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GEOLOGICAL SURVEY CIRCULAR 570

Suggested Areas for Prospecting in the Central Koyukuk River Region Alaska

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By Thomas P. Miller and Oscar J. Ferrians, Jr.

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Suggested Areas for Prospecting in the Central Koyukuk River Region, Alaska

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Abstract

Anomalous amounts of copper, lead, zinc, silver, and gold in stream-sediment samples and mineralized outcrops define seven areas favorable for prospecting in the central Koyukuk River region, west-central Alaska. These areas, listed with their metals of interest, are (1) Indian Mountain: silver, lead, copper, and gold, (2) Sun Mountain: lead, copper, and silver, (3) Dakli: copper, (4) Clear Creek: gold, (5) Caribou Mountain: uranium and thorium, (6) Hawk River: lead and silver, and (7) Purcell Mountain: gold. Mineralization at all these localities is closely related to granitic plutons of Late Cretaceous age. These plutons are intrusive into volcanic rocks ranging in composition from quartz latite to andesite and in age from possibly Late Jurassic to Early Cretaceous.

INTRODUCTION

Reconnaissance investigation of the mineral resources of the central Koyukuk River region, west-central Alaska, for the Heavy Metals program, U.S. Geological Survey, suggests seven localities that are particularly interesting for mineral prospecting (fig. 1). Although the region currently has a productive placer gold deposit, much of the region is relatively inaccessible and has received little attention from prospectors.

The central Koyukuk River region includes 6,600 square miles covering portions of the Hughes, Melozitna, and Shungnak 1:250,000-scale quadrangle maps. The only town in the district is Hughes, a small village on the Koyukuk River (fig. 1), which is serviced several times a week by scheduled airlines from Fairbanks.

Areas with known mineral deposits and other areas with geologic environments favorable for the occurrence of mineral deposits were investigated in the summer of 1967. Over 400 samples were collected and analyzed by semiquantitative spectrographic procedures and by atomic-absorption methods.

The authors were assisted in the field by Vernon DeRuyter, geologic field assistant. Semiquantitative spectrographic analyses were done by Arnold Farley, Jr., J. M. Motooka, G. W. Sears, Jr., and Chris Heropoulos, and atomic-absorption analyses were done by W. L. Campbell, R. L. Miller, T. A. Roemer, A. L. Meier, and M. S. Rickard. C. W. Maeser assisted on the fission-track analysis. Officials of the United States Smelting Refining and Mining Co., particularly Jack Fisher, manager of the Hogatza placer mine, were very helpful in permitting the investigation of the mine.

The first geologic mapping in the region was done primarily along the Koyukuk River by Schrader (1900, 1904). Later, mapping of parts of the region and of contiguous areas of interest was done by Smith (1913), Eakin (1916), and Fernald (1964). The most recent mapping, by Patton and Miller (1966) and Patton and others (1968), includes the Hughes, Shungnak, and part of the Ambler River quadrangles.

GEOLOGIC SETTING

The bedrock of the central Koyukuk River region consists chiefly of granitic rocks intruded during two late Mesozoic plutonic episodes into marine andesitic volcanic rocks, volcanic graywacke, and mudstone of older Mesozoic age. Quartz latite exposed near Purcell Mountain (fig. 1) was extruded between plutonic episodes, and fine-grained felsic intrusives of Late Cretaceous or Early Tertiary age occur near Indian Mountain (figs. 1, 2). Mineralization in the region appears to have been associated with the granitic intrusions.

The oldest bedrock unit in the province is a thick sequence mainly of andesitic volcanic rocks of Early Cretaceous and possibly Late Jurassic age. It consists of pyroxene andesite and trachyandesite flows, pyroclastic and volcaniclastic rocks, and subordinate fossiliferous limestones. The unit crops out over large areas of west-central Alaska and has been assigned to the Koyukuk Group by Smith (1913, p. 80).

Overlying this unit is a thick sequence of interbedded volcanic graywacke, mudstone, and quartz conglomerate of late Early Cretaceous and perhaps younger age (Patton and Miller, 1966). The graywacke and mudstone are composed of angular detritus derived primarily from the underlying volcanic rocks and consist chiefly of plagioclase and volcanic rock fragments

