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Metalliferous Deposits Near Granite Mountain Eastern Seward Peninsula Alaska

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By Thomas P. Miller and Raymond L. Elliott

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By THOMAS P. MILLER and RAYMOND L. ELLIOTT

ABSTRACT

New deposits of lead, zinc, and silver were found in a large altered zone 18 miles long and 2 to 5 miles wide near Quartz Creek west of Granite Mountain in the eastern Seward Peninsula, Alaska. New deposits of molybdenum, bismuth, and silver were found associated with a previously reported occurrence of uranium, copper, lead, and zinc minerals in the upper Peace River drainage northeast of Granite Mountain. Both groups of deposits are associated spatially with felsic plutonic rocks and occur near the western edge of a late Mesozoic province of volcanic plutonic rocks. Both groups of deposits warrant further investigation as possible exploration target areas.

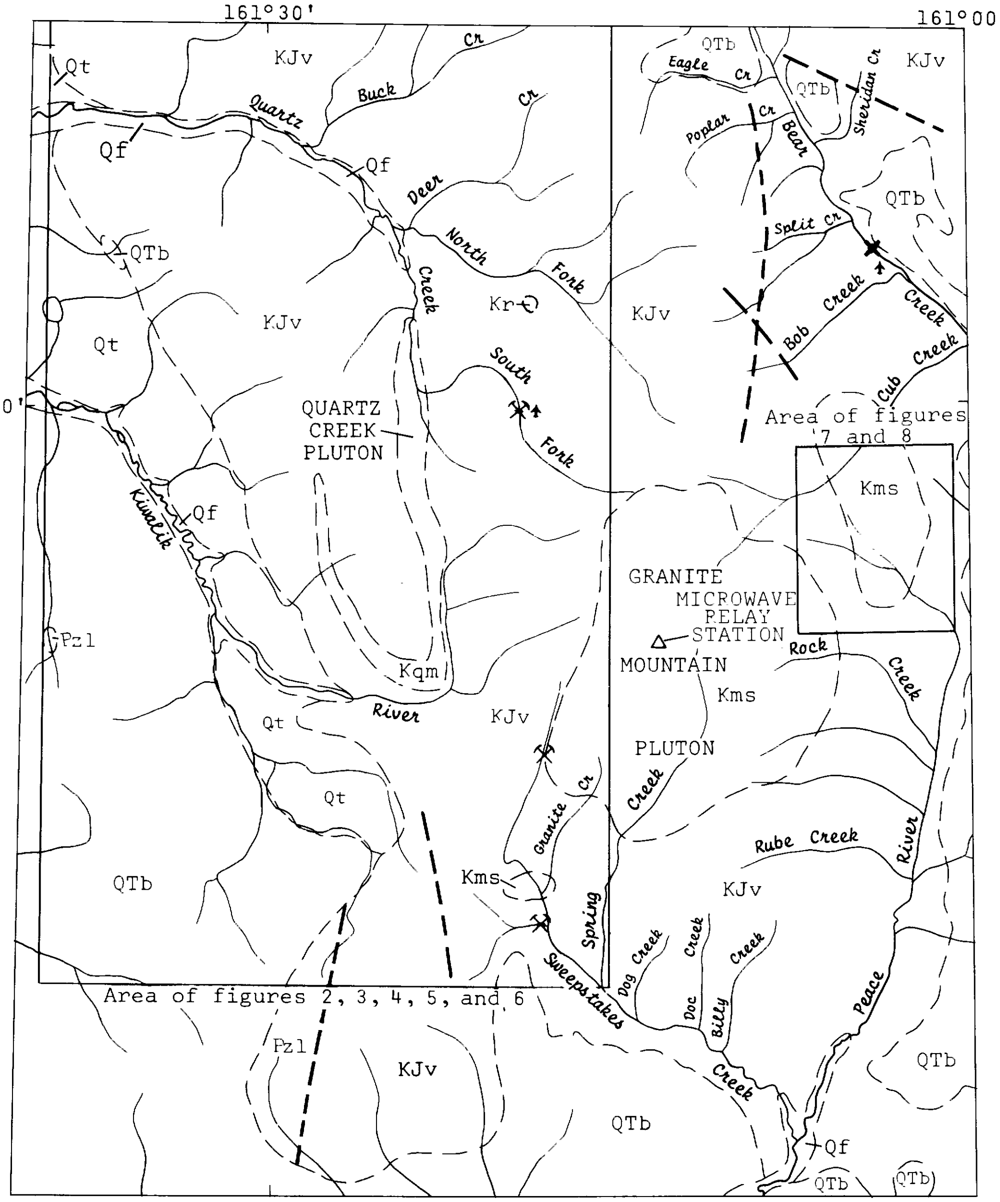
INTRODUCTION

New deposits of lead, zinc, and silver were found over a large mineralized area near Quartz Creek west of Granite Mountain, in the eastern Seward Peninsula, Alaska, during investigations conducted in 1968 as part of the U.S. Geological Survey's Heavy Metals program. In addition, anomalous concentrations of molybdenum, silver, and bismuth were found in altered syenite and quartz veins in the upper Peace River drainage basin northeast of Granite Mountain at a locality where anomalous amounts of lead, zinc, copper, and uranium have been reported in panned concentrates (Gault and others, 1953). A previously known lead-zinc-gold deposit at Bear Creek (Herreid, 1965) was reexamined and sampled. Placer gold has been mined on a small scale at several localities since the 1900's, and a little platinum has been recovered as a byproduct. The area has not, however, been extensively prospected for other metals.

The deposits occur in the Candle B–5, B–6, C–5, and C–6 quadrangles (mapped at scale of 1:63,360). The closest towns are Candle, 45 miles northeast; Buckland, 40 miles north; and Koyuk, 40 miles south. At Bear Creek a small dirt landing field suitable for light aircraft was in use during the summer of 1968. Another landing strip along the South Fork of Quartz Creek has apparently been unused for many years, but small balloon-tired aircraft may be able to land in the east-west direction (fig. 1). The landing field at the microwave relay station at Granite Mountain itself is restricted and unavailable for civilian use. Most of the area is tundra covered and free of brush except locally along major stream bottoms. The area is one of moderate relief comprised of flat-topped mountains and ridges up to 2,800 feet in altitude that form the divide between the Kiwalik and Buckland Rivers.

More than 400 rock, stream-sediment, and soil samples collected during the study of the Granite Mountain region were analyzed by semiquantitative spectrographic and atomic-absorption methods; results were available while fieldwork progressed. A helicopter was used throughout the investigation of the Granite Mountain region—an investigation which lasted about 3 weeks during the summer of 1968.

The authors were ably assisted in the field by Donald H. Grybeck and Richard F. Hardyman, geologic field assistants; Grybeck also assisted in the polished-section study. Semiquantitative spectrographic analyses were done by K. J. Curry, E. E. Martinez, and J. M. Motooka, and atomic-absorption analyses were done by R. L. Miller and W. R. Vaughn. Officials of the Radio Corp. of America and their personnel at the Granite Mountain microwave relay station were very helpful and cooperative.



Base from U.S. Geological Survey
1:250,000 Candle, 1961

Geology by W. W. Patton Jr., (1967)
Modified by T. P. Miller and
R. L. Elliott, 1968

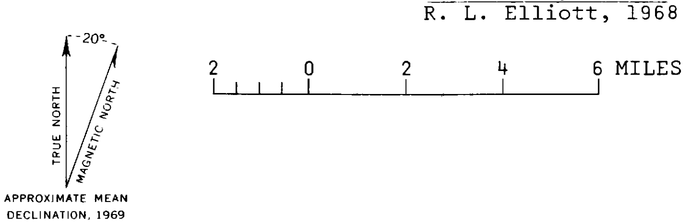


FIGURE 1.—Geologic map of the Granite Mountain region showing location of areas described in text.

EXPLANATION

QUATERNARY

- Qf — Floodplain deposits
- Qt — Terrace deposits

TERTIARY(?) AND QUATERNARY

- QTb — Basalt

CRETACEOUS

- Kqm — Quartz monzonite
- Kms — Monzonite, syenite, and nepheline syenite
- Kr — Altered rhyolite

JURASSIC(?) AND CRETACEOUS

- KJv — Andesitic volcanic rocks

PALEOZOIC

- Pzl — Limestone and schist

- Approximate contact
- Approximate fault
- ✕ Bear Creek prospect
- ⚒ Mine
- ⚒ Abandoned mine
- ✈ Airstrip

