six samples. The same general sparsity of gold appears to characterize other southwestern Alaska mercury deposits. At the suggestion of C. L. Sainsbury, samples collected earlier and reported by Sainsbury and MacKevett (1965, table 1) were resubmitted for gold analysis. Of the 13 samples with adequate splits available, gold was detected only in eight. At the White Mountain mine, however, significant amounts of several other trace elements which may serve as tracers for mercury ore were detected in fault gouge in the South ore zone.

The White Mountain mercury mine is about 60 miles south-southeast of McGrath, approximately on the physiographic boundary between the Alaska Range and the Tanana-Kuskokwim Lowland (Wahrhaftig, 1965). The mine is best reached by air, and a good gravel airstrip is just west of the mine workings.

The other mines or prospects represented by the older samples are: (1) North ore zone, White Mountain, (2) Alice and Bessie mine, Willis Property, and Red Devil mine, Sleetmute area, (3) Red Top mine north of Dillingham, (4) Rhyolite prospect on Juninggulra Mountain, and (5) the Cinnabar Creek and Lucky Day prospects in the Cinnabar Creek area.

GEOLOGIC SETTING

The main deposits at the White Mountain mine are in a northeasterly trending zone about 1,600 feet west-northwest of the main break of the Farewell fault (Sainsbury and MacKevett, 1965, pl. 3). The zone of deposits coincides with a subsidiary fault system which places shales and limestones, or different limestones, all of Ordovician age, in juxtaposition. At the South ore zone, the subsidiary faults dip much steeper than the strata, but generally both dip steeply. Dolomitized or silicified limestones were recognized in the three main productive areas of the mineralized zone (Sainsbury and MacKevett, 1965).

The other prospects represented by the older samples are dominantly in graywacke and siltstone or altered diabasic(?) rocks as shown by the following information abstracted from Sainsbury and MacKevett (1965; pages given in parentheses refer to their report).