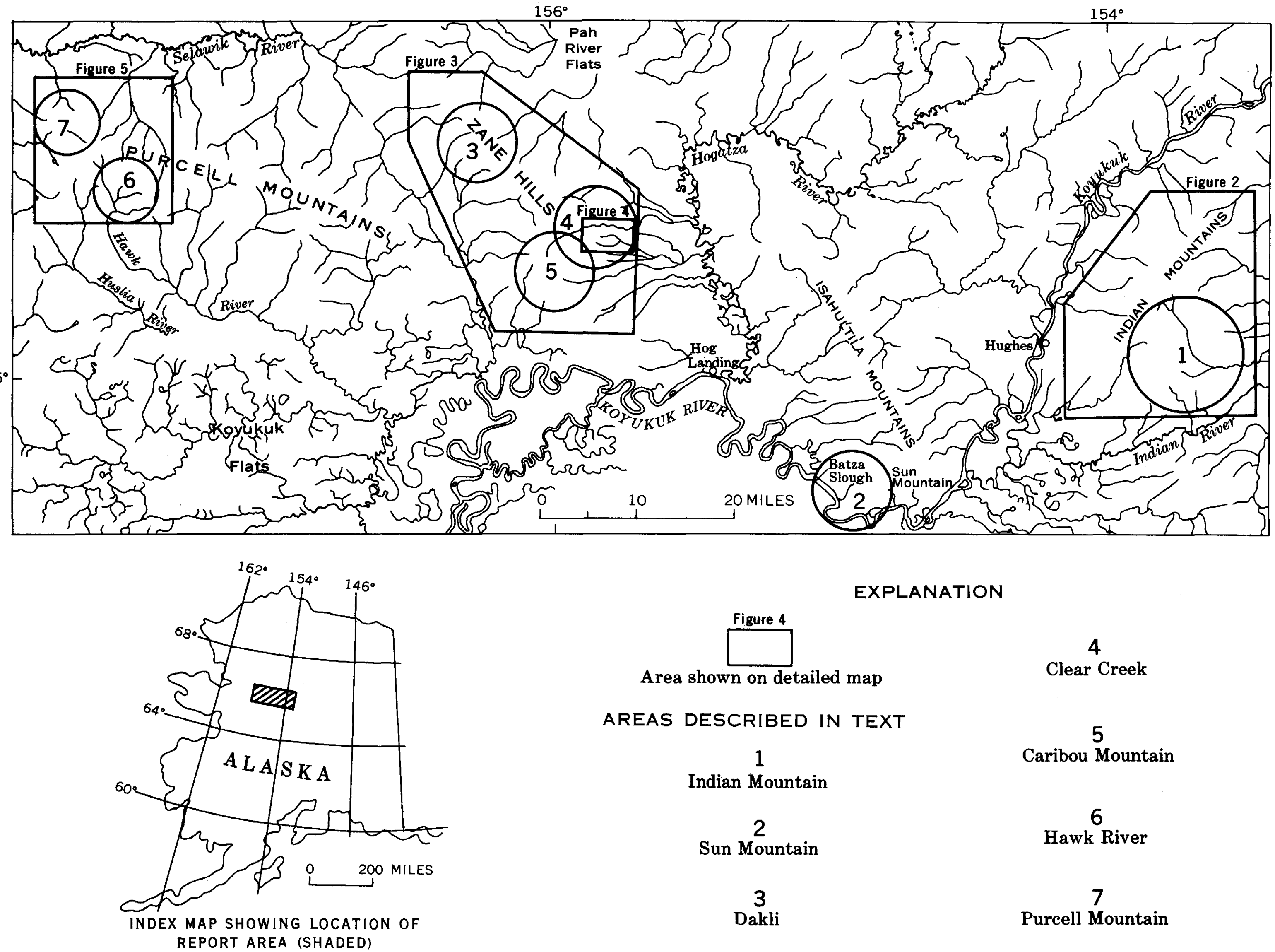

Figure 1.--Map of central Koyukuk River region showing location of areas described in text.

in an argillaceous matrix. Locally, this unit contains marine fossils, plant fragments, and coal beds. Crystal lithic tuffs and volcaniclastic rocks locally occur at the base of this unit.

Plutons and dikes of medium-grained granodiorite, quartz monzonite, and syenite intruded the volcanic and sedimentary rocks during two Late Cretaceous plutonic episodes. Three intrusive igneous bodies in the western part of the region that are tentatively assigned an age of 100 m.y. (million years) based on potassium-argon age determinations (Miller and others, 1966) were intruded during the earlier episode. These bodies are the Purcell Mountain pluton composed chiefly of porphyritic quartz monzonite, the Shiniliaok Creek pluton composed of monzonite and syenite, and the Hawk River pluton composed chiefly of monzonite. Other main igneous bodies of the region were intruded during the younger episode and are assigned an age of 80 m.y. (Miller and others, 1966). They consist chiefly of granodiorite and quartz monzonite with subordinate alaskite. Late-stage aplite and alaskite dikes cut both episodes of plutonic rocks. A few quartz veins occur near the borders of the main igneous bodies and in the nearby wallrock. A volcanic unit composed of quartz latite, latite, and rhyolite separates the two plutonic episodes in the vicinity of Purcell Mountain; it is dated at 86 m.y. (Patton and others, 1968) and is assigned a Late Cretaceous age.

The granitic rocks of both suites are generally massive and medium grained, and contacts between the igneous bodies and country rock are sharp, relatively straight, steeply dipping, and everywhere appear to be discordant. Rocks of the hornblende-hornfels facies form a narrow zone in country rock adjacent to the intrusive and grade into a broader zone of albite-epidote-hornfels facies rocks away from the contacts. Elsewhere, the volcanic and sedimentary units are unaltered. The hornfelsic contact rocks are generally more resistant than the granitic rocks and form topographic ridges surrounding parts of the igneous bodies.

The region lies along the Hogatza arch, which is described by Miller and others (1959) as a linear structural high extending from the northeast end of the Seward Peninsula to the Koyukuk River. The rocks of the region have been deformed into broad, gentle to moderate folds and are broken by a complex fault system. The structural grain is roughly east-west for the central and western part of the region and northeast-southwest for the eastern part.

The lowland areas are underlain by unconsolidated deposits in contrast to the mountainous areas and adjacent uplands, which are underlain by bedrock. Most of the Koyukuk Flats, in the southwestern part of the region, is underlain by fine-grained, water-laid, and windborne sediments of Pleistocene and Holocene age. The lowlands in the northern part of the region surrounding the Purcell Mountains, Zane Hills, Isahultila Mountains, Indian Mountains, and adjacent uplands are underlain by glacial drift of Pleistocene age (Coulter and others, 1965), which was deposited by large piedmont glaciers that came from the Brooks Range to the north. Also, small local glaciers emanated from the higher parts of the Purcell Mountains, Zane Hills, and Indian Mountains during Pleistocene time and deposited glacial drift in some of the larger valleys within these mountains.

Most mineralized areas in the region occur along or near the contacts between the late Mesozoic plutons and country rock, indicating a close relationship between the igneous intrusive rocks and the mineralization.

MINERALIZED AREAS

Introductory statement

Mineral occurrences in outcrop or anomalous concentrations of metals in stream-sediment and rock samples indicate seven areas that are worthy of further investigation and prospecting. These areas are: Indian Mountain, Sun Mountain, Dakli, Clear Creek, Caribou Mountain, Hawk River, and Purcell Mountain (fig. 1). They are described in the following sections of the report and all the areas except Sun Mountain are shown on small-scale geologic maps (figs. 2, 3, 5); a more detailed map is provided for the Clear Creek area (fig. 4). The geologic maps also show the lead and copper content of stream-sediment samples. Lead and copper values above 50 parts per million are anomalous for streams draining the bedrock of the region.

Indian Mountain

Mineralized rock was found in the Indian Mountain area (fig. 2) near old placer mines at Utopia and Black Creeks and along the east-northeast-trending fault zone south of Utopia Creek.