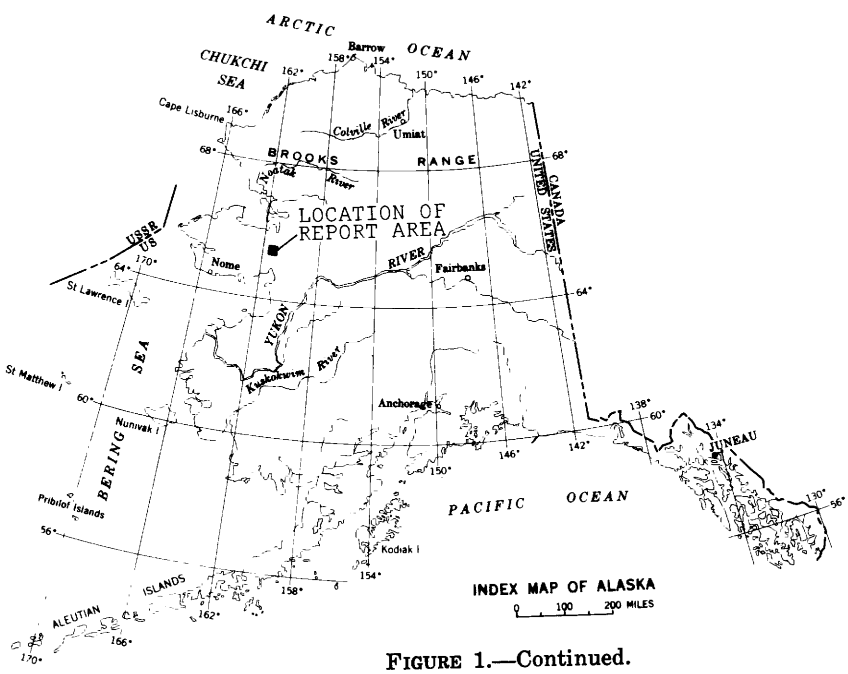
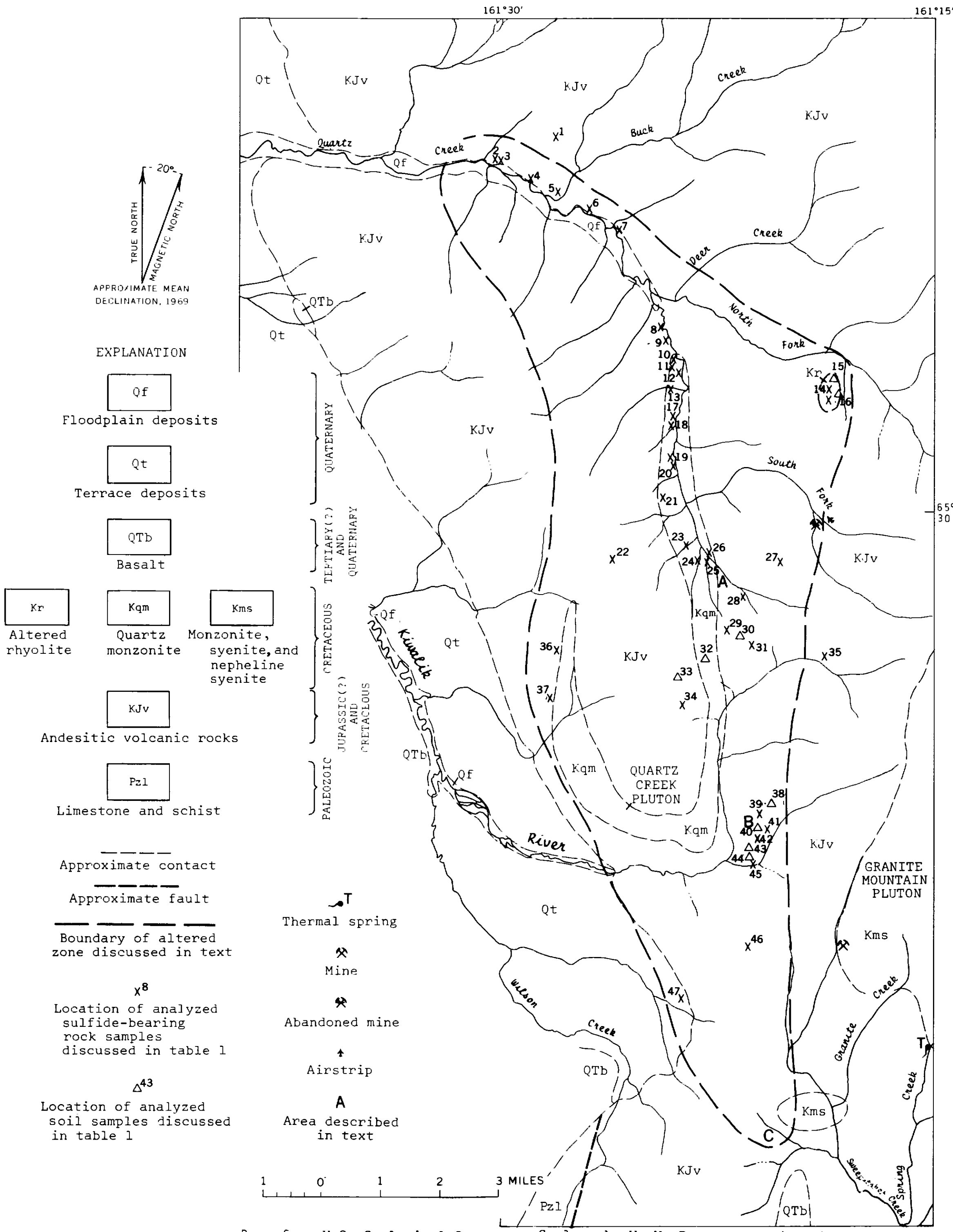


FIGURE 1.—Continued.



Base from U.S. Geological Survey 1:250,000 Candle, 1961

Geology by W. W. Patton Jr., (1967) Modified by T. P. Miller and R. L. Elliott, 1968

FIGURE 2.—Geologic map of the Quartz Creek area.

The first geological report on the Granite Mountain region was by Moffit (1905) who briefly described the geology of the Buckland-Kiwalik divide in his report on the gold placers of the Fairhaven district. Smith and Eakin (1911) and Harrington (1919) discussed the gold and platinum placers at Bear and Sweepstakes Creeks. Gault, Killeen, West, and others (1953) found anomalous amounts of uranium-bearing minerals and base-metal sulfides in pan concentrates in the upper Peace River drainage. Herreid (1965) mapped the geology in the vicinity of Bear Creek and took geochemical samples throughout the northern part of the Granite Mountain region. Patton (1967) mapped the regional geology of the Candle quadrangle at a scale of 1:250,000.

GEOLOGIC SETTING

The Granite Mountain region is underlain chiefly by andesitic volcanic rocks of Jurassic(?) and Cretaceous age intruded by felsic plutonic rocks of diverse composition and by small hypabyssal felsic intrusives. Metamorphic rocks of Paleozoic and perhaps Precambrian age lie to the west of the area. Olivine basalt of late Tertiary(?) and Quaternary age occurs in a few low-lying areas and caps some ridges. The mineral deposits in the area are spatially related to the plutonic rocks and occur in both the intrusive rocks and in the surrounding country rocks.

Light-gray massively bedded recrystallized limestone and dolomite with subordinate amounts of mica schist and phyllite crop out only in the southwestern part of the map area (fig. 1). This unit has been tentatively assigned a middle Paleozoic age by Patton (1967) and is the oldest bedrock unit in the Granite Mountain region. It is in fault contact with the Mesozoic volcanic rocks.

The next oldest unit is composed of andesitic and trachyandesitic pyroclastic and volcaniclastic rocks intercalated with andesite flows. The bulk of the unit is thought to be of earliest Cretaceous age on the basis of fossil and radiometric age determinations (Patton, 1967). The andesite near the contact of the various plutons is thermally metamorphosed into rocks of the hornblende hornfels facies, and these grade into rocks of the albite-epidote hornfels facies away from the contact.

The andesitic volcanic rocks were intruded in mid-Cretaceous time by felsic plutonic rocks of diverse composition. The Granite Mountain pluton is the largest intrusive body in the map area. It covers about 30 square miles and is roughly circular in plan. The pluton consists of a complex composed of a core of hornblende-pyroxene syenite and monzonite and a border of pseudoleucite syenite, biotite pyroxenite, and various types of garnet-bearing nepheline syenite. It has been assigned a mid-Cretaceous age as a result of a lead-alpha age determination of 100±15 m.y. (million years) (Patton, 1967). Satellitic stocks of syenite and nepheline syenite occur northeast and south of the pluton. A hook-shaped pluton, herein called the Quartz Creek pluton, of fine-grained biotite-hornblende quartz monzonite crops out along the upper reaches of the Kiwalik River and Quartz Creek (figs. 1 and 2). The northeastern part of the pluton is extensively altered. All these bodies, though of diverse composition, are tentatively correlated with nearby plutons to the north and northeast that range in composition from quartz monzonite to syenite and monzonite and that include scattered nepheline syenite complexes (Patton and Miller, 1968; Patton and others, 1968). The plutons in this part of west-central Alaska have been assigned to the "older" suite of Cretaceous plutonic rocks as a result of several potassium-argon age determinations ranging from 100 to 107 m.y. (Miller and others, 1966).

Fine-grained dikes (not shown in figs. 1 and 2), ranging in composition from latite to trachyte, and dikes of pseudoleucite porphyry cut the andesitic volcanic rocks near the plutons. These dikes are generally less than a few tens of feet thick. The dikes near the Quartz Creek pluton are locally mineralized and contain disseminated pyrite, galena, and sphalerite.

A small body of intensely altered and oxidized rhyolite intrudes the andesite northwest of Granite Mountain (figs. 1 and 2, map unit Kr). The rhyolite is tentatively assigned a Cretaceous age, but its absolute age is unknown. Similar rhyolite bodies to the northeast in the Shungnak quadrangle are assigned an early Late Cretaceous age on the basis of geologic relationships and potassium-argon age determinations (Patton and others, 1968).

The youngest rocks in the region are the vesicular olivine basalt flows of late Tertiary (?) and Quaternary age. These flows cover large areas of the Kiwalik River valley and cap some of the ridges north of Bear Creek.