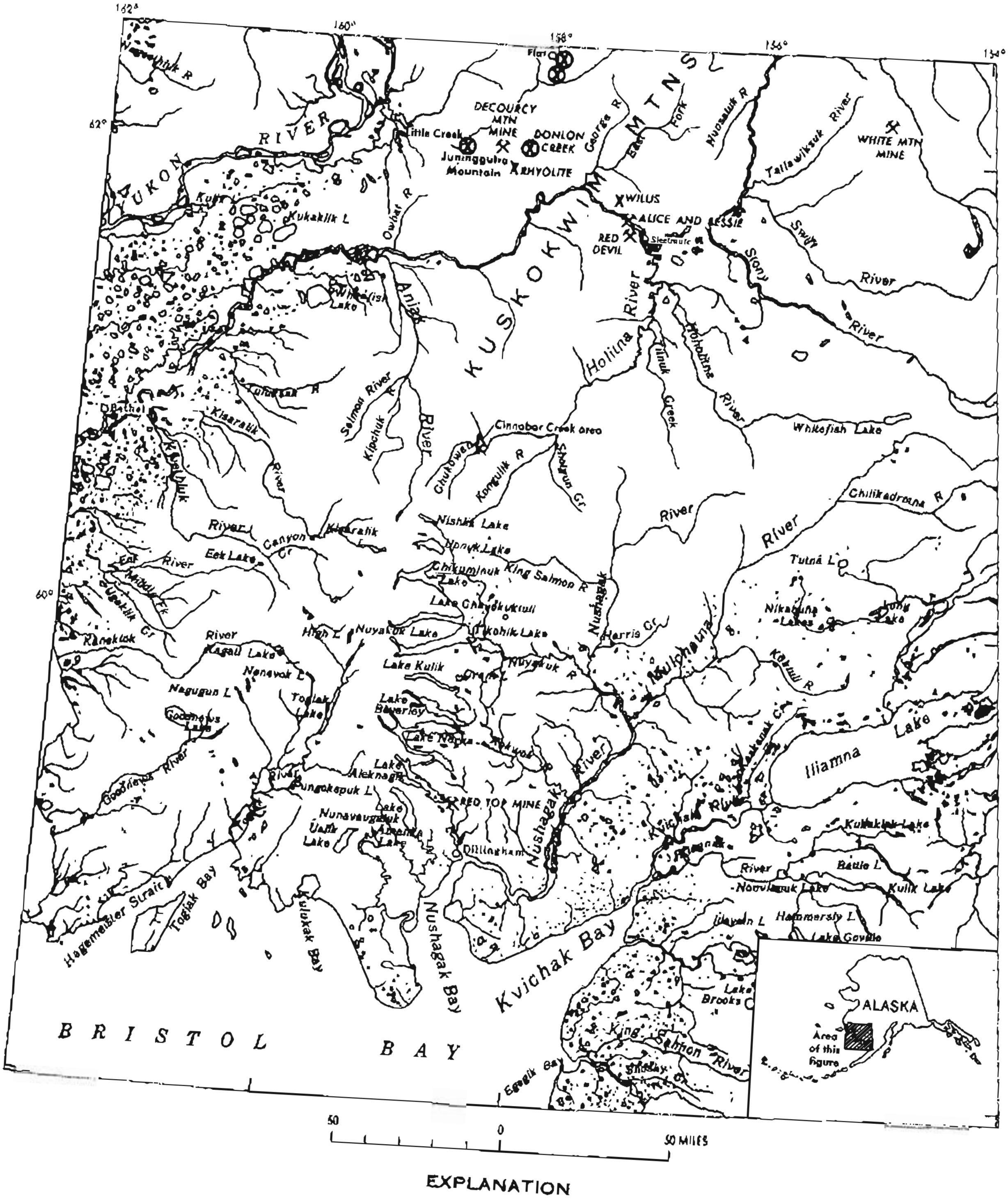


Figure 11.—Map showing locations of some mercury mines and prospects and areas with associated cinnabar and gold.

Sleetmute Area

Red Devil mine.—Mercury ores occur as pencil-shaped shoots along intersections between altered diabase(?) dikes and graywacke and slate of the Kuskokwim Group of Cretaceous age (p. 9–11).

Alice and Bessie prospect.—Mercury Ores occur in and near altered sills intruded into graywacke and slate of the Kuskokwim Group (p. 11–12, pl. 1).

Willie property.—Rocks are similar to the Alice and Bessie prospect (p. 15–18).

Cinnabar Creek Area

Cinnabar Creek mine.—Ore occurs in and near a northwesterly striking fault zone cutting graywacke and siltstone of the Gemuk Group of Mississippian(?) to Cretaceous age and an altered diabase(?) dike (p. 36–39, pl. 4).

Lucky Day prospect.—Massive siltstone of the Gemuk Group cut by dikes (p. 41–42).

Juninggulra Mountain

Rhyolite prospect.—Ore occurs in altered dike rocks and in graywacke of the Kuskokwim Group near a large mass of rhyolite porphyry (p. 46–47, pl. 6).

Dillingham Area

Red Top mine.—Graywacke and siltstone of the Gemuk Group, locally calcareous; one minette dike noted (p. 59–60, pl. 7).

Table 3.—*Analyses of mercury ores and associated rocks, South ore*

[Gold samples 1–7 analyzed by atomic absorption and arsenic, antimony, and tungsten, by by John Marinenko and Floyd Brown by rhodamine B fluorometric method following aqua regia method; other mercury analyses by atomic absorption. Results are given in parts per million, except for those indicated above, are semiquantitative spectrographic by E. E. Martinez and on, or by the following symbols: N, not detected; L, detected but below limits of limits of determination given in parentheses: Ag(0.5), Be(1), Bi(10), Cd(20), La(20), and in sample 5; La, detected but below limit of determination in samples 1 and 4]

Sample No.	Lab. No.	As	Au	B	Ba	Co	Cr	Cu	Hg	Mn	Nb	Ni	Pb
					South ore zone, White Mountain								
1		300	N	300	200	10	100	15	>6	200	10	30	20
2		20	N	L	N	N	L	1	>6	100	N	N	L
3		60	0.03	N	N	N	N	2	>6	150	N	N	L
4		300	N	200	200	100	100	2	>6	20	10	10	10
5		80	N	N	N	N	N	2	>6	200	N	7	L
6		30	N	N	N	N	N	2	>6	150	N	N	L
7	278244	N	.03	N	7	3	3	3	45.69	30	N	N	Trace
					Other localities, southwest Alaska								
8	278243	N	0.02	N	30	N	7	7	60.31	150	N	7	30
9	245	3,000	.02	N	300	N	3	70	10.6	30	N	7	30
10	246	N	<.01	N	15	N	3	30	57.68	70	N	N	N
11	248	N	<.006	N	70	N	30	30	38.74	300	N	N	N
12	249	N	.03	N	700	N	30	70	64.10	30	N	7	L
13	251	3,000	.14	L	300	N	3	30	6.53	70	N	7	L
14	252	N	.008	N	7	N	7	30	70.10	7	N	N	N
15	253	7,000	.05	N	30	7	30	70	35.87	15	N	30	30
16	254	3,000	.01	N	700	7	30	150	34.53	15	N	7	15
17	257	7,000	<.005	70	700	7	30	70	5.16	300	15	30	N
18	260	3,000	<.05	N	30	N	1.5	15	30.31	N	N	N	N
19	261	15,000	<.006	L	1,500	7	70	30	20.97	150	N	30	N
Limits of determination---		200	0.005–.02	10	5	5	5	5		10	10	5	10

