STATE OF ALASKA

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GEOCHEMICAL REPORT NO. 23

Geochemistry and Geology, Boundary Area, Fortymile District Eagle A-1 Quadrangle, Alaska

By

R. R. Asher

College, Alaska

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GEOCHEMISTRY AND GEOLOGY, BOUNDARY AREA, FORTYMILE DISTRICT

EAGLE A-1 QUADRANGLE, ALASKA

By

R. R. Asher

A B S T R A C T

Geological and geochemical field investigations were conducted in a 38 square mile area near Boundary, Alaska on the Taylor Highway. Rich placer deposits were formerly mined in the area, and reconnaissance geochemistry done in 1966 indicated lode mineralization.

Metamorphic rocks in the area were referred to as Birch Creek Schist of Precambrian age by early workers. Recent work by the U. S. Geological Survey has shown that the rocks may in part be Paleozoic in age. Mapping for this report was done on the basis of lithology, and formal stratigraphic units are not used. There are ultramafic rocks in the area as well as metamorphic rocks.

The area has been subjected to several episodes of metamorphism. At least three directional trends of fold axes can be recognized. Tight isoclinal folds and a left lateral fault are the main structural elements.

Mapping, rock sampling, and geochemical sampling reveal a possible lead-zinc deposit between Brophy and Camp Creeks near Boundary. Some anomalous geochemical samples are related to lithology; however copper and nickel anomalies associated with an ultramafic plug may warrant further investigation. Sources of some anomalous samples are probably across the Canadian border.

INTRODUCTION

PURPOSE AND SCOPE

This project was undertaken to investigate the mineral potential of part of the Fortymile district, Alaska. The map area was selected because of extensive placer operations there in past years and because Saunders (1966) found several geochemical anomalies on some of the creeks draining the area. In addition the area is within the projected extension of Dawson Range copper belt in the Yukon Territory.

A field party of two men spent 21 days in the field. During this period about 38 square miles of geology were mapped and 176 stream sediment geochemical samples were collected from approximately 20 streams.

LOCATION, ACCESS, POPULATION

The area studied is in the southeast part of the Eagle A-1 quadrangle about 100 miles east of Tetlin Junction, which is on the Alaska Highway (*fig 1*). The map area is located on the Taylor Highway and includes the small settlement of Boundary, Alaska. It is within the region known generally as the Fortymile district. The eastern edge of the map area follows the international boundary between Canada and the United States. Dawson, Yukon Territory, is located about 55 miles to the east. The map area extends from 64° 00' to 64° 06' N latitude and from 141° 00' to 141° 10' W longitude.

Access to the area is by the Alaska Highway to Tetlin Junction, where the Taylor Highway begins (*fig 1*). The region is also accessible from Canada by the road that extends west from Dawson and joins the Taylor Highway near Boundary (*fig 1*). Within the area there are a few unimproved roads that can be traveled in a pickup truck or four wheel drive vehicle.