Abundant boulders of massive white barite as much as 2 feet in diameter were found in the tailings near the head of an abandoned placer gold mine along Utopia Creek. Some of the barite boulders contain fine-grained tetrahedrite, galena, and sphalerite. Analyses of two samples of barite, one barren of visible metallic minerals and the other containing visible but minor amounts of tetrahedrite and other metallic minerals, are given in table 1 (samples 1A and 1B). Both samples contain silver and anomalous amounts of lead, zinc, copper, antimony, and gold; the tetrahedrite-bearing sample (1B) contains about 21 ounces of silver per ton and the principal silver-bearing mineral is probably tetrahedrite. A stream-sediment sample (table 1, sample 1C), taken from a tributary on the south side of the valley near the upstream end of the tailings, contains the highest values of lead, zinc, and silver found in any stream-sediment sample in the region. The lead value of 2,000 ppm and the zinc value of 700 ppm are extremely high. Contamination by the placer mining operation seems unlikely because the sample was col-

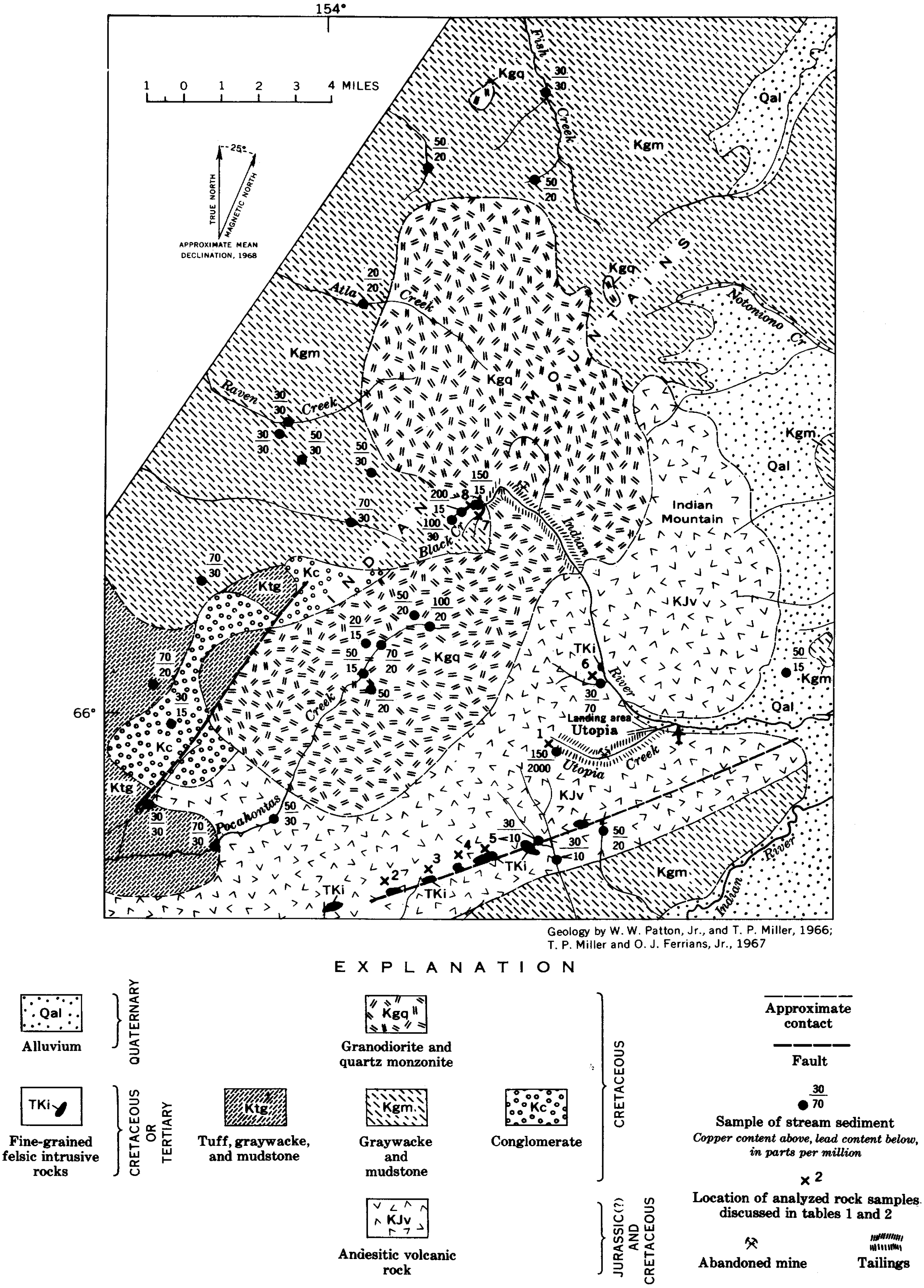

Figure 2.--Geologic map of the Indian Mountain area.

Table 1.--Analyses of selected grab samples from Utopia Creek placer mine and altered fine-grained felsic intrusives, Indian Mountain area

[Results reported in parts per million. Gold analysis by atomic absorption except for sample 2, which is by fire assay. All other analyses are semiquantitative spectrographic with results reported to the nearest number in the series 1.0, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1. N, not detected; <, present but below limit of determination or below values shown. Sample localities are shown in figure 2]

Sample No.	Lab. No.	Cu	Ag	Au	Pb	Zn	Mo	Description
1A	ACN—801	7	3	0.16	1,000	N	7	Massive white barite with no visible metallic minerals.
1B	996	1,500	700	1.3	1,500	3,000	5	Massive white barite with minor amounts of tetrahedrite, galena, and sphalerite; Sb=1,000 ppm.
1C	ACC—115	150	3	.07	2,000	700	3	Stream sediment.
2	64M1705	50	7	.04	300	N	7	Oxidized pyritiferous fine-grained intrusive.
3	ACN—999	100	3	.1	100	N	N	Do.
4A	998	200	N	N	70	N	.5	Do.
4B	997	300	N	N	70	N	N	Oxidized pyritiferous andesite.
5	996	30	N	N	30	N	7	Oxidized pyritiferous fine-grained intrusive.
6A	496	150	2	.5	3,000	700	7	Oxidized pyritiferous andesite.
6B	ACC—251	1,000	15	.2	1,000	700	20	Oxidized and silicified, fine-grained intrusive with disseminated pyrite and sphalerite.
6C	252	20	7	N	200	N	N	Deeply oxidized pyritiferous fine-grained intrusive.
6D	253	100	.7	.1	500	500	5	Oxidized pyritiferous andesite.
6E	254	700	1	6	1,000	500	30	Oxidized pyritiferous fine-grained intrusive.
6F	255	20	<.5	N	20	200	N	Do.
Limits of determination		5	.5	.02	10	200	5	

lected away from the operation and because of the high silver value. Copper, gold, and barium also are anomalously high in the sample.

