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Geologic Report No. 25

GEOLOGIC AND GEOCHEMICAL INVESTIGATIONS IN THE METAL CREEK AREA CHUGACH MOUNTAINS, ALASKA

By

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Juneau, Alaska
May 1967

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CHUGACH MOUNTAINS, ALASKA

BY Donald H. Richter

ABSTRACT

The Metal Creek area is 25 miles east of Palmer and 50 miles northeast of Anchorage in the Chugach Mountains of southcentral Alaska. Placer gold has been mined intermittently and on a very small scale along Metal Creek, since 1906.

The principal country rock in the area is interbedded slate, siltstone, and graywacke of Cretaceous age locally metamorphosed to phyllite and quartz mica schist. Andesitic volcanics (greenstone) apparently outcrop in the headwaters of Metal Creek and the Glacier Fork of the Knik River. Narrow, discontinuous dikes of light-colored, slightly porphyritic quartz diorite(?) are common throughout the area and one small stock of quartz diorite (trondjhemite) is present. A raised terrace of clay and glacial deposits extends up Metal Creek and recent glaciers and glacial debris mantle most of the high valleys. In the upper Metal Creek drainage, cold water springs charged with CO_2 and H_2S are presently forming calcareous tufa deposits.

The sedimentary rocks are tightly folded about nearly horizontal northeast axes. Strike of the bedding averages N10°-30°E and the dip is vertical to steep. Foliation and slaty cleavage parallel the bedding except at the nose of folds or in areas of intense local shearing.

Quartz veins with minor pyrite and chlorite are common throughout the area. Around the periphery of the small quartz diorite stock an altered zone contains abundant quartz veins with minor pyrrhotite and chalcopyrite. Copper and gold values, however, are low.

Placer gold is restricted in occurrence to Metal Creek and significant concentrations appear to be limited to the downstream half. The gold is apparently being reworked from terrace glacial deposits by present stream action. The original source of the gold is presumed to be local. Heavy minerals associated with the gold are pyrite, zircon, and scheelite. No platinum was observed.

No stream sediment trace element anomalies were detected in the 79 streams sampled. Heavy mineral concentrates from the stream sediments, however, indicate anomalous concentrations of scheelite in parts of the Metal Creek drainage.

Prospecting for additional placer gold along lower Metal Creek and in the glacial terrace and for lode scheelite deposits appears warranted.

INTRODUCTION

Metal Creek, a tributary of the Knik River, is 25 miles east of Palmer and 50 miles northeast of Anchorage in southcentral Alaska. Placer gold was discovered in Metal Creek about 1906 (Brooks, 1907, p. 118) and since that time small scale placer mining has been intermittently carried on, especially along the lower reaches of the creek. Total production, however, probably does not exceed a few thousand dollars. In 1924 platinum metals were first reported (Smith and others, 1926, p. 25) to occur in the place concentrates but the amount and nature of the platinum metals were apparently never divulged.

The source of the gold is not known, and the geology of the Metal Creek and adjacent drainages is only poorly understood. Hearsay and various reports (Landes, 1927) tell of gold values and gold coarseness increasing upstream and of large bodies of granitic rock toward the headwaters of Metal Creek. This lack of geologic information in an area known to contain limited reserves of gold and possibly platinum metals and an abundance of tales common to many mining areas prompted this geological-geochemical investigation.

Location, topography, and accessibility

The area investigated, which covers approximately 160 square miles, includes most of the country drained by Metal Creek and the Glacier Fork of the Knik River (figure 1). The center of the area is approximately 25 miles east of Palmer, a community on the Glenn Highway 45 miles by road north of Anchorage.

Like so much of the Chugach Mountains in southcentral Alaska, the area is characterized by extremely rugged topography and high relief. Elevations range from less than 700 feet, where Metal Creek and the Glacier Fork flow out on the broad Knik River outwash plain, to over 7,000 feet along the divide between the two streams and to as much as 8,700 feet at the headwaters of the streams. Most of the larger valleys tributary to both streams are filled with glaciers or recent glacial debris. Physically, the two main stream valleys are markedly different. Metal Creek flows through a narrow and straight V-shaped valley for over 12 miles, whereas the Glacier Fork, which has a parallel but irregular course, is in a wide flat-floored valley. Deep gorges, with shear walls upwards of 200 feet high and less than 50 feet wide, occur at intervals along most of the course of Metal Creek.

Due to the nature of the terrain the area is difficult of access, especially in the upper Metal Creek area. Wheeled vehicles of the swamp buggy type can drive up the Knik River plain to the southwest corner of the area, and landing strips suitable for Super Cub aircraft have been cleared in Grasshopper Valley on the lower Glacier Fork and above Marcus Baker Glacier on the upper Glacier Fork (see figure 2). Larger aircraft can also land on the strip at the end of the swamp buggy road near the terminus of Metal Creek and the Glacier Fork. From this point a good two-mile long foot trail skirts the lower Metal Creek-Glacier Fork gorge and continues up the west side of Metal Creek to an old placer mining camp. Above the end of the trail, Metal Creek is accessible only by arduous back-packing through thick alder or by helicopter.