The region has not been glaciated, and thus the valleys are free of glacial drift. Outcrops are sparse owing to the extensive frost riving which has reduced most of the exposures to rubble.

The Granite Mountain region is located near the west edge of a late Mesozoic province of andesitic volcanic rocks and felsic plutonic intrusives. Rocks of this volcanic-plutonic province crop out over much of west-central Alaska and the easternmost Seward Peninsula. The central and western Seward Peninsula consists of a thrust-faulted province of metamorphic and sedimentary rocks of Paleozoic age (some of these rocks are perhaps as old as Precambrian) cut by intrusive bodies of various compositions and ages. A north-south boundary separates these two provinces. This boundary is concealed over much of its length by Quaternary flows, but wherever Mesozoic volcanic rocks can be observed in juxtaposition with older rocks, the contact is a faulted one. This boundary between two provinces so different in lithology, age, and tectonic history may be a fault over its entire length.

MINERAL DEPOSITS

The known mineral occurrences of the Granite Mountain region include lead, zinc, and silver deposits in the Quartz Creek area; a molybdenum, bismuth, silver, copper, lead, and uranium deposit in the upper Peace River drainage; and a lead, zinc, and gold deposit at Bear Creek. The relationships among the individual deposits are unknown, and there are differences in mineralogy, chemistry, and lithology. All the deposits, however, are related spatially to felsic plutonic rocks.

Each of the deposits is described in the following sections of the report, and geologic maps of the Quartz Creek and upper Peace River areas are included. Geochemical maps showing the distribution of lead, zinc, copper, and boron in stream sediments from the Quartz Creek and upper Kiwalik River drainage basins are included. These elements were determined by semiquantitative spectrographic analyses in which the results are reported to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, and so forth. Stream-sediment values of 70 ppm (parts per million) or greater for lead and boron, 100 ppm or greater for copper, and 10 ppm or greater for molybdenum are considered anomalous. Because of the high limit of detection for zinc (200 ppm), even detectable zinc is considered anomalous. The selection of these limits is subjective and interpretive on the part of the authors; they are, however, based on the distribution of elements in several hundred stream-sediment samples collected from this geologic province over a period of several years.

Semiquantitative spectrographic and atomic-absorption analyses of mineralized rock samples are shown in tables 1, 2, and 4. Anomalous limits for bedrock samples are difficult to determine, because many of the rock samples are so altered that it is impossible to identify the original rock or mineral. For this reason, limits have been arbitrarily selected for each element. These limits, which are thought to be above what is generally considered background for the various rock types found in the Granite Mountain region, are given at the bottom of each table as are the limits of detection of the analytical technique.

QUARTZ CREEK

Numerous occurrences of argentiferous galena, sphalerite, pyrite, and arsenopyrite have been found in an altered zone about 18 miles long and 2 to 5 miles wide west of Granite Mountain (fig. 2). This zone extends N. 15° W. across the drainage basins of the upper Kiwalik River and Quartz Creek and is roughly parallel to prominent lineaments in the area. Conspicuous reddish-orange oxidized areas and large buff carbonate replacement bodies occur in the andesite and in the quartz monzonite that underlies this zone. A striking feature of the mineralized rock in this zone is the association of sulfides with tourmaline.

Semiquantitative spectrographic analyses of sulfide-bearing material from this zone (table 1) show, in addition to the high lead, zinc, arsenic, and silver contents, consistently high boron contents which indicate the abundance of tourmaline. The manganese and scandium content is also high. Copper and antimony, though present in anomalous amounts in many samples, never exceed 2,000 and 700 ppm, respectively. Gold is low, less than 1 ppm, even though arsenic is high. Tin occurs in about 50 percent of the analyzed samples in amounts ranging from just detectable to 500 ppm. Many of these chemical characteristics are similar to those described by Sainsbury and Hamilton (1967) as being typical of lode tin deposits. The sulfide mineral suite and the abundance of tourmaline are also similar to the mineral assemblage of the western Seward Peninsula tin district (Sainsbury, 1964).

Many stream-sediment samples from this zone contain very anomalous amounts of lead, zinc, copper, and boron (figs. 3–6). Silver is reported in many of the samples but is never more than 0.7 ppm. Arsenic is reported in some samples, particularly near the head of the easternmost creek in area A where values as high as 2,000 ppm occur. Sediment samples from streams draining area A contain as much as 1,000 ppm lead and 1,500 ppm zinc (figs. 3 and 4), in addition to anomalous boron and copper. Sediment in streams from area C contains anomalous zinc values ranging from 300 to 1,500 ppm (fig. 4). This low area is completely covered with tundra, and the source of the anomaly was not found. Anomalous concentrations of lead, zinc, arsenic, silver, and boron were found in soil and rock samples from the ridge in area B in the upper Kiwalik River drainage (fig. 2). Stream sediments west of this ridge (figs. 3 and 4) show anomalous lead and zinc. A copper anomaly occurs in the stream sediments of the northern part of the Quartz Creek drainage basin. The higher copper content generally coincides with lower lead and zinc values and suggests lateral zonation in the major altered zone. The eastern edge of the copper anomaly begins in the North Fork of Quartz Creek near a small body of intensely oxidized rhyolite (map unit Kr, fig. 2; fig. 5), and composite grab and soil samples of the rhyolite (samples 14, 15, and 16 in table 1) show anomalous concentrations of copper, antimony, and boron. The copper anomaly persists in the stream sediments of Quartz Creek all the way to the Kiwalik River Valley (fig. 2).

The largest area of sulfidized rock within this altered zone is in area A in and around hydrothermally altered quartz monzonite of the Quartz Creek pluton (fig. 2). The presence of sulfide-tourmaline-quartz-carbonate float in all the streams draining this tundra-covered area and the location of lode occurrences of sulfide minerals and of anomalous stream-sediment and soil samples (fig. 2; table 1) outline a strongly mineralized area of about 6 square miles extending from the ridge at the headwaters of the streams draining area A to about a mile north of their junction with the South Fork of Quartz Creek.

The principal sulfide minerals in area A are galena, sphalerite, pyrite, and arsenopyrite. Realgar and orpiment were found on fracture surfaces at locality 28 (fig. 2), and chalcopyrite occurs as small blebs generally associated with sphalerite and visible only in polished section. The intrusive rock in this area appears to have been tourmalinized along closely spaced fractures and (or) joints. Where the tourmaline, a black to green variety, first replaced the mafic minerals, a "bleached" quartz-feldspar-tourmaline rock resulted. Where tourmalinization was complete, a dense fine-grained black rock composed entirely of quartz and tourmaline was formed. Sericitization has also taken place, and where the feldspars were not replaced by tourmaline, they were sericitized. Late carbonate veins and replacement bodies cut the altered quartz monzonite. The andesite in this area is also pervasively altered, and scapolite is common as thin veinlets and as pseudomorphs after feldspar. The sulfide minerals occur in both the altered tourmalinized rock and in the carbonate veins as disseminated grains, masses, and aggregates of grains. The poor exposures and extensive frost riving prohibit determination of the thickness and attitude of the sulfide-bearing material. However, at locality 25 (fig. 2), a strongly mineralized aggregate of quartz, tourmaline, carbonate, and sulfide minerals crops out for about 50 feet in the streambed and cutbank. A composite grab sample (sample 25B, table 1) shows over 2 percent lead, 4 percent zinc, and 1½ ounce per ton silver.