The country rock at Utopia Creek is slightly metamorphosed andesite of Late Jurassic(?) and Early Cretaceous age cut locally by fine-grained, felsic intrusives. The Indian Mountain granodiorite pluton is about 2 miles away, and Utopia Creek does not drain the granodiorite-andesite contact as do the other streams in the region that contain gold-bearing gravel deposits. The lack of granitic rocks in the tailings, together with the abundance and size of the barite boulders, suggests that the boulders were derived from tetrahedrite-sphalerite-galena-bearing veins in the andesite volcanic rocks. Veins of this sort may also have been the source of the placer gold found here. Also, the location of the tailings suggests that the pay streak did not lie in the main part of the valley in this area but instead continued up the south slope of the valley toward the area drained by the tributary stream containing sediments rich in lead and zinc. Because of inclement weather near the end of the field investigation, little time was available to look for the bedrock source of the barite. The drainage basin is not large and therefore should be amenable to prospecting.

An east-northeast-trending belt of pyritiferous, silicified, fine-grained intrusive rocks occurs along a well-marked fault zone a few miles south of the Indian Mountain pluton and immediately south of the Utopia Creek barite occurrence (fig. 2). The age of these intrusives is unknown, but they may be as young as early Tertiary. Oxidation of disseminated pyrite in the intrusives has resulted in the formation of conspicuous orange-red-yellow gossans visible from many miles away. Typical intrusive rocks from these gossans contain small but anomalous amounts of lead, copper, silver, and gold (table 1, samples 2–5).

Highly altered, fine-grained, pyritiferous intrusive rocks, similar to the intrusives mentioned above, occur on Indian River at locality 6 (fig. 2). Both the intrusive rocks and the intruded andesite are much oxidized and altered; however, some of the fresher specimens of intrusive rock contain disseminated pyrite and sphalerite. Both the altered andesite and intrusive show anomalous amounts of lead, zinc, copper, molybdenum, silver, and gold (table 1, samples 6A–6F). Sample 6E contains about 6 ppm of gold, equivalent to approximately 0.16 ounce per ton.

Pyrite and sparse chalcopyrite are disseminated in metavolcanic rocks and late-stage aplites near the pluton at the head of Black Creek (fig. 2), upstream from gold placer operations. The coarse, angular nature of the gold panned here, together with the very small drainage-basin area, indicates a local and nearby source. Several bedrock grab samples from this area contain disseminated sulfides and show anomalous copper values, but only two contain gold (table 2). No other large zones of alteration or obvious source rock

Table 2.--Analyses of selected grab samples from the head of Black Creek, Indian Mountain area

[Results reported in parts per million. Gold analysis by atomic absorption; all others are by semiquantitative spectrographic analysis with results reported to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1. N, not detected; <, present but below limits of determination or below value shown. Sample localities are shown in figure 2]

Sample No.	Lab. No.	Cu	Pb	Ag	Au	Mo	B	Description
7A	ACN—492	30	15	N	N	7	15	Pyritiferous hornfels.
7B	493	20	<10	N	N	N	15	Pyritiferous fine-grained felsic intrusive.
7C	494	1,000	20	0.5	N	5	200	Pyritiferous hornfels.
7D	495	50	15	<.5	N	N	20	Do.
7E	862	700	15	N	N	N	1,500	Do.
7F	863	700	15	N	N	15	70	Do.
7G	864	500	30	N	0.04	N	N	Do.
7H	865	700	10	N	N	N	N	Do.
8	ACC—102	1,000	N	N	.05	7	N	Do.
Limits of determination		5	10	.5	.02	5	10	

for the placer gold of the Indian River gold mine were found. It is possible that larger zones of mineralization are buried beneath the colluvium and talus of the steep-walled canyon.

The area in the vicinity of the Indian Mountain pluton and, in particular, near Utopia Creek warrants further investigation. The fine-grained pyritiferous intrusive rocks found here are strongly altered and slightly mineralized. Although the rocks are not nearly of commercial grade, they may indicate deeper or hidden mineralization, and it seems possible that the fault controlling the main zone of intrusives could be mineralized. The general area is only 15 miles from the Koyukuk River, which is navigable by barge during the summer months and which provides access to shipping points farther south.

Sun Mountain

Scattered occurrences of chalcopyrite, malachite, and pyrite were observed along the Koyukuk River in the southern Isahultila Mountains near Sun Mountain (fig. 1). In addition, a 2-foot-long angular float block of altered silicified rock, which contained disseminated cerussite, galena, and malachite, was found on a cutbank at the south end of Batza Slough (fig. 1). The float block contains 5 percent of lead, 0.5 percent of copper, and 3 ounces of silver per ton. The numerous quartz latite porphyry dikes throughout the Sun Mountain area, together with a widespread zone of thermally metamorphosed andesite, suggest a buried pluton at shallow depth. Several massive fossiliferous limestones, as much as 65 feet thick in this area, are favorable hosts for ore deposits. Prospecting will be handicapped by the heavy forest cover and by the thick covering of loess that mantles most of the area and prevents reliable stream-sediment sampling.

Dakli

The Dakli area is just east of the Dakli VABM in the northwest part of the Zane Hills (fig. 3) near the northern edge of the Zane Hills pluton. The contact between the hornblende-biotite granodiorite pluton and andesite wallrock dips gently to the north in contrast to the steep contact around the rest of the pluton. This contrast in dip is shown by the occurrence of granodiorite in the valleys and of andesite hornfels on the ridgetops, as well as by a broad zone (not shown on the map) of thermally metamorphosed rocks north of the pluton. The abundance of hornblende in the northern half of the pluton, in contrast to the hornblende-poor southern half, suggests contamination of the pluton near its roof. Roof areas such as this are known to be favorable zones for mineralization.

Copper minerals were found in three places (fig. 3, locs. 1–3) along the contact between gneissic hornblende-biotite granodiorite and andesite. Anomalous copper values in stream-sediment samples from nearby streams draining east and west from the Zane Hills divide (fig. 3) indicate an even larger area of mineralization. Massive chalcopyrite occurs in fractured quartz gangue in frost-riven blocks of meta-andesite near the granodiorite contact at locality 1 (fig. 3). Pyrite and malachite, which are locally abundant, and covellite are also constituents of these blocks. The chalcopyrite is little oxidized and shows only minor replacement by covellite and malachite. Grab samples (5 inches across) of chalcopyrite in quartz from locality 1 (table 3) contain as much as 4.5 ounces of silver per ton (150 ppm) and 0.023 ounce of gold per ton (0.8 ppm). Several streams near locality 1 (fig. 3) have float of meta-andesite that is cut by chalcopyrite-pyrite-quartz veins and contains disseminated chalcopyrite and pyrite.