At the time of this study (June) Metal Creek could only be forded, and then with extreme difficulty, above the confluence of Cottonwood Creek, and the Glacier Fork only

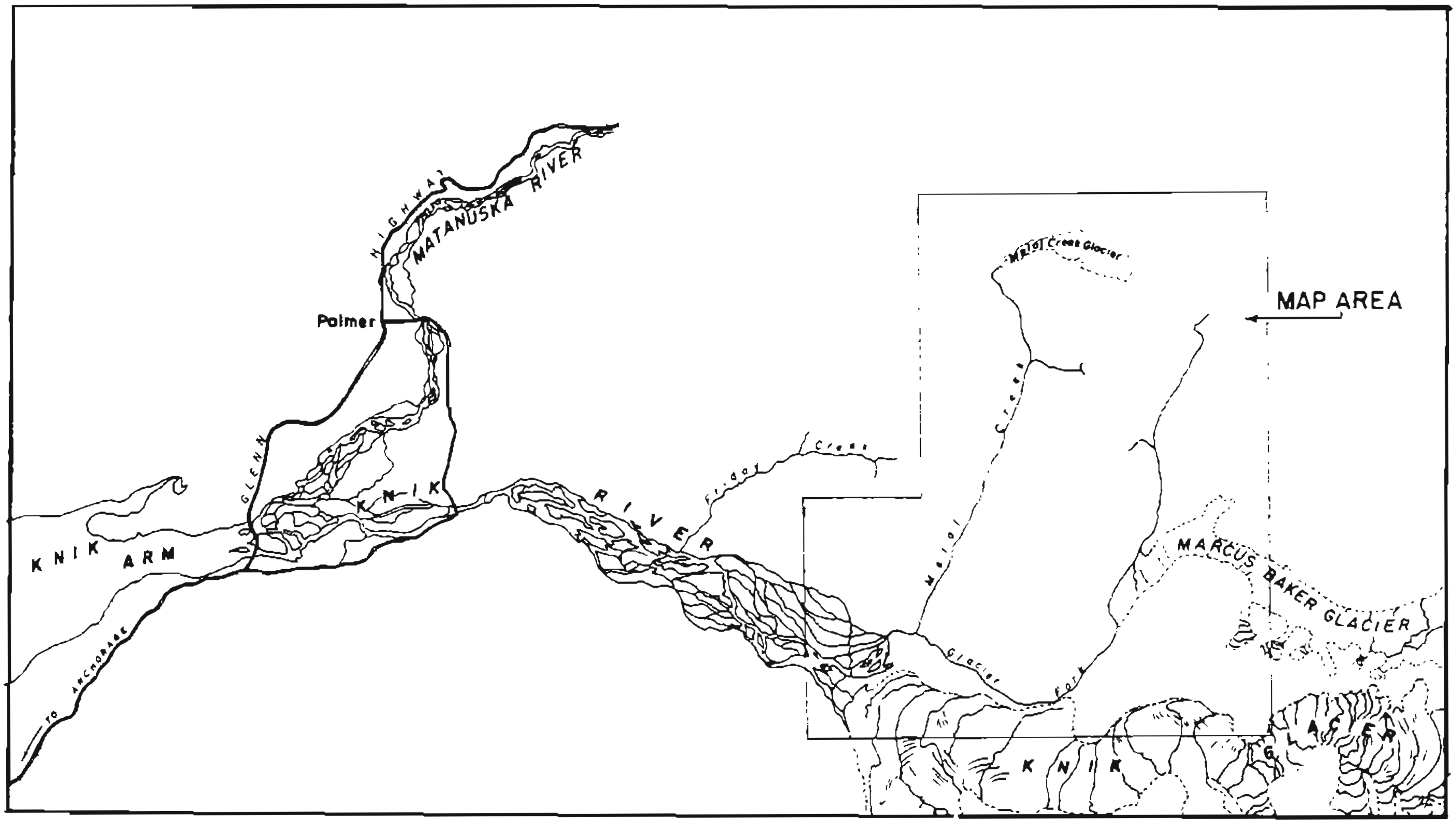

Figure 1. Index map of Metal Creek area.

above Marcus Baker glacier. Earlier in the spring, avalanche snow bridges may provide crossing spots along Metal Creek and locally on the upper Glacier Fork.

Present investigation

A total of 19 days between June 6 and July 1, 1966 were spent in the Metal Creek area. Geologic mapping was restricted almost entirely to the stream valleys as snow cover and difficult terrain precluded work at the higher elevations. However, float was examined carefully in all water courses to insure against missing anomalous rock types where no traverses were made. Stream sediments were collected from most of the active streams for total heavy metal field testing and laboratory analyses of selected trace elements. Sediments from the larger streams were panned and the concentrates saved for heavy mineral study in the laboratory.

Joe Britton served as field assistant during the entire study and was responsible for the collection and field testing of most of the stream sediment samples.

GEOLOGY

The Metal Creek area is in the Chugach Mountains geosyncline of probable Cretaceous age (Payne, 1955). The predominant rock in the area is interbedded Mesozoic slate and graywacke typical of much of the Chugach-Kenai arcuate mountain belt. The rocks are steeply dipping, tightly folding, and locally exhibit strong foliation. Massive andesiti volcanics (greenstones) were not observed in place in the area but on the basis of stream float, apparently crop out along the north side of Metal Creek Glacier and in the headwaters of the Glacier Fork. No large bodies of crystalline igneous rock appear to be present; light-colored dikes are common throughout the area and one small body of quartz diorite (trondjhemite) was observed along the upper Glacier Fork.