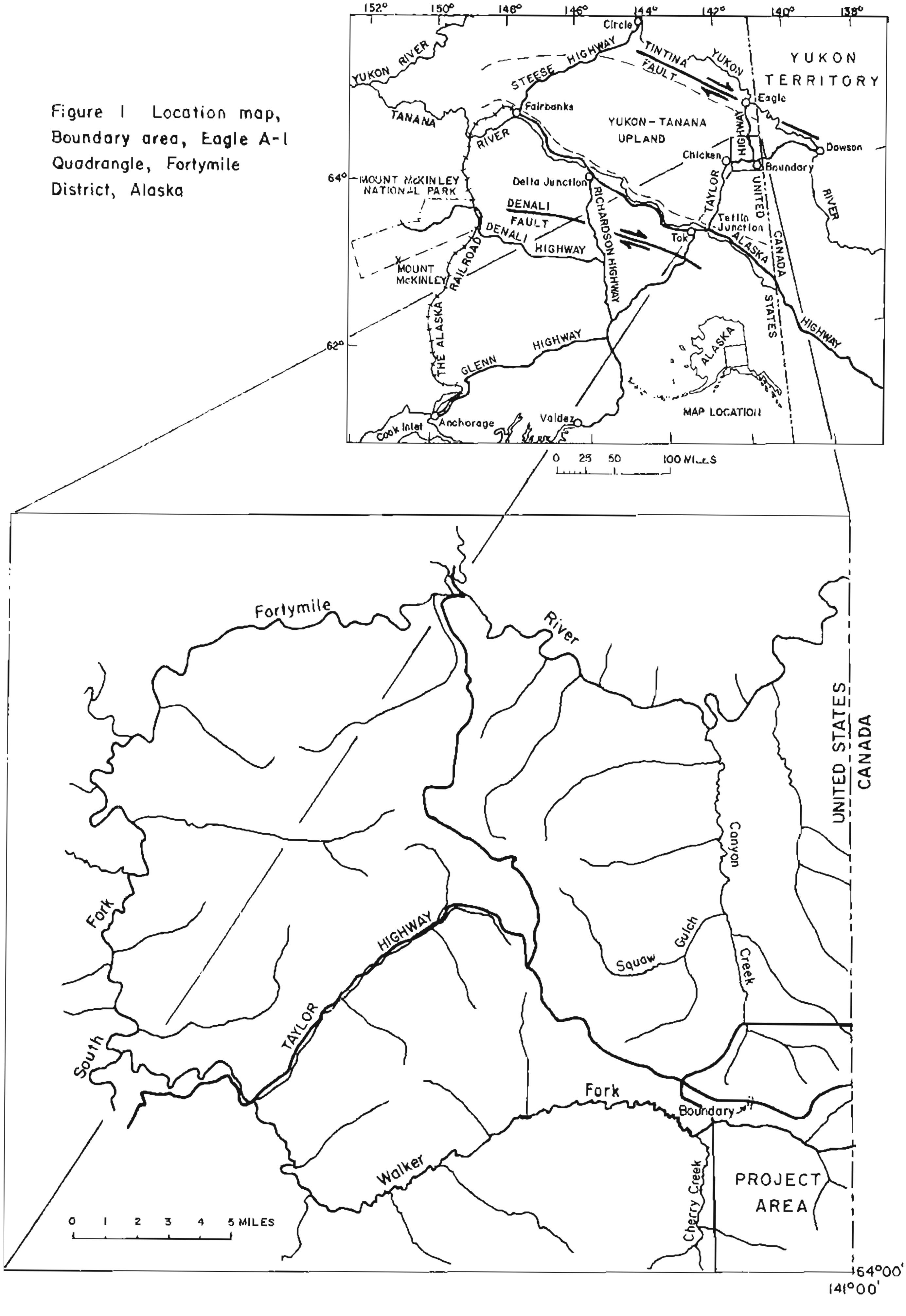
The region is sparsely populated. Two groups of placer miners were in the Canyon Creek drainage during the summer of 1969, and there were six residents at Boundary.

CLIMATE AND VEGETATION

Climate in the region is typical of interior Alaska. Winters are severe with deep snow, and subzero temperatures from November through March. High winds cause deep snow drifts along parts of the Taylor Highway. Summers are warm and pleasant with few rainy days.

Spruce trees grow on the higher slopes and ridge tops. Birch, alder brush, and willows are found along the lower slopes and stream valleys. Above an elevation of about 3000 feet, ridge tops are generally free of dense vegetation and rocks are better exposed than at lower elevations.

Figure 1 Location map, Boundary area, Eagle A-1 Quadrangle, Fortymile District, Alaska



TOPOGRAPHY AND DRAINAGE

The topography of the map area is hilly to mountainous. Foster (1969, p 26) states that the high, benched, ridge surfaces which are present may be the result of altiplanation.

The Taylor Highway follows a ridge that forms a divide between Walker Fork and Canyon Creek the principal streams in the area. Both streams are tributary to the Fortymile River (*fig 1*).

Throughout the Yukon-Tanana upland, youthful streams are incised into a mature topography. The Fortymile country is part of this upland (Mertie, 1937, p 32). Throughout much of its length the Fortymile is deeply entrenched, and there are terraces above the present valley floor. According to Mertie (1937, p 30-31) the Fortymile is a rejuvenated stream that once was in adjustment to the topography, but because rejuvenation is fairly recent the effects have not yet progressed into the upper valleys of the Fortymile. In the map area second and third order streams flow in steep V-shaped valleys with steep gradients. The valleys of primary streams have lower gradients and wider valley floors.

A description of the Walker Fork Valley from Mertie (1938, p 159) is given below:

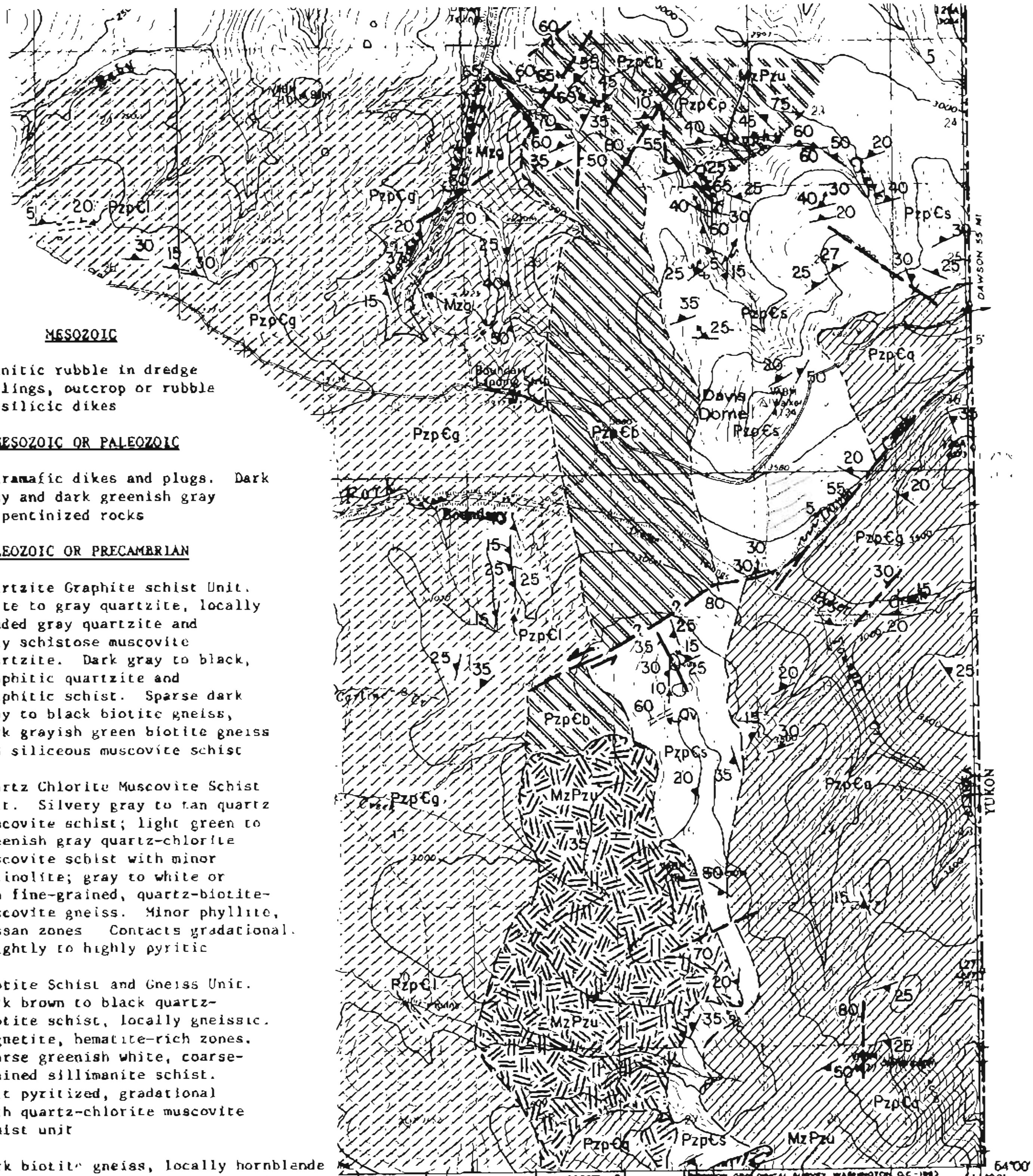
> In its Upper Valley, where the course of the stream is west, Walker Fork has an elevation above sea level ranging from 1,600 to 2,200 feet. (Author's note: recent topographic maps indicate that the elevations cited by Mertie are about 500 feet too low.) East of Cherry Creek, where mining operations are in progress, the elevation is about 2,000 feet and the gradient of the stream is about 100 feet to the mile. In this stretch the valley is asymmetric, with a rather steep south wall and gentle slopes and spurs forming the north wall. The valley floor in general is a wide alluvial flat, but it narrows considerably for short stretches. A terrace about 400 feet above the creek level is recognizable on both sides of the Creek; and a lower terrace, about 100 feet high, is developed farther downstream, in the vicinity of Twelvemile Creek.

Some streams in the region such as Canyon Creek (*fig 1*) are remarkably straight. Foster (1969, p 26) suggests that this is the result of structural control, but the evidence is not conclusive.

Historically, the most important streams in the area are Davis Creek, Poker Creek, and the main Walker Fork where some of the earliest mining in interior Alaska took place. Davis and Poker Creeks are in the headwater portion of Walker Fork (*fig 2*). On the north, Canyon Creek and Squaw Gulch are important in regard to previous mining activity (*fig 1*).