Sample	*Description*
1 --------	1.0-foot channel sample; dark-brown clay gouge, footwall on breccia zone.
2 --------	7.0-foot channel sample; silicified limestone breccia, veinlike cinnabar near footwall, disseminated cinnabar throughout breccia.
3 --------	0.5-foot channel sample; high-grade cinnabar on hanging wall.
4 --------	1.5-foot channel sample; dark-brown clay gouge, central to breccia zone.
5 --------	5.0-foot channel sample; silicified limestone breccia.
6 --------	Grab sample of veinlike and disseminated cinnabar ore in thin-bedded limestone.
7 --------	Sample reported by Sainsbury and MacKevett (1965, table 1).

WHITE MOUNTAIN MINE

The White Mountain mine was discovered in 1958; mining started in 1964, and since then the mine has been operated during the summer seasons by R. F. Lyman. Mercury ore has been produced from three recognized zones at the mine, which were called the South, Center, and North ore zones by Sainsbury and MacKevett (1965). The data recorded here show the results of mining at the South ore zone and were collected in 1-day visit to the mine in 1967 by C. C. Hawley.

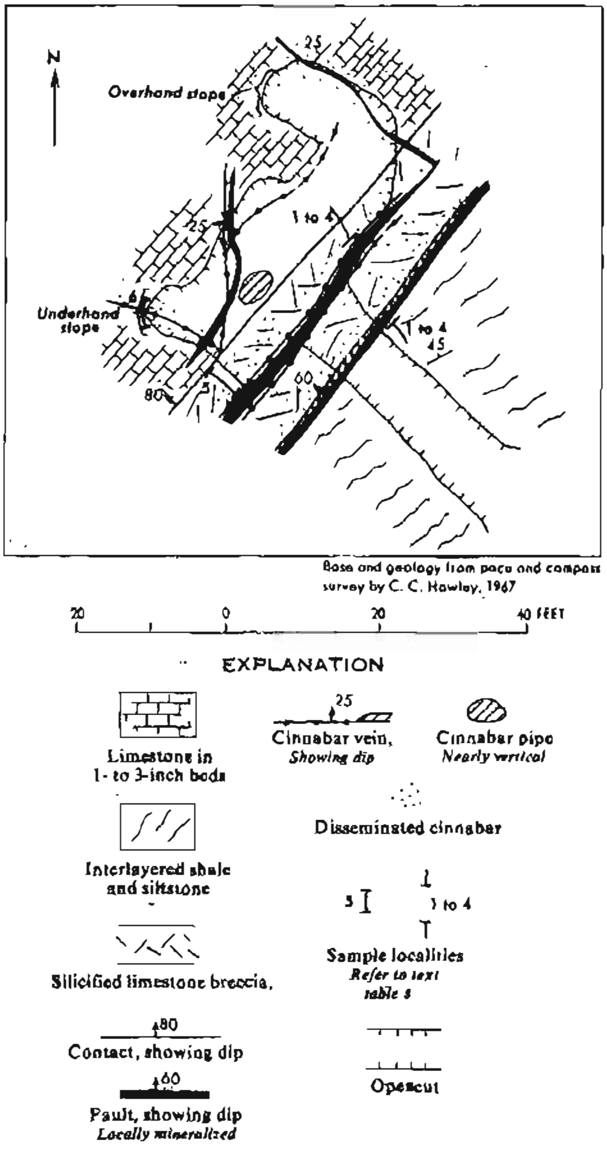
Most of the mercury produced from the South ore zone has come from a shallow open pit (fig. 12). From southeast to northwest the pit cuts interlayered shale and siltstone, a complex shear zone, and thin-bedded limestone. The fault zone strikes approximately N. 40° E. and dips 60°–80° NW. It is mainly composed of a silicified limestone breccia, but it also has cinnabar vein material and two prominent clay gouge zones, one on the footwall, and the second in the approximate center of the zone. Cinnabar is disseminated in the breccia, but it is especially concentrated next to the hanging wall of the footwall gouge zone and on both walls of the central gouge zone. Cinnabar also is found in the hanging-wall limestone, both in veins and in disseminations. According to R. F. Lyman (oral commun., 1967), very rich cinnabar also occurred in a nearly vertical pipelike body in limestone on the hanging wall of the fault zone, as shown in figure 12.