Slate and graywacke

Interbedded slate, graywacke, siltstone, minor pebble conglomerate, and their foliated equivalents probably constitute more than 95 percent of the country rock in the area. With the exception of some graywacke units, the rocks are generally thinly bedded, with individual beds less than a foot thick. The rocks range in color from black in the slates and siltstones to lighter shades of gray, gray-brown, or greenish-gray in the coarser graywackes. All the rocks show the effects of low-grade regional metamorphism and locally are strongly foliated. Field evidence suggests an increase in the degree of schistosity from south to north across the area.

Many of the rocks classified as slates in the field are dark siltstones showing a pronounced slaty cleavage. In thin section both the slates and the coarser-grained siltstones are seen to consist of quartz, feldspar, oriented white mica flakes, carbonaceous material, and minor chlorite, carbonate, and opaque minerals. In the more schistose varieties there is an increase in the size of the micaceous minerals, quartz tends to have a tight mosaic texture, and strong deformational micro-structures such as kink-banding and micro-augen are common.

In the graywackes, quartz, feldspar, and rock fragment clasts as much as two to three mm in diameter are generally set in a matrix of fine-grained quartz, white mica, chlorite, epidote, carbonate, and minor carbonaceous material and sphene. A weak foliation is usually observed in thin section, but in hand specimen the rock appears massive. Some of the graywacke beds consist almost entirely of quartz with an occasional flake of white mica and some wavy septa of dark carbonaceous material. Most graywacke beds are less than one-foot thick, but much thicker units have been observed. On the west bank of the Glacier Fork opposite Marcus Baker Glacier a number of massive graywacke beds, some over 50 feet thick, are exposed. These rocks are generally light gray-green in color, homogeneous in grain size, and show no apparent bedding or other primary structures.

Quartz veins are common in all the bedded rocks in the area. The veins consist of massive white quarzt with occasional pyrite and chlorite and are generally less than a few inches thick. In the slates, siltstones, and quartz mica schists, the veins often parallel the cleavage or foliation but also irregularly cross-cut the bedding and/or foliation. Where folding is pronounced, masses of vein quartz may be localized around the noses of the folds. In the massive graywackes, spectacular series of en echelon quartz veins, probably filling tension fractures, are commonly observed.

Andesitic volcanics (greenstones)

No volcanic rocks were observed in place in the map area. However, the increase in abundance of volcanic float near the foot of Metal Creek Glacier and in one tributary (sample 22, figure 2) at the head of the Glacier Fork indicates that volcanics do outcrop somewhere in the upper drainages of these two streams. Landes (1927) who mapped the area between the Matanuska and Knik Rivers shows the greenstone-sedimentary rock contact on the Knik River about seven miles west of the mouth of Metal Creek. This contact, if projected northeastward with a trend similar to the average strike of the rocks in the Metal Creek area, would extend roughly through the Metal Creek Glacier.

The volcanic float observed in the area is typical greenstone of low-grade metamorphic rank. The greenstones range from massive structureless rocks to complex breccias with abundant quartz veins. The one thin section of a piece of float from upper Metal Creek shows an extremely fine-grained dense rock consisting of chlorite, epidote, and albite(?) cut by serpentine and quartz veinlets.

Intrusive rocks

Narrow light-colored dikes are relatively common throughout most of the area. The dikes range from less than a foot to over 10 feet in thickness; most are short and discontinuous but a few can be traced for upwards of one mile. In general, the dikes cut the slate and graywacke at very small angles, often following the bedding for considerable distances.

In thin section, the dike rock is slightly porphyritic with occasional phenocrysts of ragged plagioclase (andesine) in a fine-grained groundmass of anhedral plagioclase with minor white mica, carbonate, quartz, chlorite, and sphene. Coarse-grained clots or masses of quartz and carbonate and clots of zoisite, white mica, and quartz are scattered throughout the rock.

Only one small body of granitic rock was observed in the area. It is exposed over a length of 500 feet along the west bank of the upper Glacier Fork above an unnamed glacier (figure 2). The intrusive is apparently zoned with a porphyritic fine-grained border zone and a medium- to coarse-grained core. Where exposed, the intrusive-country rock contact dips away from the intrusive, indicating a much larger crystalline rock mass at depth.

The rock is a quartz diorite or trondjhmite with a Color Index of about 10. In thin section, the prophyritic border phase consists of euhedral plagioclase (calcic oligoclase to sodic andesine) up to five mm long in a fine-grained groundmass of anhedral plagioclase (calcic oligoclase) quartz,mica, and minor chlorite and opaque minerals The mica is weakly pleochroic (yellow to light brown) with a small optic angle (-) and interlayered with normal colorless white mica. Myrmekitic intergrowths occur around the margins of some of the plagioclase phenocrysts. The core rock is coarser-grained with a subhedral granular texture consisting of zoned plagioclase (calcic oligoclase to sodic andesine) with minor interlayered white mica-septechlorite and carbonate. The feldspar is altered in part to white mica, carbonate, and epidote.

Calcareous tufa

Surficial deposits of calcareous tufa are presently forming along the valley walls of Metal Creek above Cottonwood Creek (figure 2). The tufa deposits are not more than a few feet thick but may cover up to a few tens of acres and consist of carbonate-cemented talus and friable masses of carbonate minerals and organic debris. The carbonate minerals in these deposits are being precipitated from a number of cold water springs discharging from the valley wall as high as a thousand feet above the creek bottom.

The waters are also charged with hydrogen sulfide, as indicated by the unmistakable odor of this gas in the vicinity of the spring. The waters are undoubtedly of meteoric origin with the carbonate derived from some limy strata and the hydrogen sulfide from pyrite in the slates. No anomalous concentrations of metal elements were detected in the carbonate-rich sediments of the springs.