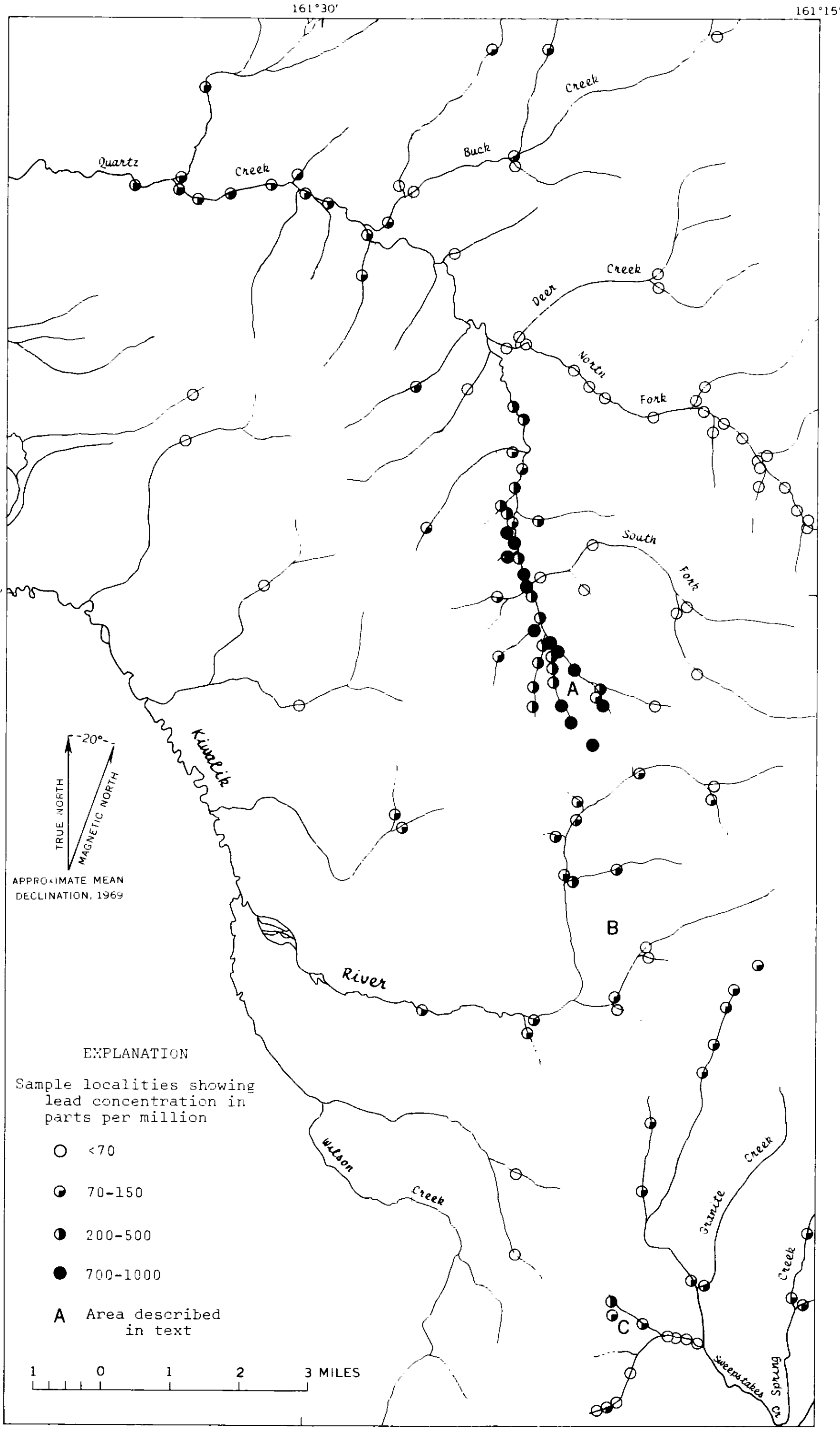


FIGURE 3.—Lead distribution in stream sediments of the Quartz Creek area.

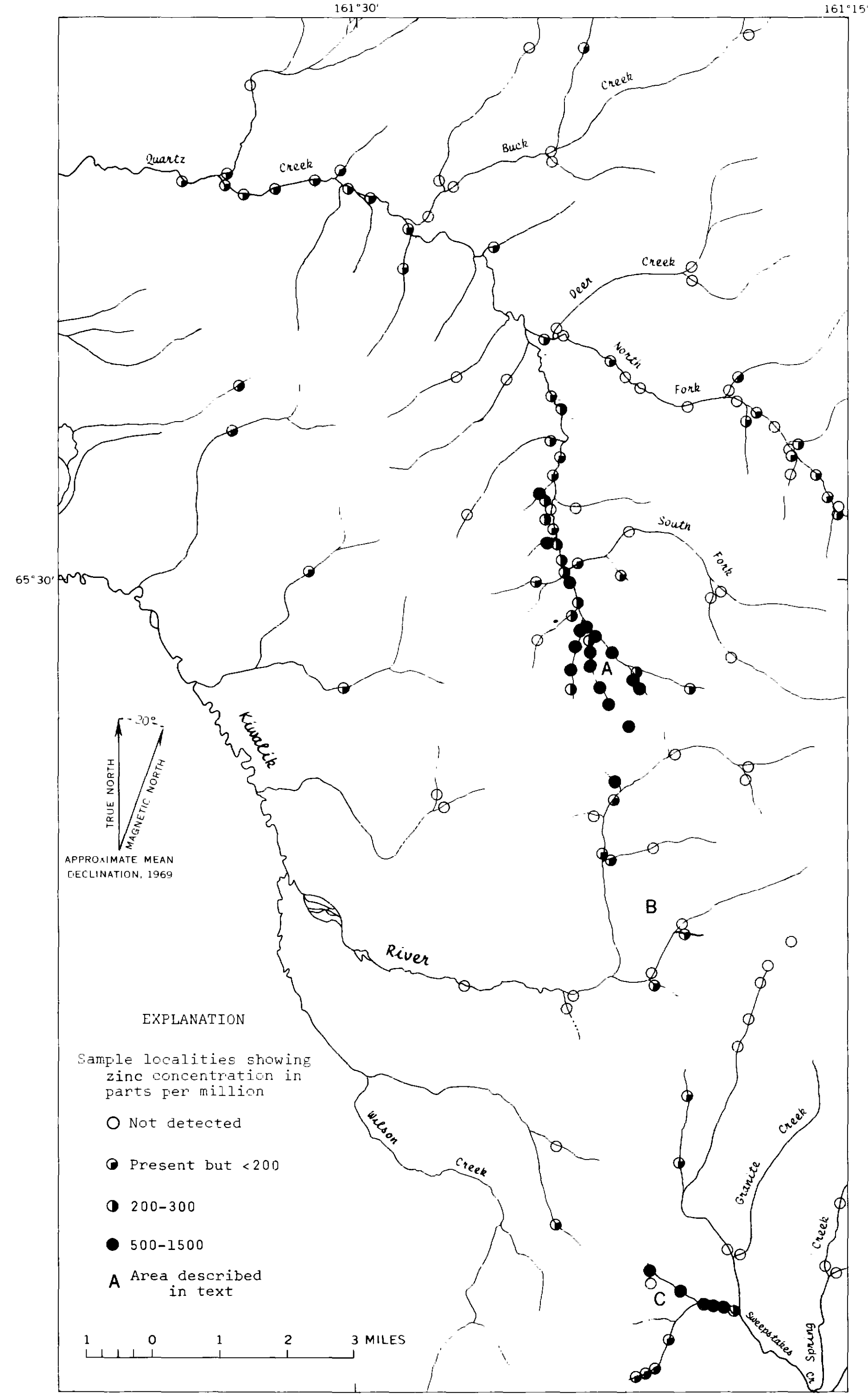


FIGURE 4.—Zinc distribution in stream sediments of the Quartz Creek area.

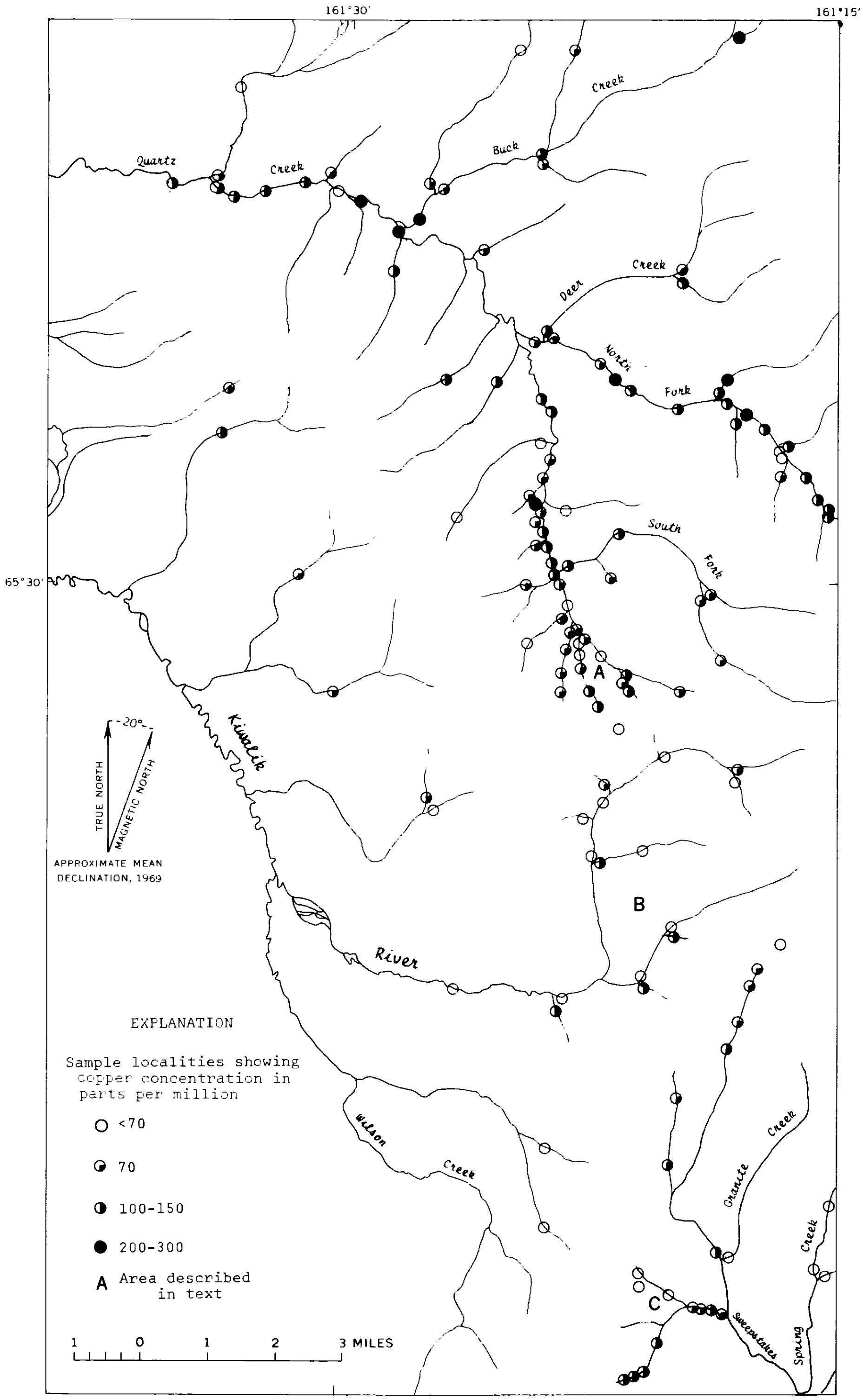


FIGURE 5.—Copper distribution in stream sediments of the Quartz Creek area.