Malachite and limonitic chalcopyrite occur in fractures in frost-riven blocks of brecciated quartz, andesite, and altered granodiorite along a belt 100 feet wide on the north side of the saddle separating the andesite from the gneissic granodiorite at locality 2 (fig. 3). The mineralized andesite and granodiorite here contain as much as 30 ppm of silver, 0.09 ppm of gold, 700 ppm of zinc, and from 1,000 to 20,000 ppm of copper (table 3). Similar rocks occur at the granodiorite-andesite contact at locality 3.

Nearby, at locality 4 (fig. 3), rusty-colored molybdenite-bearing quartz veins as much as 2 feet thick

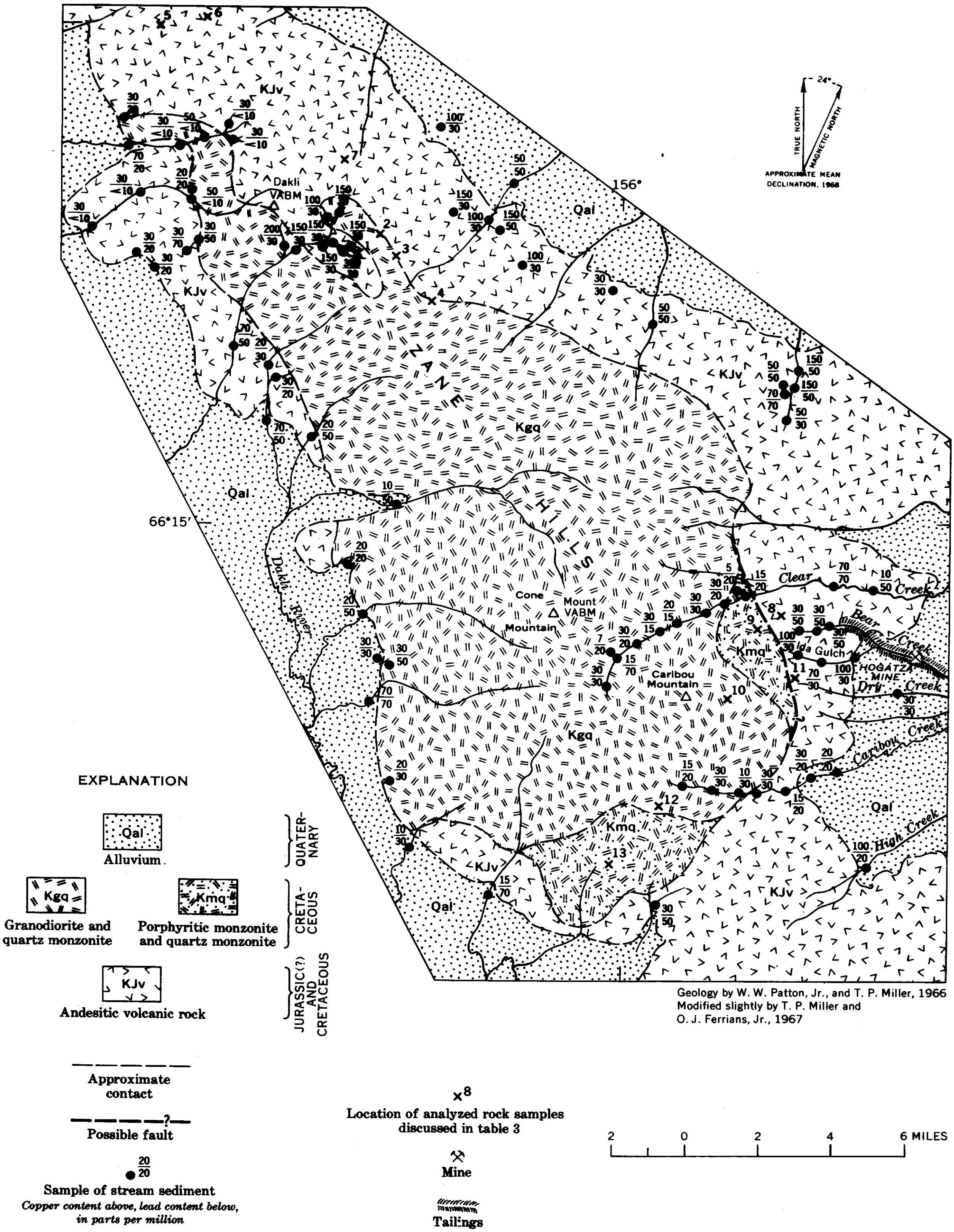

Figure 3.--Geologic map of the Zane Hills area.

Table 3.—Analyses of selected grab samples from mineralized localities in the Zane Hills area

[Results reported in parts per million unless otherwise noted. Gold analysis by atomic absorption; all others are by semiquantitative spectrographic analysis with results reported to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1. N, not detected; I, interference; -, not looked for; >, greater than value shown; <, present but below limit of determination. Sample localities are shown in figure 3]