Glacial deposits

Glaciers and recent glacial debris fill most of the stream valleys above about 3,500 feet in elevation. The wide flat of the Knik River is an extensive recent outwash plain extending from the foot of the Knik Glacier to Knik Arm.

A distinct terrace is present between Fall Creek and the Glacier Fork and along the west side of Metal Creek at an elevation of between 600 to 700 feet above sea level or about 300 to 400 feet above the present Knik plain. Locally along Metal Creek this terrace is underlain by one to five feet of blue-gray dense clay. The terrace and presence of clay suggests that a glacial lake persisted for a relatively long time on the north side of the Knik Glacier probably within the last two thousand years when the glacier stood in Knik Arm.

Structure

The bedding in the sedimentary rocks of the Metal Creek area has an average strike of N10°E to N30°E and dips moderately to steeply to the northwest and southeast. Slaty cleavage and foliation trends are parallel to the bedding except locally at the nose of folds and in zones of strong shearing. Small minor folds with limbs ranging from less than an inch to many feet in length and with both right- and left-handed sense were observed throughout the area. The axis of these minor folds plunge at low to moderate angles to the southwest and northeast.

Figure 3 is a lower hemisphere stero plot of the poles of bedding cleavage, and foliation planes and the axis of minor folds and crinkles. These data indicate moderately tight folding about nearly horizontal northeast axes.

MINERAL DEPOSITS

Lode deposits

The only lode deposits of possible economic significance observed in place in the Metal Creek area are related to the small quartz diorite stock near the headwaters of the Glacier Fork. On both the northeast and southwest sides of the intrusive, the host sedimentary rocks are strongly iron-stained and contain abundant irregular quartz veins with pyrrhotite and minor chalcopyrite. The mineralized zone on the northeast side of the stock is as much as 50 feet wide and appears to contain more sulfides than the narrower zone of the southwest side of the stock. Grab samples of sulfide-bearing quartz across the northeast mineralized zone assayed 0.02 ounces of gold and 0.08 ounces of silver per ton and 0.08 percent copper (sample M-13, table 1). One shear(?) zone within the intrusive also contains rusty quartz veins with visible pyrrhotite and chalcopyrite.

A large boulder of vein quartz with pyrrhotite and chalcopyrite was found as float on the Glacier Fork, four miles downstream from the deposit described above. A representative sample of the boulder assayed 0.02 ounces of gold, 0.26 ounces of silver per ton and 0.2 percent copper (sample M-5, table 1). Another boulder of massive pyrite and vein quartz was found at an elevation of 3000 feet in one of the main tributaries of Metal Creek near its headwaters. This material assayed 0.02 ounces of gold per ton; silver and copper were not detected (sample M-20, table 1).

Table 1

Gold, silver, and copper content of sulfide-bearing quartz veins in Metal Creek area.

Sample No.	Type of sample	Ounces per ton		Weight percent
		Gold	Silver	Copper
M-5	Float	0.02	0.26	0.2
M-13	In place	0.02	0.08	0.08
M-20	Float	0.02	nil	not detected

Location of samples:

M-5 - Glacier Fork between sample sites 77 and 78.

M-13 - Northeast side of small quartz diorite stock south of sample site 20.

M-20 - Metal Creek tributary, elevation 3000 feet, below sample sites 30 and 31.

Placer deposits

Although the value of the gold recovered from Metal Creek since its discovery in 1906 has been relatively minor, the area does represent a limited potential source of the metal. The importance of platinum minerals1/ in the area is questionable as no platinum nor any ultramafic rock, which platinum is usually associated with, was seen during the course of the investigation.

At the time of this investigation, Douglas Sumner and James Andrulli of Eagle River, Alaska, were exploring and dredging along Metal Creek and the lower Glacier Fork, below the confluence of Metal Creek. According to records available to the Division, this group holds nine placer claims that were located in 1965. These claims apparently cover most of the ground from the outlet of the Glacier Fork to near Sample Site 61 on Metal Creek. Above Sample Site 61, no evidence of any recent claim staking was observed.

Placer gold in amounts amendable to mining appears to be restricted to the lower half of Metal Creek. Only one grain of gold was found in heavy mineral concentrates collected throughout the entire Glacier Fork drainage (sample number 3, table 4) to the east of Metal Creek, and none was observed in Fall Creek or in the headwaters of Friday Creek (not shown on figure 2) to the west of Metal Creek. In an attempt to determine the source of the gold in the Metal Creek drainage and to locate possible concentrations of the metal, the bedrock was panned at intervals along Metal Creek and its accessible major tributaries. All samples were collected from bedrock at the present stream level where a pronounced slaty cleavage or foliation formed natural riffles. The bedrock was shipped out, the fine material washed off in a gold pan, and then panned. The results are shown in table 2. The highest concentration of gold detected was at the first sample site, a little over one mile upstream from the mouth of Metal Creek at an elevation of approximately 575 feet (sample 61) where over 10 grains of gold were counted in the bedrock pan sample and 32 grains of gold in the stream sediment sample (see table 4). Above this point, the gold content appears slightly lower (samples 80, 81, and 47) for a distance of about five miles and then drops sharply to only a few grains per pan above an elevation of 1225 feet. Above an elevation of 2160 feet no gold was detected. No samples were collected below sample 61, as Metal Creek enters a deep gorge which is more or less continuous down to its confluence with the Glacier Fork.