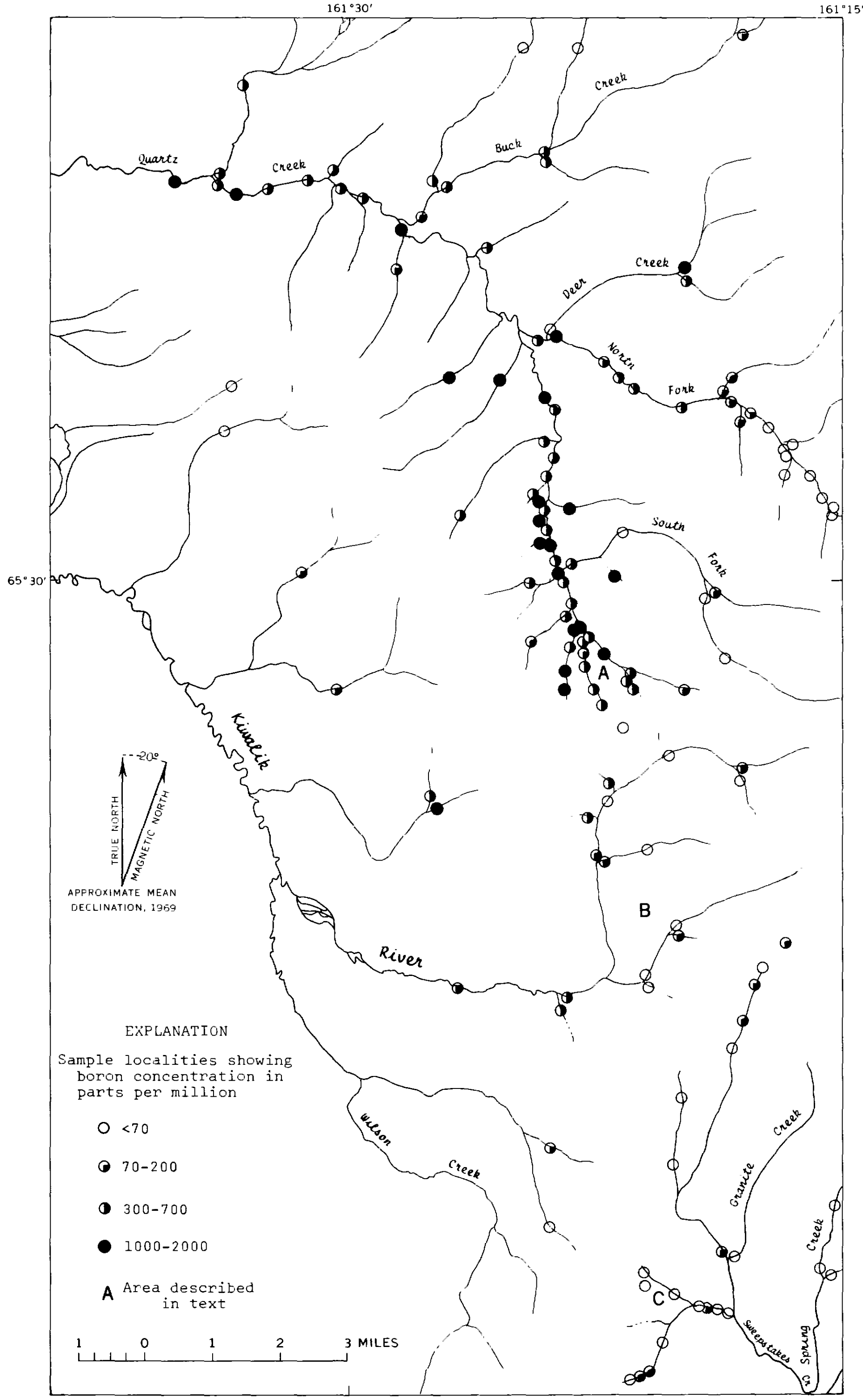


FIGURE 6.—Boron distribution in stream sediments of the Quartz Creek area.

The hooked shape of the Quartz Creek pluton suggests the exposed roof of an otherwise concealed pluton. If so, the strongly mineralized zone described here may be only part of a larger zone along the roof of this pluton. Widespread mineralization is also indicated in the andesite away from the Quartz Creek pluton throughout the 18-mile-long altered zone, as shown by the many occurrences of galena, sphalerite, arsenopyrite, and pyrite. These sulfides occur with tourmaline as disseminated grains in oxidized carbonate veins and replacement bodies. Other occurrences of sulfide minerals undoubtedly exist in oxidized areas that were not examined but are common throughout the large altered zone. The original sulfides have been completely oxidized in many cases, but analyses of oxidized rock and soil show anomalous lead, zinc, silver, arsenic, and boron. Scheelite was found in pyrite-tourmaline-quartz vein material in frost-riven rubble at locality 36 (fig. 2) and a composite grab sample of this material (sample 36, table 1) contained more than 10,000 ppm tungsten.

The age of the mineralization is not known. Both the Quartz Creek quartz monzonite and the small rhyolite body (map unit Kr) are mineralized, but their mutual relationship is uncertain. The 18-mile-long altered zone is roughly centered around the east limb of the hook-shaped Quartz Creek pluton, and the strong mineralization in area A occurs chiefly in the quartz monzonite of the pluton. These observations suggest that the mineralization is genetically related to the quartz monzonite. A possible structural control of mineralization is suggested by the rough parallelism of the trend of the 18-mile-long altered zone and prominent lineaments in the area.

All these factors make this large 18-mile-long altered zone worth further investigation as a possible exploration target. Trenching and stripping in area A would help define the extent and potential of the large area of mineralized rock there. Soil sampling and perhaps the use of reconnaissance electrical geophysical methods over much of the upper Kiwalik River and Quartz Creek drainage basins might locate mineralized areas in the andesite and indicate good drilling locations. Drilling would certainly be necessary to determine the extent of mineralization in the altered metalliferous rhyolite (map unit Kr).

UPPER PEACE RIVER

Anomalously high concentrations of molybdenum, bismuth, silver, copper, and lead are found in the soils, stream sediments, and outcrops of the upper Peace River drainage basin (figs. 7 and 8). These anomalous metal concentrations occur over an area of about 2 square miles centered around the two main forks of the Peace River. The area is low and tundra covered except for a few scattered outcrops and frost-riven rubble along the cutbanks of the creeks.

The area is underlain by a small satellitic stock of the Granite Mountain pluton. The stock is composed of several varieties of syenite —the most common being a pink, medium-grained, hornblende-biotite variety. A pink, fine- to medium-grained, porphyritic syenite composed of over 90 percent perthitic feldspar and less than 1 percent mafic minerals is also common. Garnet-bearing nepheline syenite crops out on the south side of the ridge between the northern fork of the Peace River and Cub Creek and garnet-bearing nepheline syenite float is common in both forks.

Locally the syenite contains abundant disseminated pyrite cubes, a little visible fine-grained molybdenite, and abundant accessory magnetite and purple fluorite. Composite grab samples of syenite taken over areas ranging from 10 to 100 square feet contain 15 to 200 ppm molybdenum (samples 2, 3, 6, 8–13, and 15 in table 2) as well as anomalously high amounts of bismuth, silver, and copper. Rubble of pyrite-quartz material is also abundant along the cutbanks of both forks; composite grab samples of this material contain from a trace to more than 2,000 ppm molybdenum as well as anomalously high bismuth, silver, and copper (samples 4, 5, 7, and 14 in table 2). A canary yellow alteration product, abundant in both syenite and vein material, has been identified as ferromolybdite from X-ray diffraction patterns. Where the syenite is cut by pyrite-quartz veins, the syenite is bleached and oxidized, and it contains disseminated pyrite and, less commonly, molybdenite.