zone, White Mountain, and other localities, southwestern Alaska

special analyses by A. L. Meier, R. L. Miller, and T. A. Roemer. Gold samples 8-19 analyzed leaching. Mercury in samples 7-19 was determined by D. L. Skinner by the Whitton distillation except for Hg in samples 7-19 and Fe, Mg, Ca, and Ti, which are given in percent. Analyses, N. M. Conklin and are reported in the series 0.1, 0.15, 0.2, 0.3, 0.5, 0.7, 1.0, 1.5, and so determination; ---, not looked for. The following elements were looked for but not detected, Mo(15); exceptions are: Ag, 15 ppm in sample 12; Be, detected but below limit of determination

Sb	Sc	Sn	Sr	V	W	Y	Zn	Zr	Fe	Mg	Ca	Ti	Sample No.
						South ore zone, White Mountain--Continued							
5,000	15	L	N	100	<20	15	N	100	0.5	7	0.2	3	1
1,000	N	L	N	L	--do--	N	N	N	>10	.7	>20	.02	2
300	N	N	N	L	--do--	N	N	N	>10	1	20	.015	3
100	N	L	N	100	--do--	15	N	100	.5	5	.5	.5	4
100	10	L	N	L	--do--	N	N	N	>10	1	20	.005	5
100	N	10	N	N	--do--	N	N	N	>10	1	20	.002	6
N	N	N	150	15	N	N	N	N	7	.07	>10	.015	7
						Other localities, southwest Alaska--Continued							
N	N	N	300	30	N	N	N	N	0.7	3	3	0.015	8
>100,000	N	N	70	N	N	N	N	N	.07	.03	1.5	.0007	9
7,000	N	N	30	150	N	N	N	N	.7	.7	1.5	.015	10
150	N	N	150	15	N	N	N	N	.7	3	3	.03	11
300	N	N	70	15	N	N	700	N	1.5	.0015	.003	.07	12
>10,000	N	N	30	15	N	15	N	15	.7	.015	.07	.07	13
300	N	N	N	N	N	N	1,500	N	.15	<.001	<.002	N	14
>10,000	N	N	30	15	N	N	700	N	.3	.007	.03	.03	15
>100,000	N	N	30	30	N	N	700	N	.15	.003	.3	N	16
700	7	N	150	30	N	15	N	30	.7	.3	.3	.15	17
>100,000	N	N	N	N	N	N	N	N	.015	.0015	<.002	.0015	18
--do--	N	N	300	15	N	N	N	30	.07	3	.03	.07	19
100	5	10	50	10	50	10	200	20	0.05	0.02	0.05	0.001	

Sample	*Location and description*
8	North Ore zone, White Mountain mine; cinnabar ore.
9	Alice and Bessie prospect; stibnite-cinnabar ore.
10	Red Top mine, ore pile; cinnabar ore.
11	Red Top mine, lower adit; cinnabar ore.
12	Rhyolite prospect; cinnabar ore.
13	Cinnabar Creek mine; cinnabar ore.
14	Lucky Day prospect; cinnabar ore.
15	Lucky Day prospect; cinnabar ore from cinnabar–quartz vein.
16	Willis property; cinnabar-stibnite ore.
17	Red Devil mine, 300-foot level; cinnabar ore.
18	Red Devil mine, surface; cinnabar ore.
19	Red Devil mine, Mary Jane stope above 200-foot level; cinnabar ore.



Base and geology from pace and compass survey by C. C. Hawley, 1967

Figure 12.—Geologic map of opencut South ore zone, White Mountain mine.

No other sulfides were observed in the ore, but limonite seems relatively abundant in veinlets near the cinnabar occurrences which suggests either the former presence of pyrite or the hypogene deposition of iron oxides with cinnabar.

Sampling and Trace Elements

Results of analyses of seven samples from the South ore zone open pit, including five from the main fault zone, one from mineralized limestone, and one reported by Sainsbury and MacKevett (1965, table 1, p. 80) are given in table 3.

Trace elements other than mercury are not abundant in samples of ore taken from the South ore zone (table 3, samples 2, 3, and 5-7). These samples contain small amounts of As, Mn, Sb, Cu, Pb, V, and possibly W. Elements detected in one or more samples of the mercury ore include B, Ba, Be, Cr, Ni, Sn, and Sr. Gold values of approximately 0.03 ppm were found in high-grade mercury ore, but gold is absent or less than 0.02 ppm in the other samples analyzed.