Maximum grain size of the gold collected in the bedrock pan samples and stream sediment samples was about five mm; the average grain size, however, was considerably less than one mm. Most of the gold is well-rounded, although a few sub-angular pieces were observed. Neither the grain size of the gold nor its angularity appear to increase upstream. Three grains of native silver were present in stream sediment sample 61 no platinum metals were identified in any of the samples. Associated heavy minerals in the stream sediments in order of decreasing abundance are pyrite, zircon, scheelite, and magnetite.

The zone of apparent maximum gold content in Metal Creek appears to occur below an elevation of 600 feet. This roughly corresponds to the height of the old glacial lake terrace (600-700 feet) up Metal Creek and suggests that most of the gold now present in Metal Creek has been reworked from this glacial deposit. Additional evidence to support a glacial origin for the gold is the presence of old trenches cut through the

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1/ It is interesting to note here that in the U.S. Geological Survey Bulletins on the Mineral Resources of Alaska the occurrence of placer gold on Metal Creek in the Knik area is mentioned in the reports for the years 1906, 1909, and 1922 (U.S. Geological

Table 2

Gold content of bedrock pan samples in Metal Creek drainage.

Sample Field Number	Map Number	Gold content (grains)	Source: Metal Creek	Source: Tributary
6D-160	61	10+	X	
E1-700	80	2	X	
E1-850	81	5 (up to 3/16" diameter)	X	
6D-146	47	5	X	
6D-145	46	1		X
E1-1325	82	2	X	
6D-139	40	0		X
E1-1700	83	2	X	
E1-2160	84	0	X	
6D-138	39	0	X	

Weight of field sample approximately 3-5 pounds (one 12-inch pan).

Bulletins 314, 442, and 755). Subsequent to that time, however, in the reports for the years 1924, 1925, 1926, 1927, 1928, and 1936 (U.S. Geological Survey Bulletins 783, 792, 797, 810, 813, and 897) Metal Creek is not mentioned in the gold section, but is mentioned very casually in the platinum section where it is put in the Kenai District. The two Metal Creeks are apparently the same as there is no known Metal Creek in the Kenai Peninsula. Very probably some platinum was recovered in the gold placers during the early 1920's and the report persisted up to the last mention of Metal Creek in 1936.

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terrace deposits above sample site 60 on the west bank of Metal Creek. It is not known how much gold was derived from these trenches, but the results must have been encouraging as evidenced by the extent of the diggings. If the gold is in the glacial deposits, the problem of its original source still remains. Evidently the source was local, as no appreciable gold is found in any of the adjacent drainages. The quartz veins in the area, especially those near the mouth of Metal Creek, may actually contain enough free gold to explain the source of the metal, but there is no data to support this conjecture. Possibly too, these same veins, or some other favorable host rock, may have been locally enriched in gold but now have been entirely removed by erosion. Whatever the case, the available evidence suggest that the gold was derived locally, deposited in a relatively recent glacial lake deposit, and is presently being reworked and concentrated by Metal Creek and its lower tributaries.

GEOCHEMISTRY

A total of 79 stream sediment samples were collected throughout the area and tested in the field for cold extractable heavy metals (Hawkes, 1963) and in the laboratory for total copper, zinc, lead, and molybdenum. The sample locations are shown in figure 2 and the results of the field tests and laboratory analyses are given in table 3.

Frequency distribution graphs for each of the four metal elements in the 79 analyzed samples are shown in figure 4. A single population, slightly lognormal in distribution, is apparent for each element, however, with the exception of copper, the mode for each element is higher than the crustal average estimate (Taylor, 1964). The higher mode for zinc, lead, and molybdenum in the Metal Creek sediments, as compared to crustal average values, is apparently due to the abundance of slate in the country rock. These fine-grained argillaceous-organic rocks are well known as absorbers of a number of metal elements, especially zinc and molybdenum. Approximate upper background limits (threshold values) for the four metal elements as deduced by inspection of the frequency distribution graphs are as follows: copper, 100 parts per million; zinc, 175 ppm; lead, 50 ppm; and molybdenum, 7 pp On the basis of these threshold values none of the stream sediments collected and analyzed in the Metal Creek area are anomalous. Moreover no abnormal concentration of readily extractable metals were detected by the field tests.

Of interest and possible economic significance are the results of the heavy mineral studies in the Metal Creek area. Twenty-five of the stream sediments sampled for trace element analyses were also sampled for their heavy mineral content. These were panned in the field to remove most of the lighter fractions and then were seived to -20 mesh and run through heavy liquids in the laboratory. The results are shown in table 4.