In soils from the banks of the northern fork, molybdenum contents reach as high as 70 ppm

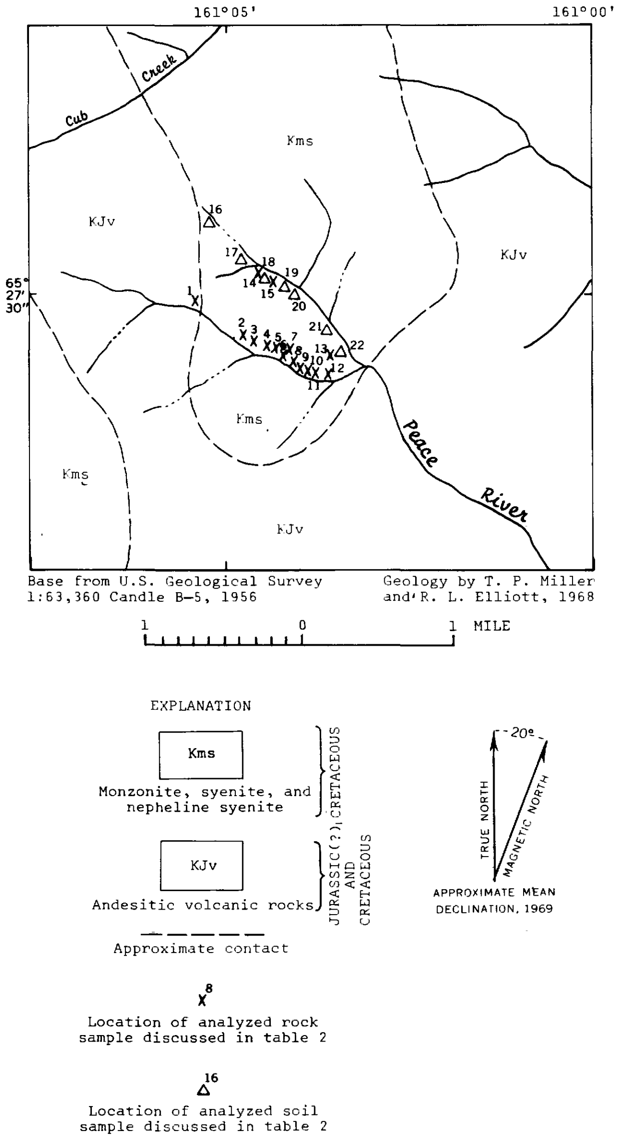


FIGURE 7.—Geologic map of the upper Peace River area.

(samples 16–22 in fig. 7 and table 2); and in stream sediments from this fork and its tributaries, as high as 30 ppm (samples 3–11 in fig. 8 and table 3). Copper and lead contents are also anomalously high in the stream-sediment samples from this area (fig. 8; table 3); however, the highest contents of copper and lead are in the upper parts of southern and northern forks respectively, whereas the highest molybdenum contents are from the lower part of the northern fork.

Pan concentrates collected from this area by the U.S. Geological Survey in 1951 and 1952 (Gault and others, 1953) in a search for uranium, showed anomalously high concentrations of uranothorianite as well as a variety of other metallic minerals such as galena, chalcopyrite, bornite, tetradymite, sphalerite, pyrite (up to 50 percent of the concentrate), and pyrrhotite. Intergrowths of galena, sphalerite, chalcopyrite, pyrite, and gummite (probably a decomposition product of uranothorianite) were observed in some mineral grains (Gault and others, 1953, p. 29). The source of the uranothorianite and associated sulfides was not found during the 1951–52 investigations, although West (in Gault and others, 1953, p. 29–30) suggested a lode deposit at the head of the Peace River. The present study shows that the syenite and associated quartz veins exposed near the junction of the two main forks both contain anomalous amounts of molybdenum, bismuth, silver, copper, and lead. These deposits, and probably similar ones upstream, are the most likely source of the sulfides and uranothorianite found in the pan concentrates. The association of uranium, silver, molybdenum, bismuth, copper, and lead seen here is typical of many uranium-bearing veins elsewhere in the United States (Walker and Adams, 1963).

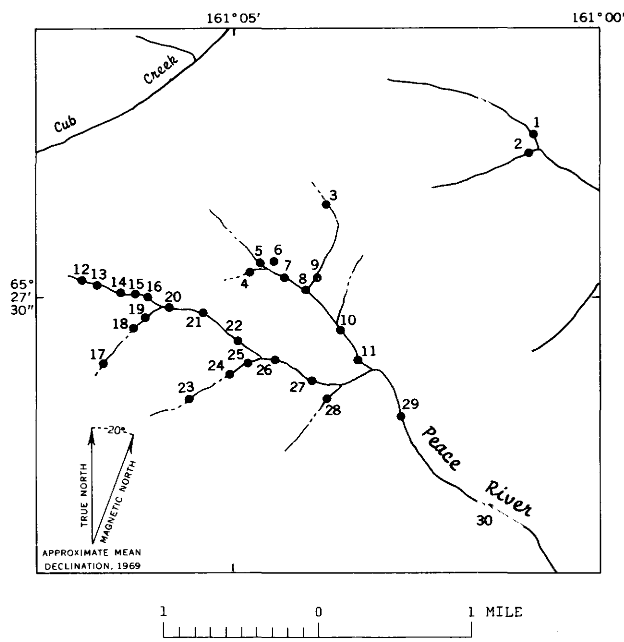


FIGURE 8.—Location of stream-sediment samples of the upper Peace River area.

The relationship, if any, between the deposits of lead, zinc, and silver at Quartz Creek and the deposits in the upper Peace River drainage is unknown. The absence of tourmaline and arsenopyrite (and therefore low boron and arsenic content), the low tin content, and the presence of abundant fluorite in the upper Peace River deposits suggests that the two deposits are not genetically related.

Because of the very poor exposures and short time spent in this investigation, it is not possible to give a complete evaluation of the potential of this area. However, a considerable area of high concentrations of a wide variety of metals has been outlined and is thought to be worthy of further exploration. A trenching and stripping program near the junction of the two main forks of the Peace River and also in their headwaters would help define the extent and amount of mineralized rock. Drilling may be necessary in areas with a thick overburden.

BEAR CREEK

Galena, sphalerite, and pyrite have been reported in andesite at the north end of the airstrip on Bear Creek north of the Granite Mountain pluton (fig. 1). The sulfides occur in quartz-calcite veinlets and as disseminated grains in the andesite near a mafic syenite dike (Herreid, 1965). The mineralized zone is about 200 feet wide and trends northwest. Gold can be panned from the limonitic capping over the mineralized rock. Stream-sediment samples downstream from the mineralized zone show a lead-zinc-copper anomaly extending for about a mile. Soil samples from a drainage ditch above the deposit contain anomalous lead and zinc and are thought by Herreid to indicate additional mineralization in the area. Placer gold has been mined on Bear Creek, particularly downstream from the mineralized area, off and on for over 60 years.

The deposit was reexamined during the present investigation. Little can be added to Herreid's account except that polished-section study shows that arsenopyrite, bournonite, and a little gold are also present in the sulfide aggregate. Analyses of mineralized rock samples are given in table 4 and show anomalous lead, zinc, silver, arsenic, cadmium, gold, copper, and antimony.

The mafic syenite dike described by Herreid appears to be a biotite pyroxenite containing potassium feldspar and is similar to pyroxenite occurring along the edge of the Granite Mountain pluton.

The Bear Creek deposit is not well enough exposed to evaluate its potential at the present time. However, the deposit is of interest because of the mineralogical and chemical differences between it and the Quartz Creek deposit. The lead-zinc deposit at Bear Creek occurs entirely in andesite and has anomalously high antimony (samples 2–6, table 4) and gold, whereas boron and tin are quite low in direct contrast to the high boron and anomalous tin in the Quartz Creek lead-zinc deposit. Thus, a different origin for the two deposits is suggested.

SUMMARY

Investigation of the Granite Mountain area located two new mineralized areas thought to be worth further exploration. Both areas are related, at least spatially, to felsic plutonic rocks. The deposits in the Quartz Creek area are scattered over an 18-mile-long zone roughly parallel to prominent lineaments in the area and centered around an altered quartz monzonite. The deposits in the upper Peace River drainage are disseminated in a syenitic stock satellitic to the Granite Mountain pluton and cut by mineralized quartz veins. Studies of stream-sediment samples in this area indicate anomalous metal contents over an area of about 2 square miles. More detailed surface prospecting together with geochemical and geophysical surveys, trenching, and drilling will be necessary to determine the extent and amount of mineralized rock.

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TABLE 1.—*Analyses of bedrock and*

[Results reported in parts per million. Gold by atomic-absorption analysis; all other elements are by semiquantitative spectrographic analysis with results
than value shown; L, present but below limit of