Sample No.	Lab. No.	Cu	Ag	Au	Pb	Zn	Mo	Description
1A	ACC—103	7,000	15	0.06	15	N	30	Float of chalcopyrite-pyrite-quartz veinlet in andesite.
1B	104	500	N	N	10	N	N	Chalcopyrite-bearing quartz veinlet in andesite.
1C	105	[1]>10	150	.3	N	1,000	N	Massive chalcopyrite with minor covellite in quartz; chalcopyrite-content estimate, 50 percent.
1D	106	[1]>10	150	.6	10	700	N	Do.
1E	107	[1]>10	150	.5	N	N	N	Do.
1F	108	10,000	50	.8	15	N	150	Chalcopyrite-bearing quartz veinlets in andesite.
2A	ACM—184	>5,000	3	.07	20	N	70	Chalcopyrite and malachite in fractured andesite.
2B	ACN—852	20,000	N	N	200	N	N	Chalcopyrite and malachite in quartz.
2C	487	1,000	30	.09	50	700	I	Hematite float.
2D	488	>5,000	20	.05	<10	700	I	Chalcopyrite and malachite in fractured andesite.
3	489	1,000	2	N	<10	N	15	Chalcopyrite and pyrite in quartz.
4	ACM—188	30	1.5	N	<10	N	2,000	Molybdenite-bearing quartz.
5	ACN—870	5,000	3	N	N	N	N	Oxidized pyrite and chalcopyrite in quartz.
6	871	100	3	.6	150	N	N	Oxidized pyrite in quartz.
7	872	150	1	N	30	N	3	Do.
8	ACM—185	100	N	N	30	N	N	Altered quartz breccia; contains 200 ppm of Sb.
9	ACN—994	50	N	N	100	N	200	Molybdenite(?)-bearing vein; contains 3,000 ppm of Bi.
10	ACM—189	500	15	.4	300	N	30	Pyrite in quartz.
11	ACN—840	300	5	2.4	150	300	10	Do.
12	867	70	200	.3	500	N	15	Pyritiferous silicified fine-grained intrusive; contains 1,000 ppm of Bi and 700 ppm of W.
13	M102348	5,000	2	-	0	0	10	Chalcopyrite in quartz; contains 7,000 ppm of W.
Limits of determination		5	.5	.02	10	200	5	

[1] Results reported in percent.

cut the andesite, again near the granodiorite contact. A grab sample from one vein (table 3, sample 4) contains 0.2 percent of molybdenum.

Sediment in streams draining both east and west from the Dakli contact area contains anomalous copper values ranging from 100 to 300 ppm over an area of about 20 square miles (fig. 3). Hence, copper deposits are probably more widespread than indicated by this reconnaissance investigation. Pyrite- and chalcopyrite-bearing quartz veins as much as 3 feet thick cut meta-andesite north of the Zane Hills pluton at localities 5, 6, and 7 (fig. 3). Analyses of grab samples are given in table 3 (samples 5, 6, 7).

Clear Creek

The Clear Creek gold area is on the east side of the Zane Hills pluton (figs. 3, 4) and includes the Hogatza placer gold mine. The granitic rocks of the pluton in this area are gneissic monzonite and quartz monzonite (**kmq**, figs. 3, 4) (discussed in greater detail in the section on Caribou Mountain) and massive, medium-grained granodiorite typical of the rest of the pluton (**kgq**, figs. 3, 4). The country rock is andesitic volcanic rock of Early Cretaceous and Late Jurassic age. The contact between granitic rock and andesite is in colluvium-filled, heavily vegetated saddles, which separate the subdued low hills of andesite from the much higher mountains of granitic rock. This abrupt scarp-like feature is indicative of a fault contact which would be a favorable site for mineralization.

Sediment samples from streams draining the andesite-monzonite contact on both sides of Clear Creek contain anomalous amounts of lead and copper (fig. 4 and table 4). A sediment sample from a spring near the contact high on the south slope of Clear Creek valley (fig. 4, and table 4, sample 11A) contained 1.74

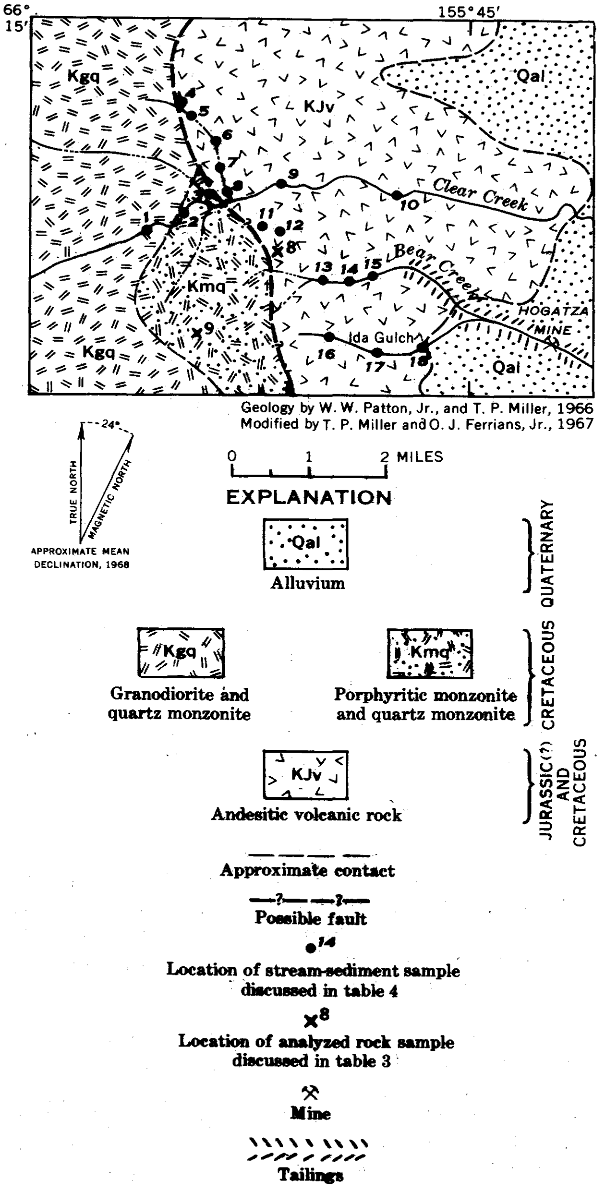

Figure 4.—Geologic map of the Clear Creek area.

ppm of gold—the highest value of gold found in any sediment sample from the entire region. Brecciated quartz float from the contact zone on the ridge above this spring (fig. 4) contains anomalous amounts of antimony (table 3, sample 8), and soil samples from this same area contain lead and anomalous amounts of copper, as shown below in parts per million:

Lab. No.	Cu	Pb
ACN-873	150	100
874	300	30
875	70	70

Mineralized bedrock is found in several places in this general area (table 3, locs. 8–11) and contains as much as 2.4 ppm of gold (0.07 oz per ton) as well as anomalous amounts of silver, bismuth, copper, and molybdenum.