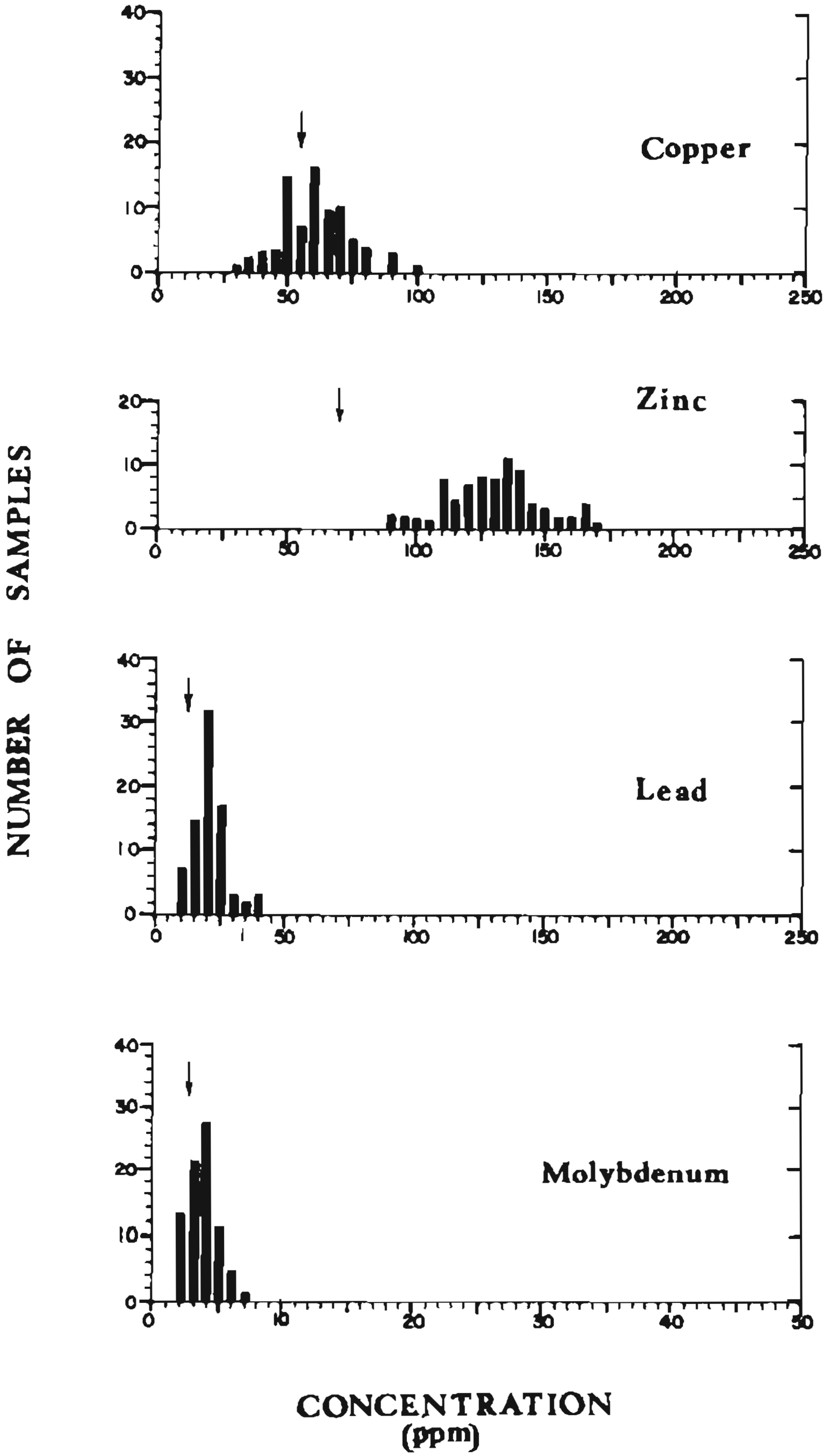

Figure 4. Frequency distribution graphs for copper, zinc, lead, and molybdenum in stream sediments in the Metal Creek area. Arrow indicates average abundance in the earth's crust after Taylor (1964).

Table 3

Copper, zinc, lead, and molybdenum content of stream sediments in the Metal Creek area.

Sample Field Number	Map Number	Concentration (ppm) Cu	Zn	Pb	Mo	Field Test (ml. of dye)
6D-100	1	75	150	35	4	0
6D-101	2	50	120	25	5	0
6D-102	3	60	135	20	4	0
6D-103	4	90	165	30	3	0
6D-104	5	100	160	20	4	0
6D-105	6	75	140	20	3	0
6D-106	7	65	135	20	3	0
6D-107	8	80	135	25	4	0
6D-108	9	65	140	20	5	0
6D-109	10	90	170	25	4	0
6D-110	11	90	165	25	4	0
6D-111	12	65	120	20	4	0
6D-112	13	60	145	15	3	0
6D-113	14	70	140	25	6	0
6D-114	15	80	155	25	4	0
6D-115	16	60	135	35	3	0
6D-116	17	70	140	25	4	0
6D-117	18	50	140	20	3	0
6D-118	19	60	125	20	3	0
6D-119	20	60	150	20	3	0
6D-120	21	50	130	10	2	0
6D-121	22	50	120	20	3	0
6D-122	23	60	140	20	4	0
6D-123	24	35	90	20	4	0
6D-124	25					0
6D-125	26	50	90	15	3	0
6D-126	27	55	122	10	4	0
6D-127	28	55	110	10	4	0
6D-128	29	60	125	15	5	0
6D-129	30	70	140	20	4	0
6D-130	31	50	130	10	4	0
6D-131	32	65	130	15	4	0
6D-132	33	70	140	20	5	0
6D-133	34	80	160	20	7	0
6D-134	35	75	165	40	6	0

Table 3
(Continued)