Sample locality	Field No.	Ag	As	Au	B	Ba	Bi	Cd	Co	Cr	Cu
1	68AMm236A	L	L	N	G(2,000)	300	N	N	20	15	200
2A	235A	.5	500	N	2,000	500	N	N	30	20	70
2B	235B	L	*G(10,000)	.06	G(2,000)	150	20	N	300	15	100
3A	68AEr124A	1.5	N	N	*G(2,000)	70	N	100	10	15	300
3B	124B	20	N	N	*G(2,000)	150	N	150	20	15	300
4	68AGk82	N	3,000	N	G(2,000)	500	L	N	20	20	70
5	80	N	N	.2	G(2,000)	3,000	N	N	15	L	70
6	68AMm372	.5	L	N	150	200	N	N	150	70	150
7	373A	L	L	N	*G(2,000)	L	N	N	20	70	150
8	68AGk44A	.7	300	N	*G(2,000)	100	N	N	5	70	70
9	43	L	L	N	G(2,000)	50	N	N	150	20	700
10A	41	N	500	N	*G(2,000)	70	N	N	15	700	200
10B	40	L	1,500	N	*G(2,000)	100	N	N	100	500	150
11	38	7	*G(10,000)	.1	*G(2,000)	L	N	N	500	70	300
12	37	7	*G(10,000)	N	*G(2,000)	L	N	N	10	300	150
13	36	N	10,000	N	*G(2,000)	L	N	N	100	150	15
14A	68AMm240	N	N	N	1,000	1,500	N	N	10	70	500
14B	360A	N	L	N	30	700	N	N	15	70	150
14C	360B	N	N	N	50	1,500	L	N	L	20	150
15	68AEr126	N	N	N	300	1,500	N	N	10	100	150
16	125	L	N	N	300	1,500	N	N	10	70	100
17	68AGk34	1.5	G(10,000)	N	*G(2,000)	150	N	N	10	15	70
18A	68AMm212A	1	N	N	15	150	N	N	N	70	20
18B	212B	N	5,000	N	1,500	1,500	N	N	15	15	100
18C	68AEr116	50	N	N	300	300	N	G(500)	50	70	2,000
19A	68AGk31A	200	700	.06	G(2,000)	300	N	150	50	7	500
19B	31B	150	3,000	.2	*G(2,000)	70	N	300	100	10	1,000
20A	29	7	N	N	*G(2,000)	150	N	50	L	15	300
20B	68AMm213B	30	N	N	*G(2,000)	L	N	100	L	70	500
20C	213C	7	N	N	*G(20,000)	L	N	N	N	15	70
21A	210A	100	5,000	N	30	L	70	N	L	70	700
21B	210C	150	L	N	30	70	L	N	10	70	700
22	370	20	N	N	10	300	L	N	15	150	200
23	68AGk52	2	N	N	30	L	N	L	10	70	500
24	50	50	N	N	700	150	N	150	50	300	700
25A	68AMm470	20	N	N	70	20	N	100	5	30	200
25B	470	[1]44									
25C	68AGk151A	3	300	N	300	300	N	50	30	150	100
26	51	150	N	N	*G(2,000)	L	N	100	10	200	1,500
27	68AMm215B	200	N	N	*G(2,000)	50	300	G(500)	100	150	200
28A	68AEr127A	L	L	N	2,000	L	L	N	70	300	150
28B	127B	1	*G(10,000)	.2	*G(2,000)	300	300	N	2,000	15	500
29	68AGk144	7	N	N	G(2,000)	300	10	N	7	150	150
30	143	1	N	N	50	500	L	N	20	200	150
31A	68AMm214A	3	N	N	70	50	N	N	10	50	70
31B	214C	300	5,000	N	*G(2,000)	L	N	G(500)	20	70	200
32	68AGk47	L	N	N	500	1,000	N	N	10	100	70
33A	45	N	N	N	500	700	N	N	50	700	100
33B	68AHd227	L	L	N	200	300	N	N	20	150	150
34	226	150	L	N	1,000	100	N	*G(500)	150	150	500
35	68AMm221A	3	N	N	70	5,000	N	500	5	7	500
36	228	L	L	N	2,000	700	N	N	15	150	500
37	227	L	3,000	1	*G(2,000)	150	20	N	30	300	300
38	68AHd56	N	N	N	G(2,000)	150	N	N	150	700	500
39	61	N	N	N	*G(2,000)	L	N	N	50	70	700
40	63	7	N	N	500	300	N	N	150	700	500
41	244	N	G(10,000)	.2	2,000	700	N	N	150	500	300
42	65	.5	*G(10,000)	.7	G(2,000)	200	20	N	150	70	300
43	67	7	200	N	700	300	N	N	150	700	500
44	73	L	1,000	N	700	300	N	N	70	700	200
45A	74	L	1,500	.04	1,500	300	N	N	70	700	300
45B	75	5	500	N	70	300	N	N	15	3,000	70
46	68AMm469	7	700	N	*G(2,000)	70	N	N	50	200	1,000
47	368	3	1,500	N	*G(2,000)	100	L	N	20	15	300
Limits of determination		0.5	200	0.02	10	50	10	50	10	10	10
Bedrock values considered anomalous in this report		0.5	L	0.04	50	2,000	10	L	150	300	200

[1] Analysts: Claude Huffman, J. A. Thomas, and V. E. Shaw; silver and zinc by atomic absorption, lead by electrolytic methods.

soil samples from Quartz Creek area

reported to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1. N, not detected; H, interference; *G, much greater than value shown; G, greater determination. Sample localities shown in fig. 2]

Mo	Mn	Nb	Ni	Pb	Sb	Sn	Sc	W	Zn	Type of sample
5	3,000	15	30	200	N	N	100	N	1,000	Composite grab.
N	2,000	L	50	700	L	N	L	N	L	Do.
L	5,000	L	70	150	L	N	100	N	N	Grab; float.
N	G(5,000)	L	10	1,500	N	N	15	N	G(10,000)	Grab.
N	2,000	L	30	G(20,000)	L	L	20	N	G(10,000)	Grab.
N	2,000	10	15	150	N	N	20	N	1,500	Selected grab.
N	700	L	7	50	N	N	5	N	N	Do.
L	2,000	L	50	300	L	N	15	N	1,500	Composite grab.
N	700	L	50	300	150	L	20	N	500	Grab.
N	G(5,000)	L	15	150	500	N	15	N	N	Composite grab.
5	300	10	50	70	N	L	70	N	N	Do.
N	700	L	150	10	N	H(70)	G(100)	N	L	Do.
N	3,000	L	150	300	N	N	G(100)	N	N	Do.
5	150	L	100	10,000	100	L	100	N	200	Grab.
5	3,000	L	70	7,000	H(300)	N	100	N	700	Grab.
5	150	L	50	100	L	30	70	N	L	Selected grab; float.
N	3,000	L	30	50	100	N	50	L	L	Composite grab.
L	150	L	30	20	L	N	20	N	L	Do.
N	150	L	70	10	N	N	20	N	N	Grab.
N	500	L	30	150	N	N	50	N	L	Soil.
N	300	L	10	15	N	N	50	N	N	Soil.
N	150	10	5	1,500	L	N	L	L	300	Selected grab; float.
5	G(5,000)	L	L	700	N	N	N	N	L	Composite grab.
L	200	L	5	150	N	N	L	N	300	Do.
N	G(5,000)	L	10	*G(20,000)	N	H(20)	L	N	*G(10,000)	Grab.
L	G(5,000)	10	50	*G(20,000)	100	H(30)	L	N	*G(10,000)	Grab.
L	300	L	30	*G(20,000)	150	H(30)	L	N	*G(10,000)	Grab.
20	5,000	10	5	7,000	L	H(30)	5	N	3,000	Grab; float.
30	2,000	L	20	G(20,000)	N	20	5	N	5,000	Composite grab.
N	5,000	L	L	15,000	L	N	N	N	1,000	Do.
L	150	L	10	*G(20,000)	100	30	5	N	7,000	Do.
15	500	L	70	G(20,000)	150	20	10	N	G(10,000)	Do.
L	3,000	L	30	15,000	100	N	10	N	700	Selected grab.
N	G(5,000)	L	30	7,000	N	N	10	N	10,000	Selected grab; float.
N	5,000	L	70	1,500	N	H(10)	20	N	*G(10,000)	Do.
N	G(5,000)	N	30	15,000	200	150	30	N	G(10,000)	Composite grab.
				[1] 22,500					[1] 46,700	Do.
N	5,000	N	50	500	L	30	20	N	G(10,000)	Chip sample.
N	G(5,000)	L	70	20,000	N	H(50)	15	N	G(10,000)	Selected grab; float.
N	3,000	L	70	*G(20,000)	150	N	30	N	*G(10,000)	Composite grab.
7	G(5,000)	10	100	150	N	50	15	N	3,000	Composite grab.
7	3,000	L	150	200	700	30	30	L	L	Grab.
5	300	L	30	1,000	L	70	20	N	1,000	Composite grab.
N	1,000	L	100	1,500	N	N	30	N	1,500	Soil.
N	G(5,000)	L	50	5,000	L	H(15)	10	N	300	Composite grab.
N	5,000	L	50	*G(20,000)	500	H(70)	30	N	*G(10,000)	Grab.
N	200	L	50	300	N	10	20	N	L	Soil.
N	700	L	100	150	N	10	50	N	L	Soil.
N	3,000	L	100	300	L	L	30	N	300	Composite grab.
N	5,000	L	150	G(20,000)	150	500	15	N	*G(10,000)	Do.
7	5,000	L	20	*G(20,000)	N	N	15	N	G(10,000)	Grab.
7	1,500	15	70	150	N	N	50	G(10,000)	N	Composite grab.
N	300	10	100	150	N	300	50	L	N	Do.
N	1,500	L	300	150	N	N	G(100)	N	L	Soil.
5	300	L	50	150	N	N	G(100)	N	L	Composite grab.
N	G(5,000)	10	300	7,000	N	N	G(100)	N	10,000	Soil.
N	3,000	L	150	150	N	N	100	N	L	Soil.
7	2,000	L	70	700	300	N	20	N	200	Composite grab.
N	G(5,000)	L	300	300	N	N	100	N	500	Soil.
N	2,000	L	200	700	N	N	100	N	1,500	Soil.
N	1,500	L	200	150	N	N	100	N	L	Soil.
N	G(5,000)	L	200	7,000	N	N	100	N	10,000	Composite grab.
15	300	L	70	300	100	70	30	N	700	Grab.
N	700	L	70	200	L	30	15	100	500	Grab.
7	10	10	5	10	100	10	5	50	200	
10	3,000	50	200	150	L	30	50	L	L	