The occurrence of these anomalous values in stream-sediment and rock samples indicates that mineralization may have taken place along and near the monzonite-andesite contact in this area. This possibility is further enhanced by the fact that the mining operations of the Hogatza gold mine on Bear Creek began only a mile downstream. The auriferous alluvial gravels in this valley are derived from outwash streams emanating from a lobe of the glacier which moved down Clear Creek valley in early Pleistocene time. This lobe crossed the ridge between Clear and Bear Creeks near the monzonite-andesite contact, eventually covered the entire ridge, and terminated in Bear Creek valley. Glaciers are not efficient sorting or mixing agents and rock material incorporated into the ice on one side of the glacier would tend to remain on that side. Since the bedrock exposed above the point where the Clear Creek glacier crossed over into Bear Creek is unaltered granitic rock, which is not a likely host rock for lode gold, the source of the placer gold is thought to be in or near the concealed andesite-monzonite contact. The location of the tailings at Bear Creek indicates that the pay streak extended to very near this contact.

The monzonite-andesite contact zone on either side of Clear Creek is an attractive site for lode gold prospecting. A small trenching or drilling program would give considerable information in evaluating the economic potential of this zone.

Caribou Mountain

Border phases of the Zane Hills pluton in two areas along the southeastern margin of the pluton (fig. 3, map unit kmq) show anomalous radioactivity—five to ten times the background radioactivity of the rest of the pluton. These border phases are composed of medium- to coarse-grained, trachytoid to gneissic, hornblende-biotite quartz monzonite and monzonite readily distinguishable in the field from the typical massive, granitic-textured granodiorite of the rest of the pluton. Tourmaline-bearing aplite dikes are common in the border phase as are dark-colored hybrid rocks indicative of contamination of granitic magma by andesitic wallrock. Large potassium-feldspar phenocrysts (as long as 3 inches) also are common in these border phases and locally in the adjacent metamorphosed andesite.

An analysis of porphyritic quartz monzonite from this border phase shows 20 ppm of uranium. This is five to six times more than the published averages for rocks of this composition (Smith, 1963, p. 402). Examination of thin sections of this rock shows that biotite and hornblende contain numerous inclusions surrounded by

Table 4.--Copper and lead content of stream-sediment samples, Clear Creek area

[Results are from semiquantitative spectrographic analysis and are reported in parts per million to the nearest number in the series 1, 0.7, 0.5, 0.4, 0.3, 0.2, 0.15, 0.1. Sample localities are shown in figure 4]

Sample No.	Lab. No.	Cu	Pb	Sample No.	Lab. No.	Cu	Pb	Sample No.	Lab. No.	Cu	Pb
1	ACN—463	30	30	7B	ACC—135	100	150	12D	ACN—975	70	70
2	464	30	20	8A	136	70	50	12E	977	50	70
3	465	5	20	8B	137	70	70	12F	978	70	70
4A	ACC—117	50	50	9	139	70	70	12G	980	70	100
4B	119	50	70	10	64M-1468	10	50	12H	981	50	70
4C	120	70	50	11A	ACN—809	50	100	12I	982	70	50
4D	122	50	70	11B	986	30	50	12J	984	70	50
4E	124	50	100	11C	ACN—988	30	50	12K	985	50	30
5A	126	30	70	11D	989	30	50	13	808	30	50
5B	127	50	50	11E	991	30	50	14	ACM—107	30	50
5C	128	50	50	11F	992	30	50	15	106	30	50
5D	130	70	50	12A	971	50	70	16	ACN—846	100	30
6A	131	100	70	12B	973	50	70	17	848	70	30
6B	132	100	150	12C	974	50	70	18	849	100	30
7A	134	100	70								

pleochroic halos indicative of radioactivity. Some of these halos are obviously around zircon crystals, but other much more intense halos are around grains of a colorless to faintly yellow, isotropic mineral of high relief. A thin section of this porphyritic quartz monzonite was exposed to a thermal neutron beam in a reactor in order to cause the fission of U^{235}. The fission events were recorded in a piece of lexan which covered the section. Later, etching of the lexan showed the anomalously occurring uranium in the sample to be associated with the colorless isotropic mineral.

Although the uranium-bearing mineral is only a minor constituent in the samples studied, it may be more abundant elsewhere in the radioactive border phase—possibly in amounts large enough to be important economically, or other uranium minerals may be present. A panned concentrate collected in 1964 from Caribou Creek on the southeastern side of the Zane Hills contained 200 ppm of thorium, which was probably derived from this more radioactive border phase of the pluton.

Other mineralized rock occurrences in this area are: (1) a pyritiferous fine-grained intrusive cutting the border phase monzonite at locality 12 (fig. 3); a sample of this material (table 3, sample 12) contains anomalous amounts of silver, gold, lead, bismuth, and tungsten, and (2) a chalcopyrite-bearing quartz vein 1 to 3 feet wide cutting monzonite at locality 13 (fig. 3); a sample of this material (table 3, sample 13) contains anomalous amounts of tungsten in addition to copper.

Hawk River

Sediment from streams in a large area south of Purcell Mountain, which includes the headwaters of the Hawk River, contains anomalous amounts of lead, copper, and silver (fig. 5, table 5). These streams drain an area in which quartz veins containing pyrite, and locally, argentiferous galena are abundant.

The bedrock south of Purcell Mountain (fig. 5) consists of andesitic volcanic rocks of Late Jurassic(?) and Early Cretaceous age and quartz latite volcanic rocks of Late Cretaceous age which are intruded by alaskite and quartz monzonite of Late Cretaceous age (Patton and others, 1968). The older andesitic volcanic rocks are thermally metamorphosed in the vicinity of the Wheeler Creek pluton, Purcell Mountain pluton, and Hawk River pluton. The Upper Cretaceous quartz latite is thermally metamorphosed only near the

Table 5.--Analyses of selected grab samples from the Hawk River locality near Purcell Mountain

[Results reported in parts per million. Gold analyses by atomic absorption; all others by semiquantitative spectrographic analysis with the results reported to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1. N, not detected; >, greater than value shown. Sample localities are shown in figure 5]

Sample No.	Lab. No.	Cu	Ag	Au	Pb	Zn	Description
1	ACM—176	10	N	0.02	50	N	Oxidized pyrite in quartz.
2A	178	70	3	N	300	N	Do.
2B	179	30	100	.03	>5,000	1,500	Galena in quartz; contains 150 ppm of Sb.
2C	ACN—881	700	200	.3	20,000	500	Galena in quartz.
3	ACM—180	3,000	50	.08	1,500	N	Chalcopyrite-galena in quartz.
4	ACN—486	70	3	.05	300	300	Oxidized pyrite in quartz.
Limits of determination		5	.5	.02	10	200	