Sample Field Number	Map Number	Concentration (ppm) Cu	Zn	Pb	Mo	Field Test (ml. of dye)
6D-135	36	60	130	40	4	0
6D-136	37	65	140	15	3	0
6D-137	38	65	155	10	4	0
6D-138	39	55	130	25	5	0
6D-139	40	50	110	10	5	0
6D-140	41	70	145	20	6	0
6D-141	42	50	115	15	5	0
6D-142	43	60	130	20	4	0
6D-143	44	50	125	15	4	0
6D-144	45	40	125	20	5	0
6D-145	46	40	95	15	4	0
6D-146	47	65	135	20	3	0
6D-147	48	70	150	20	4	0
6D-148	49	70	145	15	3	0
6D-149	50	60	110	15	3	0
6D-150	51	60	110	15	3	0
6D-151	52	55	105	20	3	0
6D-152	53	60	100	15	6	0
6D-153	54	65	135	15	4	0
6D-154	55	70	135	20	3	0
6D-155	56	70	135	20	3	0
6D-156	57	75	165	20	3	0
6D-157	58	60	135	20	3	2
6D-158	59	45	110	25	2	0
6D-159	60	50	110	25	2	1
6D-160	61	55	115	20	2	0
6D-161	62	55	115	25	2	0
6D-162	63	60	115	30	4	0
6D-163	64	55	110	20	3	0
6D-164	65	70	125	25	4	0
6D-165	66	50	120	20	3	0
6D-166	67	35	95	15	5	1
6D-167	68	45	125	20	2	1
6D-168	69	50	125	20	2	1
6D-169	70	50	120	20	2	1

Table 3
(Continued)

Sample Field Number	Map Number	Concentration (ppm) Cu	Zn	Pb	Mo	Field Test (ml. of dye)
6D-170	71	30	115	10	2	2
6D-171	72	40	100	20	2	0
6D-172	73	45	110	25	2	0
6D-173	74	50	120	30	2	0
6D-200	75	80	135	20	5	0
6D-201	76	75	130	25	5	0
6D-202	77	60	125	25	4	0
6D-203	78	65	145	40	4	0
6D-204	79	50	130	15	4	0

All analyses on -80 mesh fraction by Rocky Mountain Geochemical Laboratories, Salt Lake City, Utah.

The interesting feature is the relative abundance of scheelite in many of the concentrates in Metal Creek. In table 4 the actual grain count of scheelite is shown followed by a theoretical value of scheelite grains per 100 milligrams of heavy minerals for comparison purposes. Sediments in six streams in the Glacier Fork drainage (samples 1, 2, 3, 9, 18, 21, 22, 24) average about 15 grains of scheelite per 100 milligrams of heavy minerals whereas in Metal Creek the average is about 40 grains per 100 milligrams of heavy minerals. The greatest concentration of scheelite is in two tributaries of Metal Creek (samples 40, 46), both draining from the east, which show 130 and 580 grains of scheelite per 100 milligrams of heavy minerals respectively. The 185 actual grains in sample 46 represents about 1 percent of the heavy mineral concentrate by volume. None of these concentrations of scheelite approach ore grade material but they do indicate the presence of unusual abundances of tungsten within the drainage area.

Surprisingly, pyrite rather than magnetite is the most abundant heavy mineral in the concentrates, and, in fact, a number of samples did not contain any detectable magnetite. The pyrite occurs generally as well-formed cubes showing little or no evidence of lengthy transport. Zircon, the second most abundant mineral in the concentrates, occurs as colorless, sharply faceted bipyramidal crystals.

The relative abundance of both the scheelite and zircon does not appear compatible with the known geology of the area as they imply an association with intrusive crystalline rocks. In the Willow Creek lode gold district, 30 miles northwest, for example, where quartz diorite is the principal country rock, the heavy mineral assemblage is pyrite-zircon-scheelite-gold. However, assuming that the gold, scheelite, and zircon in the Metal Creek area have a more or less common source, it follows, on the basis of the restricted gold distribution, that their source is also local.

CONCLUSIONS

Placer gold in the Metal Creek area appears to be concentrated along the downstream half of Metal Creek. The available evidence strongly suggests that the gold is being reworked by present stream action, principally from recent glacial deposits of local origin. The exact source of the gold is not known. Small scale placer mining along Metal Creek south from Paradise Creek to its junction with the Glacier Fork should be economically feasible, especially during periods of low water. Prospecting the glacial lake terrace above Metal Creek may also reveal buried channel deposits or other concentrations of placer gold.

Relatively abundant scheelite in the heavy mineral concentrates along the lower half of Metal Creek also raises the possibility of local lode scheelite deposits in the area. Prospecting the high country between Metal Creek and the Glacier Fork for scheelite - and also gold - appears to be warranted.

The altered zone, containing abundant quartz veins with pyrrhotite and chalcopyrite, around the small intrusive on the upper Glacier Fork, does not appear to have sufficient grade or size to warrant further exploration at the present time. No other lode deposits were observed. Trace element analyses of stream sediments throughout the area are not encouraging.

Table 4

Selected heavy minerals in stream sediments in the Metal Creek area.