In contrast to the ore, the clay gouge on the footwall and in the center of the main breccia zone has a rather abundant and unusual trace-element suite (table 3, samples 1 and 4), characterized by titanium, arsenic, boron, chromium, antimony, and zirconium as well as mercury.

This trace-element suite is similar to that in a sample of mud from a nearby sulfur spring that also contains anomalous Ti, Sb, Ba, and Cr. (Sainsbury and MacKevett, 1965, table 1).

GOLD CONTENT OF OTHER MERCURY ORES

Gold in the samples collected earlier by Sainsbury and MacKevett (1965) ranged from 0.008 to about 0.14 ppm, but it was absent or less than the limit of sensitivity in five of the 12 samples (table 3). The limit of sensitivity varies with the sample size. Samples 11, 17, and 19 contain less than 0.005 or 0.006 ppm gold, or less than the abundance of gold in several common rock types—including carbonates, sandstones, and shales—which has been estimated by Turekian and Wedepohl (1961) to be 0.00X ppm. Gold was most abundant in the ore from the Cinnabar Creek mine, where two splits of one sample showed, respectively, 0.11 and 0.16 ppm gold. Perhaps significant is the association of this ore with abundant native mercury (Sainsbury and MacKevett, 1965, p. 39), which could trap gold by amalgamation.

CONCLUSIONS

The mercury ore in the South ore zone of the White Mountain mine has a very small gold content and a general sparsity of trace elements. Its associated clay gouge is more strongly metalliferous and is mainly characterized by its Ti, As, B, Cr, Sb, and Zr content. This trace-element suite is similar to mercury-bearing mud from a spring in the same area. Although data from other areas are lacking, it seems possible that muds and clay gouges near mercury deposits may trap or otherwise contain anomalous amounts of metals and consequently may be an indirect guide to mercury deposits.

Other mercury ores sampled contain less than detectable amounts of gold to amounts measured in tenths of a part per million. The present data suggest, but do not conclusively prove, that gold is a very minor constituent of typical mercury ores in southwestern Alaska. The sparsity of gold in the typical ores, together with the occurrence of cinnabar and gold in some other deposits of the region and with the occurrence of mercury in some types of gold deposits elsewhere, suggests that much more study is needed to explain the geochemical cycle of mercury in relation to that of gold.

Geochemical Data in the Sikonsina Pass Area

By Sandra H. B. Clark, W. H. Condon
Helen L. Foster, and J. M. Hoare

ABSTRACT

Anomalous concentrations of lead, gold, copper, and molybdenum were detected locally in analyses of stream-sediment samples from the Sikonsina Pass area. Only two bedrock samples were analyzed: one sample contained about 1 percent copper, and the other contained 3 ppm silver. The area is mainly underlain by metasedimentary rocks of Paleozoic(?) age.

INTRODUCTION

Reconnaissance geochemical sampling in part of the Tanacross quadrangle of east-central Alaska in conjunction with the Heavy Metals program of the U.S. Geological Survey indicated weakly anomalous concentrations of lead, molybdenum, gold, and copper near Sikonsina Pass. The cause or causes of the anomalous concentrations have not been investigated. Although the metal concentrations are low, they indicate possible mineralization in the southwestern part of the Tanacross quadrangle.

Location and access

The Sikonsina Pass area is in the eastern Alaska Range in the southwestern part of the Tanacross A-6 quadrangle (U.S. Geol. Survey, 1:63,360 topographic map series). Sikonsina Pass itself is in a conspicuous glaciated valley occupied by Timber Creek, Burnt Lake, Burnt Creek, and lower Bone Creek. Relief in the map area is approximately 4,000 feet.

The Sikonsina Pass area is accessible by floatplane, by foot, or possibly by tracked vehicle from Mentasta Lake.