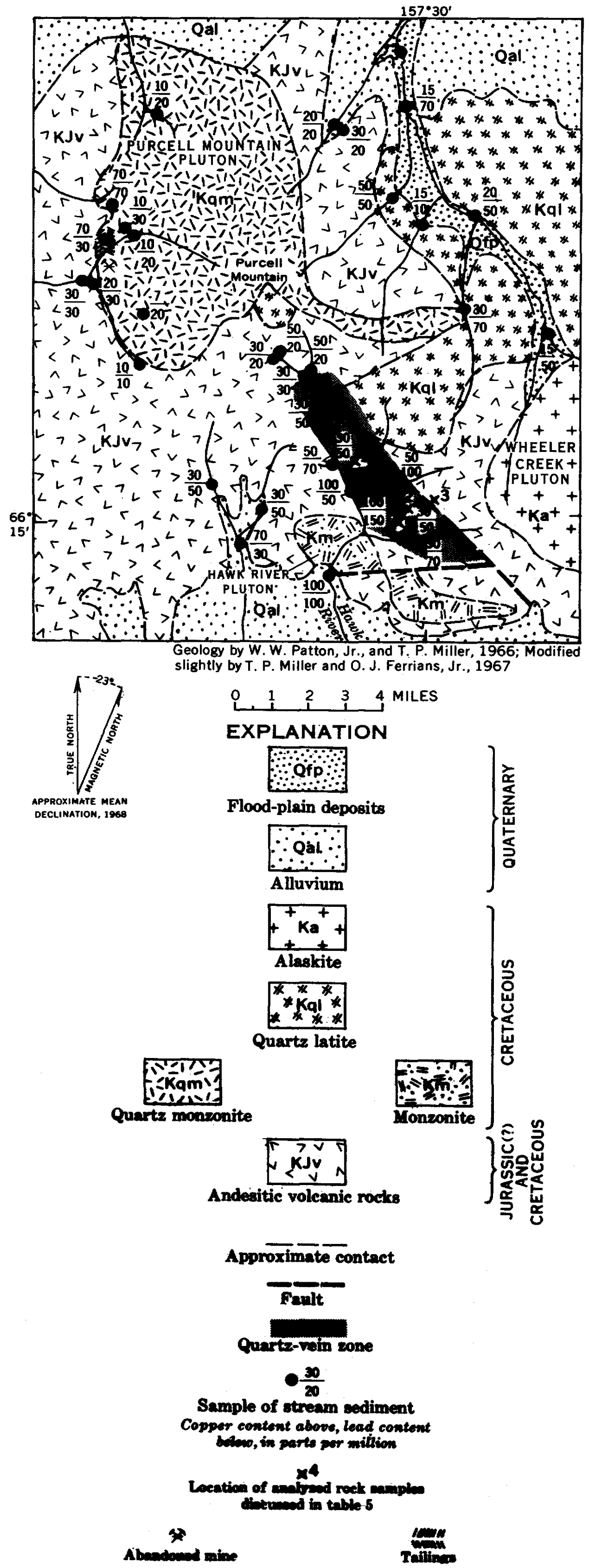

Figure 5.--Geologic map of the Purcell Mountains area.

Wheeler Creek pluton. Numerous fine-grained pyritiferous felsic dikes as much as tens of feet wide cut both the andesitic and quartz latite volcanic rocks throughout this area.

Pyritiferous milky-white vuggy quartz veins showing well-developed comb structure cut both volcanic units in a northwest-trending belt 6½ by 1½ miles in areal extent (fig. 5). This belt is parallel to a zone of prominent northwest-trending lineations and faults. The veins are mostly narrow, ranging in width from 1 inch to 2 feet, and they appear to strike northeast and dip steeply to the north. They seem to occur as clusters of veins 2 to 20 feet apart; the most extensive concentrations of quartz veins are at localities 2 and 3 (fig. 5). Locally, they contain irregular segregations of argentiferous galena with lesser amounts of chalcopyrite and malachite. Pyrite occurs in cubes up to 1 inch on a side and is almost completely oxidized to limonite; galena is fresh and fills vugs and fissures along the edge of the veins. Chemical analyses of grab samples representative of these deposits are given in table 5. No galena or chalcopyrite was found in the andesitic or latitic volcanic rocks; however, the andesitic wallrock locally contains abundant disseminated pyrite.

The mineralized quartz veins cut the Upper Cretaceous quartz latite, dated at 86 m.y. (Patton and others, 1968), and may be related to the intrusion of the Wheeler Creek pluton dated at 80 m.y. (Miller and others, 1966) that is just east of this area (fig. 5).

Purcell Mountain

A small inactive placer mine is on a stream draining to the west from the Purcell Mountain pluton (fig. 5). The stream crosses the contact between the quartz monzonite and andesite. Although no large zones of altered rock were observed in the area, abundant pebbles and cobbles of black tourmaline as much as 3 inches in diameter and of albitized quartz monzonite cut by black tourmaline veinlets were found in the tailings and gravels of this stream and the stream to the north. The tourmaline is associated with quartz and sparse disseminated oxidized sulfide, and it occurs in the veinlets as radiating sunbursts of crystals with individual crystal lengths of a few millimeters. The quartz monzonite appears to be altered adjacent to the veinlets. Analyses of two tourmaline-rich altered quartz monzonite cobbles show 700 and 1,000 ppm of copper but no detectable gold. The abundance of tourmaline, the small drainage basin, and the lack of any exposed large alteration zones suggest that the source of the placer gold here may be quartz-tourmaline-sulfide veins which cut and altered the quartz monzonite near the andesite contact. If this is so, the presence of tourmaline veinlets in place or in material in the alluvium may serve as a guide to possible gold mineralization elsewhere in this part of the region; similar tourmaline-rich cobbles are found within the Bear Creek placer-mine area on the east side of the Zane Hills and in a stream draining the Dakli copper prospect.

SUMMARY

Investigation of the central Koyukuk River region located seven areas containing mineral occurrences thought to be worthy of further prospecting. Because of the size of the district and the short time available for detailed investigation, individual areas were not studied in detail, and more concentrated surface prospecting and closer spaced geochemical stream-sediment sampling is needed to determine the extent and amount of mineralized rock. These mineralized areas are all near granitic plutons, and future prospecting elsewhere in the region should be conducted with this in mind.

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