Sample Field Number	Sample Map Number	Weight of heavy mineral fraction (milligrams)	Magnetite	Pyrite	Zircon	Gold (grains)	Scheelite (grains)	Scheelite, recalculated to grains per 100 milli-grams of heavy minerals.
6D-100	1	7	N.D.	m	tr.	0	1	14
6D-101	2	8	tr.	M	m	0	1	12
6D-102	3	3	N.D.	m	tr.	1	1	33
6D-108	9	61	tr.	M	tr.	0	11	18
6D-117	18	18	tr.	M	tr.	0	3	17
6D-120	21	4	N.D.	tr.	tr.	0	0	0
6D-121	22	7	tr.	m	tr.	0	0	0
6D-123	24	49	m	M	m	0	2	4
6D-126	27	232	tr.	M	m	0	15	6
6D-129	30	375	tr.	m	tr.	0	3	1
6D-130	31	89	tr.	tr.	tr.	0	0	0
6D-136	37	129	tr.	M	m	0	3	2
6D-138	39	157	tr.	M	tr.	0	2	1
6D-139	40	31	tr.	M	M	3	40	130
6D-145	46	32	tr.	M	M	6	185	580
6D-149	50	27	tr.	M	m	0	10	37
6D-159	60	14	m	m	tr.	0	5	36
6D-160	61	211	tr.	M	m	32 1/	89	42
6D-162	63	10	tr.	tr.	tr.	0	2	20
6D-163	64	13	tr.	m	tr.	0	2	15
6D-164	65	24	m	m	m	0	1	4
6D-168	69	14	tr.	M	m	0	2	14
6D-169	70	17	m	m	m	0	5	29
6D-171	72	16	tr.	m	tr.	0	15	94
6D-172	73	3	tr.	m	tr.	0	0	0

Weight of original field sample, approximately 3-5 pounds (one 12-inch pan). Samples were panned in the field and seived and run through heavy liquids in the laboratory. All determinations made on -20 mesh fraction with specific gravity greater than 3.3.

1/ Includes 3 grains of native silver.

M - major constituent (>10% by volume)
m - minor constituent (between 1 and 10% by volume)
tr. - trace constituent (<1% by volume)
N.D. - not detected

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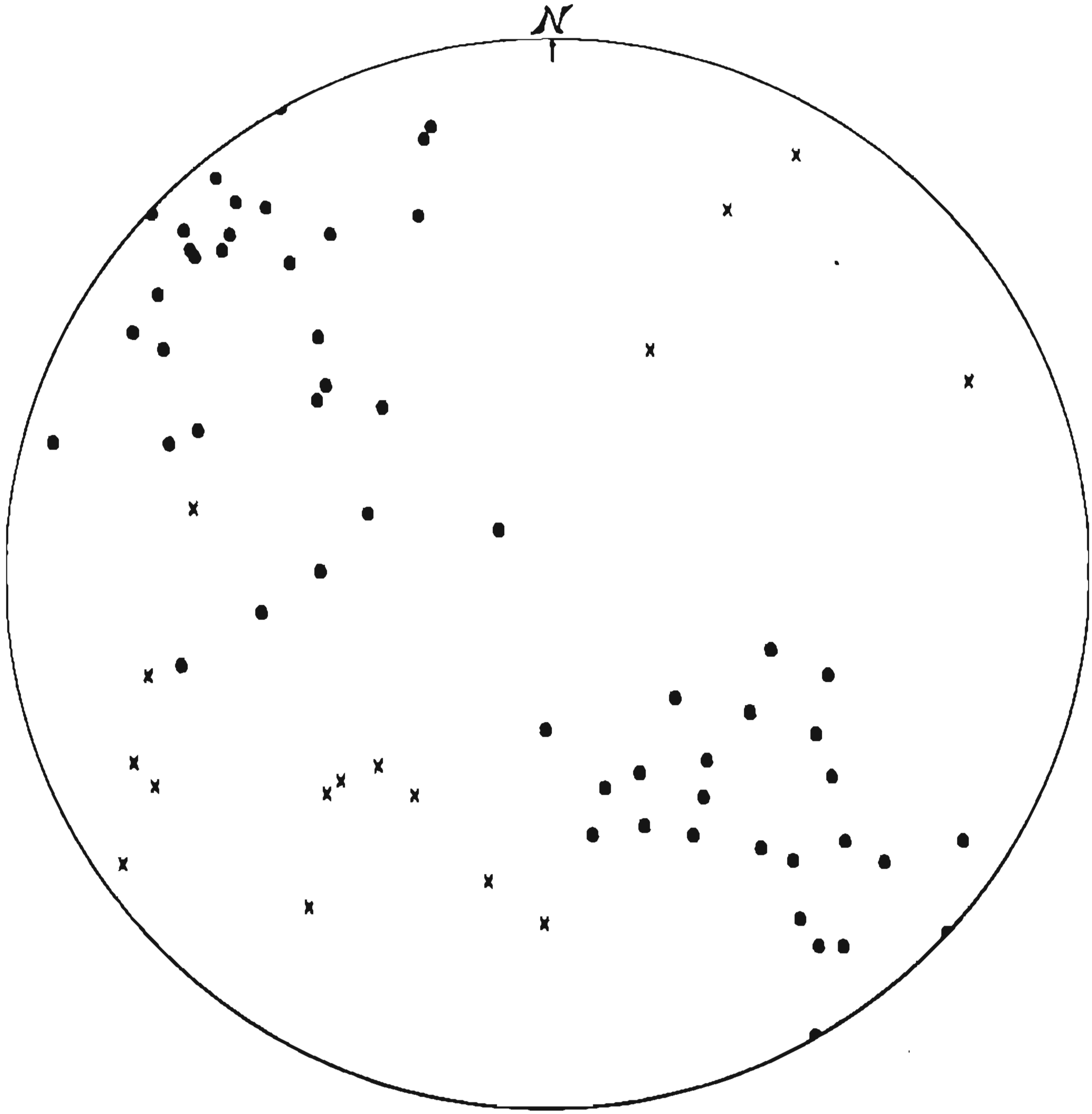

Figure 3. Lower hemisphere stereographic projections of poles of bedding, cleavage and foliation (circles) and axes of minor folds (crosses) in the Metal Creek area