GEOLOGIC SETTING

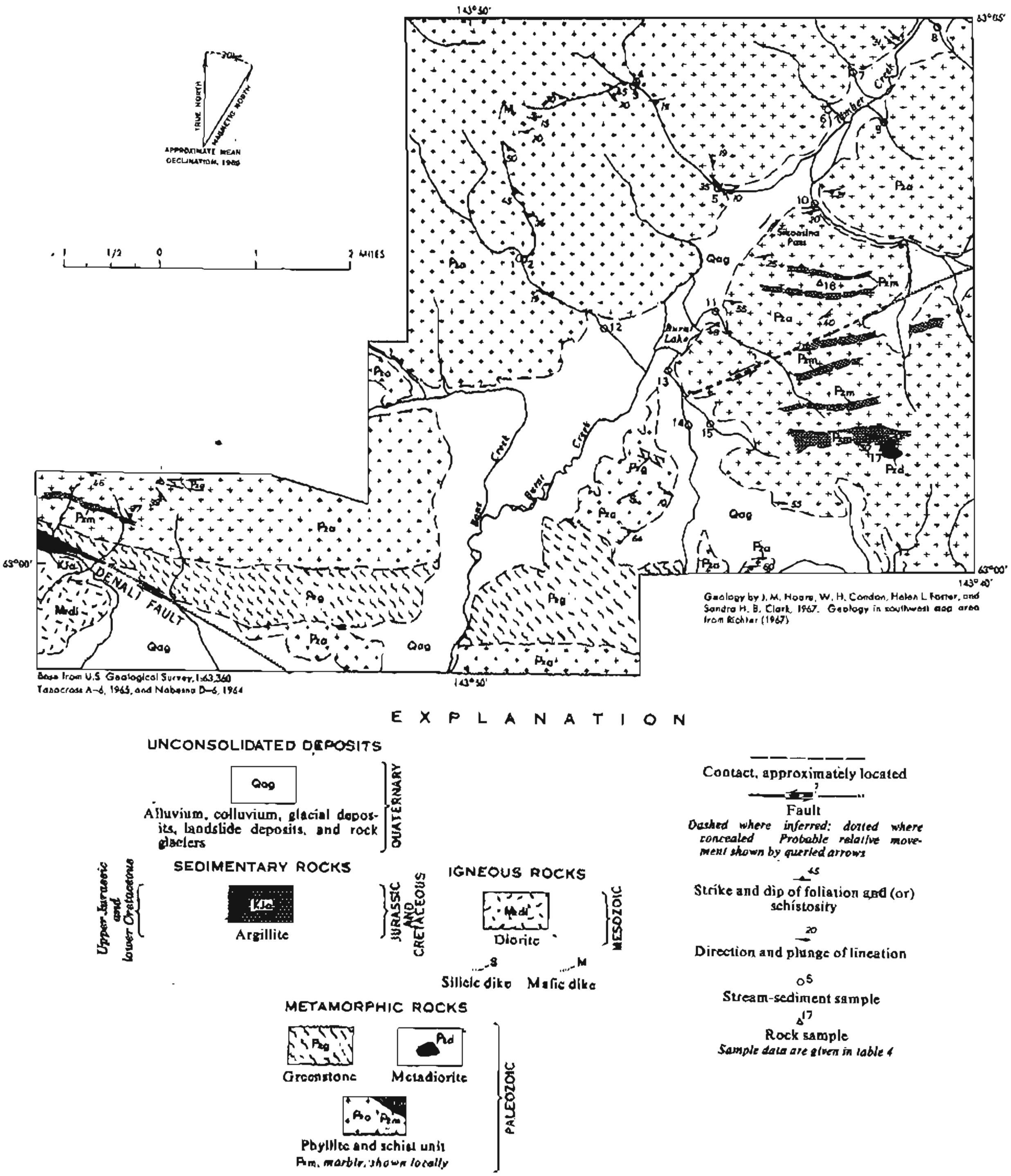
The Sikonsina Pass area is predominantly underlain by a sequence of quartz-mica schists, phyllites, quartzites, marbles, and some metaconglomerates. These rocks are part of Moffit's (1954) unit of undifferentiated early Paleozoic or Precambrian rocks and Foster's (1968) phyllite and schist unit of Paleozoic(?) age. Richter (1967) mapped the continuation of this metamorphic sequence to the southeast as part of a unit of quartz-mica schist, phyllite, and slate of Devonian(?) age. Several distinctive marble layers are shown on the geologic map (fig. 13), and locally, other calcareous layers occur in the phyllite and schist unit.

The metaigneous rocks include a metadiorite and Devonian(?) greenstone. Devonian(?) greenstone is in a layer probably as much as 5,000 feet thick (Richter, 1967, p. 4) and in other small bodies.

Rocks of the phyllite and schist unit commonly contain small-scale structures that indicate intense folding. The Denali fault (fig. 13), a major strike-slip fault, separates the metamorphic sequence from sedimentary and volcanic rocks to the south (Richter, 1967, p. 1). A second fault, which may also be a strike-slip fault, has been mapped in the area, and other faults are likely.