TABLE 1.—*Analyses of bedrock and soil samples from Quartz Creek area*—Continued

Sample	*Description*
1	Gossan in altered andesite.
2A	Pyrite-calcite vein 6 inches wide.
2B	Float; arsenopyrite and quartz.
3A	Talus; quartz vein with sphalerite.
3B	Talus; quartz vein with galena and sphalerite.
4, 5	Altered andesite.
6	Pyrite-bearing calcite vein.
7	Calcite veinlet cutting andesite; minor galena.
8	Pyrite-tourmaline-carbonate rock in 100-yard-long altered zone.
9, 10A	Pyrite-tourmaline veinlets 1 inch thick in altered andesite.
10B	Talus over 300 yards along creek; sulfide-bearing tourmaline-rich rock.
11, 12	Sulfide-bearing tourmaline-quartz rock.
13	Float; silicified breccia with arsenopyrite.
14A, B, C	Silicified, extensively oxidized rhyolite.
17	Float; sulfide-bearing tourmaline-quartz rock.
18A	Pyrite-calcite vein 1 foot thick cutting altered fine-grained felsic intrusive.
18B	Fine-grained felsic intrusive; altered.
18C	Talus; sphalerite-galena-calcite vein; angular blocks up to 1 foot long.
19A	Talus; galena-bearing gossan.
19B	Talus; quartz-pyrite-arsenopyrite vein.
20A	Float; sulfide-bearing quartz.
20B, C	Float; sulfide-bearing gossan.
21A, B	Gossan with visible galena; several gossans up to 4 feet wide in quartz monzonite.
22	Galena-bearing calcite vein 1 foot thick.
23, 24	Float; large boulders up to 1 foot in diameter; quartz-carbonate-sulfide rock.
25A	Galena-bearing calcite vein 18 inches thick.
25B	Sulfide-carbonate-quartz rock.
26	Float; quartz-carbonate-sulfide rock.
27	Sulfide-bearing oxidized carbonate in altered andesite.
28A, B	Float, talus(?); pyrite-bearing quartz.
28B	Talus; altered andesite containing arsenopyrite, realgar, and orpiment.
29	Sample from over 200- by 200-foot area of gossan and altered andesite.
31A	Oxidized carbonate-rich gossan in altered andesite.
31B	Galena-bearing gossan.
33B	Oxidized rubble in frost boil.
34	Galena-sphalerite-pyrite-quartz veins in altered andesite.
35	Talus; disseminated galena in oxidized carbonate-quartz rock.
36	Talus; disseminated pyrite and scheelite in quartz.
37	Gossan along quartz monzonite-andesite contact.
39	Oxidized quartz-tourmaline rubble.
42	Oxidized rubble in frost boil.
45B	Talus(?); disseminated galena in oxidized quartz-carbonate rock.
46	Oxidized pyrite-tourmaline vein.
47	Oxidized breccia.

TABLE 2.—*Analyses of bedrock and soil samples from the Upper Peace River area*

[Results reported in parts per million. Gold by atomic-absorption analysis; all other elements by semiquantitative spectrographic analysis 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; *G, much greater than value shown; G, greater than value shown; L, present but below level of determination. Sample localities are shown in fig. 7]

Sample locality	Field No.	Ag	Au	B	Bi	Cu	Mo	Pb	Sn	W	Zn	Remarks
1	68AHd99	N	0.04	30	N	200	N	30	N	N	N	Altered andesite; composite grab sample.
2	103	5	N	15	*G(1,000)	300	150	300	L	N	N	Pyritiferous oxidized syenite; composite grab sample.
3	104	150	.04	20	*G(1,000)	700	30	3,000	N	N	N	Do.
4	189	1	N	10	300	200	150	150	10	N	N	Oxidized syenite with pyritiferous quartz veinlets; composite grab sample.
5	68AMm361G	1	N	10	*G(1,000)	300	1,500	150	L	N	L	Pyritiferous quartz in oxidized syenite; composite grab sample.
6	68AHd105	1.5	N	30	300	500	G(2,000)	300	N	N	N	Oxidized syenite(?); composite grab sample.
7	186	1	N	15	10	200	1,000	150	15	N	N	Pyritiferous quartz veins in oxidized syenite; composite grab sample.
8	185	1.5	N	10	70	200	200	150	20	N	N	Pyritiferous oxidized syenite; composite grab sample.
9	184	.7	N	30	10	100	30	70	10	L	N	Do.
10	68AMm361C	L	N	20	150	150	15	20	L	N	N	Do.
11	361A	1.5	N	L	15	300	200	20	N	N	N	Do.
11	361B	7	N	L	20	200	100	20	30	N	N	Do.
12	473	L	N	30	15	300	30	100	10	N	N	Oxidized fine-grained syenite; composite grab sample.
13	68AGk160	3	N	100	20	20	70	150	L	N	N	Oxidized syenite; selected grab sample.
14	68AMm362	L	N	20	30	150	30	150	15	L	N	Pyritiferous quartz in syenite; composite grab sample.
15	68AGk155	7	N	200	20	150	15	300	L	30	L	Oxidized fluorite-bearing pyritiferous syenite; selected grab sample.
16	63	N	N	70	N	50	N	100	N	N	L	Soil samples.
17	154	N	N	70	L	30	15	70	N	N	N	Do.
18	155	1	N	N	15	500	70	300	N	N	N	Do.
19	156	N	N	30	N	200	50	200	N	70	N	Do.
20	158	N	N	70	N	150	30	150	N	N	N	Do.
21	159	N	N	30	15	200	30	150	N	N	N	Do.
22	160	15	N	200	70	200	30	1,000	N	N	N	Do.
Limits of determination		0.5	0.02	10	10	5	5	10	10	50	200	
Bedrock values considered anomalous in this report		0.5	0.04	50	10	200	10	150	30	L	L	

TABLE 3.—*Partial analyses of stream sediment samples from the upper Peace River area*

[Results are reported in parts per million. Analyses are by semiquantitative spectrographic methods 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; L, present but below limit of determination. Sample localities shown in fig. 8]

Sample locality	Field No.	Mo	Cu	Pb	Ag	Sample locality	Field No.	Mo	Cu	Pb	Ag
1	68AHd197	N	50	30	N	16	68AHd213	N	300	10	N
2	68AEr193	N	15	150	N	17	88	N	15	15	N
3	243	7	30	100	N	18	94	N	100	15	N
4	68AGk66	7	70	100	L	19	95	15	100	100	N
5	65	L	30	500	L	20	214	N	30	30	N
6	157	30	150	200	N	21	98	N	150	15	N
7	67	10	70	300	.7	22	100	7	100	30	N
8	69	15	30	300	.7	23	196	N	30	70	N
9	68	15	30	150	L	24	195	N	70	20	N
10	70	30	300	150	.5	25	194	N	100	70	N
11	71	30	150	150	L	26	190	N	150	70	N
12	68AHd204	N	15	100	N	27	106	N	70	70	N
13	205	N	100	L	N	28	68AEr246	L	10	30	N
14	210	N	200	20	N	29	200	7	200	150	N
15	211	N	150	L	N	30	201	N	100	100	N
Limits of determination		5	5	10	0.5	Limits of determination		5	5	10	0.5

TABLE 4.—*Analyses of bedrock samples from the Bear Creek prospect*

[Results reported in parts per million. Gold by atomic-absorption analysis; all other elements by semiquantitative spectrographic analysis 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; *G, much greater than value shown; G, greater than value shown; L, below limit of determination]

Sample	Field No.	Ag	As	Au	B	Ba	Bi	Cd	Co	Cr	Cu	Mo	Mn	Nb	Ni	Pb	Sb	Sn	Sc	Zn
1	68AGk95	1.5	*G(10,000)	3.0	30	500	L	N	70	100	50	N	2,000	10	30	200	L	N	30	1,000
2	98	50	2,000	.8	30	L	10	L	50	100	500	N	G(5,000)	10	50	20,000	3,000	N	50	3,000
3	175D	30	500	1.4	20	20	10	N	15	30	200	N	2,000	N	30	20,000	1,000	N	7	700
4	175E	30	1,000	1.2	30	150	N	150	15	70	150	5	G(5,000)	L	50	*G(20,000)	1,000	N	10	G(10,000)
5	175F	150	1,500	1.1	20	20	10	200	20	50	1,000	N	2,000	N	50	G(20,000)	1,000	N	10	G(10,000)
6	175G	30	3,000	.4	30	700	N	70	15	70	500	7	G(5,000)	10	70	*G(20,000)	G(10,000)	N	15	G(10,000)
7	175H	150	7,000	.7	30	150	N	150	10	70	500	7	G(5,000)	10	30	*G(20,000)	*G(10,000)	N	7	G(10,000)
Limits of determination		0.5	100	0.02	10	50	10	50	10	10	10	7	10	10	5	10	100	10	5	200
Bedrock values considered anomalous in this report		0.5	L	0.04	50	2,000	10	L	150	300	200	10	3,000	50	200	150	L	30	50	L

Sample	*Description*
1	Selected grab sample of oxidized andesite float; contains 10 to 15 percent sulfide.
2	Selected grab sample of andesite along 100-yard-long altered zone in creek bank.
3	Chip sample over 11 feet of andesite in cutbank. Visible pyrite, arsenopyrite, and galena in quartz-carbonate gangue.
4	Chip sample over 18 feet of oxidized andesite.
5	Grab sample from 12-inch-thick vein of galena, pyrite, and sphalerite in quartz-carbonate gangue.
6	Composite grab sample from pyrite-galena-bournonite veinlets in altered andesite. Collected over 10- by 30-foot area.
7	Selected grab sample from 8-inch-thick pyrite-galena-quartz-carbonate vein in andesite.

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