STREAM-SEDIMENT ANOMALIES

Stream-sediment samples collected near the mouths of tributaries to Burnt and Timber Creeks near Sikonsina Pass and above some of the upstream forks of the tributaries were analyzed for gold by atomic absorption and for other elements by semiquantitative spectrographic analysis (table 4). Sample density is only one to two samples per square mile but is much higher than in other parts of the Alaska Range in the Tanacross quadrangle. The regional sparsity of samples precludes the calculation of significant background values, but comparison of metal concentrations from the Sikonsina Pass area (table 5; fig. 13) with concentrations of the other samples from the Alaska Range in the Tanacross quadrangle, with concentrations considered average or anomalous in nearby areas (table



Base from U.S. Geological Survey, 1:63,360 Tanacross A-6, 1965, and Nabesna D-6, 1964

Geology by J. M. Hoare, W. H. Condon, Helen L. Foster, and Sandra H. B. Clark, 1967. Geology in southwest map area from Richter (1967)

Figure 13.—Reconnaissance geologic map of the Sikonsina Pass area showing sample localities.

Table 4.—*Analyses of stream-sediment and bedrock samples, Sikonsina Pass area*

[Gold analyses by atomic absorption by A. L. Meier, R. L. Miller, and T. A. Roemer. Other analyses by J. C. Hamilton and J. L. Finley are semiquantitative spectrographic and are reported in the series 0.1, 0.15, 0.2, 0.3, 0.5, 0.7, 1.0, 1.5, and so on, or by the following symbols: N, not detected; L, detected but below limit of determination; ---, not looked for. Results given in parts per million. Looked for but not detected, limits of determination given in parentheses: Ag(0.05), As(200), Bi(10), Cd(20), Sb(100), Sn(10), W(50), and Zn(200); exception, Ag, 3 ppm in sample 16]

Sample No.	Lab. No.	Field No.	Au	B	Ba	Be	Co	Cr	Cu	La	Mo	Mn	Nb	Ni	Pb	Sc	Sr	V	Y	Zr
								STREAM-SEDIMENT SAMPLES												
1	ACD-834	67AFr1048s	<0.02	100	700	1.5	20	70	30	70	N	700	15	30	70	15	100	70	70	200
2	833	47s	<.02	70	700	1.5	15	70	70	100	N	700	15	50	30	15	150	70	30	200
3	830	37s	<.02	100	700	1.5	15	70	30	70	N	700	10	30	100	15	100	70	70	150
4	832	38s	<.02	70	1000	1.5	15	70	50	100	N	700	15	50	20	15	100	70	30	200
5	ACC-949	32s	<.02	70	700	2	15	70	100	70	N	700	15	30	20	15	100	100	30	300
6	935	75s	<.02	70	1500	1.5	15	70	100	70	N	700	15	30	70	15	100	70	30	300
7	936	74s	<.02	70	1000	2	15	70	50	70	N	700	15	30	15	15	100	70	30	300
8	937	72s	<.02	100	1500	3	15	70	30	70	3	700	15	30	20	30	150	150	50	200
9	938	71s	<.02	70	700	2	15	70	50	70	N	700	15	30	30	15	150	70	30	200
10	ACD-823	69s	.02	70	700	1.5	15	70	50	50	3	700	15	30	20	15	150	150	30	150
11	940	66s	.04	70	700	2	15	70	50	70	N	700	15	30	30	15	150	70	30	200
12	835	51s	<.02	70	500	1.5	15	70	30	70	N	700	15	30	30	15	100	70	70	300
13	836	52s	<.02	70	1000	N	20	150	100	N	3	700	L	50	15	30	200	300	30	100
14	838	64s	<.02	70	700	N	20	70	100	N	3	700	L	50	10	30	150	200	30	100
15	837	54s	<.02	100	1000	3	15	70	30	100	N	500	15	30	30	30	150	150	70	200
								BEDROCK SAMPLES												
16	ACD-872	67AFr3124	<0.02	N	3000	N	N	5	15	N	N	50	L	N	20	10	150	15	15	150
17	873	13	<.02	N	1000	1	15	50	10,000	30	10	500	L	50	30	10	150	50	15	200
Limits of determination			0.02	10	5	1	5	5	5	20	3	10	10	2	10	5	50	10	10	20

Table 5.—*Maximum metal concentrations in the Sikonsina Pass area compared to crustal average and to concentrations considered anomalous along the Taylor Highway and in the Slana area*

[Results given in parts per million]

	Crustal average (Taylor, 1964)	Stream-sediment samples			
		Sikonsina Pass area	Slana area (Richter, 1967; Richter and Matson, 1968)		Taylor Highway (Saunders, 1966)
		Maximum concentrations	Mode	Anomalous concentrations	
Lead----------	12.5	100	10	≥55	>20
Copper--------	55	100	40–50	≥150	>40
Molybdenum----	1.5	3	2.5	≥8	>3
Gold----------	.004	.04	<.02	≥.02	---

5), and with average crustal abundances (table 5) suggests that the contents of lead, gold, molybdenum, and copper in the area are weakly anomalous. The large percentage of the samples which are anomalous in at least one metal and the large area of anomalous concentrations may be significant, even though metal enrichment is only two or three times the apparent background.

The highest concentrations of lead occur northwest and northeast of Burnt Lake (fig. 14), whereas anomalous copper values were found throughout the sampled area (fig. 15). Molybdenum was detected in 4 samples (table 4 and fig. 13, samples 8, 10, 13, 14), and gold in two (samples 10, 11). The distribution of metals suggests that more sampling might result in recognition of zonal pattern, and the association of copper, molybdenum, lead, and gold suggests a possibility that any mineral occurrences in the area could be polymetallic.

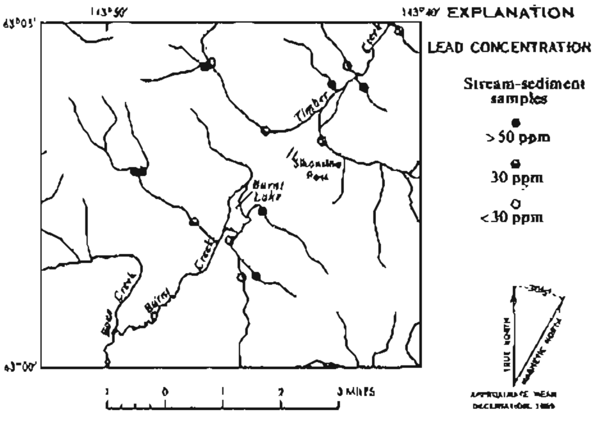


Figure 14.—Lead concentrations in stream-sediment samples, Sikonsina Pass area.

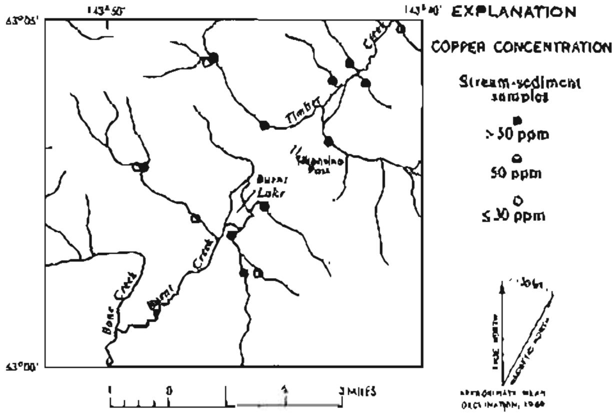


Figure 15.—Copper concentrations in stream-sediment samples, Sikonsina Pass area.

METAL CONCENTRATIONS IN TWO BEDROCK SAMPLES

Two bedrock samples which contained some metal-bearing minerals were also analyzed. Sample 17 (fig. 13; table 4) represents a calcareous phyllite and was collected a few inches below the base of a metadiorite sill, about 200 feet of which is exposed capping a knob on the ridge. Rock surfaces near the contact are stained with malachite and azurite, and the metadiorite contains small amounts of sulfides. Sample 17 contained about 1 percent (10,000 ppm) copper and 7,000 ppm of barium. Because most of the slope just below the metadiorite is covered with talus, the thickness of the copper-bearing rock is not known, but the exposed copper-bearing zone is less than a foot wide.

Sample 16 (fig. 13), from a limonite-stained gray quartzite layer not known to be near any intrusive rocks, contained 3 ppm silver. The layer from which the sample was collected is several feet thick, and much more detailed sampling and mapping would be necessary to determine the significance of the silver value.

CONCLUSIONS

Reconnaissance geochemical sampling in the Sikonsina Pass area shows weakly anomalous concentrations for lead, gold, molybdenum, and copper widely scattered throughout about 20 square miles. Some mineralization is associated with a metadiorite sill which may be one possible source of anomalous values. Proximity to the Denali fault, the existence of other faults in the anomalous area, and the presence of favorable host rocks such as marbles and calc-phyllites as well as rocks of igneous origin are geologic features which seem to make the area attractive for prospecting. Because of the sparsity of samples in adjacent areas, it cannot yet be concluded that the Sikonsina Pass area is, however, any more favorable than elsewhere in the Alaska Range parts of the Tanacross quadrangle.

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