HISTORY

The Fortymile country is the oldest mining area in interior Alaska. Howard Franklin discovered gold on gravel bars of the Fortymile in 1886. The river was formerly the Shitando River, but early prospectors and traders gave it the name Fortymile because the mouth of the river is 40 miles downstream from the old Hudson Bay Trading Post at Fort Reliance (Mertie, 1938, p 157). About one year after Franklin's discovery, gold was found in Franklin Gulch on the South Fork of the Fortymile near Chicken (Mertie, 1938, p 157). Mertie (1938, p 157) remarks that mining has continued in the region from the time of the original discovery until the present (1938) without interruption. That statement is probably still accurate today although mining in recent years has been at a low level.



MESOZOIC

Mzg - Granitic rubble in dredge tailings, outcrop or rubble of silicic dikes

MESOZOIC OR PALEOZOIC

MzPzu - Ultramafic dikes and plugs. Dark gray and dark greenish gray serpentinized rocks

PALEOZOIC OR PRECAMBRIAN

PzpЄq - Quartzite Graphite schist Unit. White to gray quartzite, locally banded gray quartzite and gray schistose muscovite quartzite. Dark gray to black, graphitic quartzite and graphitic schist. Sparse dark gray to black biotite gneiss, dark grayish green biotite gneiss and siliceous muscovite schist

PzpЄs - Quartz Chlorite Muscovite Schist Unit. Silvery gray to tan quartz muscovite schist; light green to greenish gray quartz-chlorite muscovite schist with minor actinolite; gray to white or tan fine-grained, quartz-biotite-muscovite gneiss. Minor phyllite, gossan zones Contacts gradational. Slightly to highly pyritic

PzpЄb - Biotite Schist and Gneiss Unit. Dark brown to black quartz-biotite schist, locally gneissic. Magnetite, hematite-rich zones. Sparse greenish white, coarse-grained sillimanite schist. Unit pyritized, gradational with quartz-chlorite muscovite schist unit

PzpЄg - Dark biotite gneiss, locally hornblende biotite gneiss; with layers and lenses of quartz, aplite, alaskite pegmatite and granite. Some exposures garnetiferous. Black to dark green amphibolite with chlorite; minor quartzite, muscovite schist and recrystallized limestone. Locally pyritic

10 Strike and dip of foliation

35 Strike and dip of layering or bedding

Contacts (inferred, approximate)

80 Fault showing dip

25 Minor fold axis with plunge

5 Minor folds showing plunge of axes

PzpЄl, Limestone ; Qv, Quartz vein

Base from U.S. Geological Survey Eagle A-1 Quadrangle, 1956

32°

TRUE NORTH

Approximate mean Declination, 1956

0 1 2 Miles

Contour interval 100 Feet

Figure 2 Geologic map, Boundary area, Eagle A-1 Quadrangle, Alaska

Within the map area gold was discovered on Davis Creek in 1888 and on Poker Creek and the main Walker Fork about a year later (Mertie, 1938, p 157). In 1892 gold was discovered on the Canadian side of the border on Miller and Glacier Creeks. These creeks head against the Walker Fork and drain southeast into the Sixtymile River.

In 1893 a stampede caused by these gold strikes brought a great influx of prospectors into the region. In the next 10 years a great many claims were staked and the important pay streaks were found (Mertie, 1938, p 157).

Large-scale, sustained mining was carried out on the Walker Fork for a number of years. The gravel thickness was moderate and early mining was done by hydraulic open-cut methods. The highest grade material was mined fairly quickly, and mechanical devices were brought to the Walker Fork early in its mining history. In 1903 a steam scraper and bucket conveyor were being used on one claim. In 1907 a dredge was installed on Walker Fork, about one mile above the mouth of Twelvemile Creek, by Russel King. This dredge operated until 1909. During the winter of 1907-1908, a second dredge was installed on Walker Fork between the mouths of Davis and Poker Creeks by Robert Mulvane. This dredge operated until 1912. (Mertie, 1938, p 160).

A steam shovel with a 50 foot boom and a 1¼ yard bucket was operated on Walker Fork from 1923 until 1934 when it was replaced by a dredge. Hydraulic giants were used for stripping. The dredge operated at least through 1938 (Mertie, 1938, p 160). It is not known how many years after 1938 the dredge operated. Mertie (1938, p 158) remarks that the landing strip on the ridge at the present side of Boundary was completed in 1938 and mining was still in progress.

Less is known concerning the mining history of Canyon Creek (*fig 1*) and other drainages on the north side of the Taylor Highway. According to Mertie (1938, p 187) the most work was done in the main valley of Canyon Creek and in Squaw Gulch. In 1938 very little work was in progress, but a high bench with auriferous gravels was being prospected on the west side of Canyon Creek.

Mining has continued until the present in the project area. For the past 15 to 20 years, mining operations have been relatively small undertakings utilizing bulldozers and sluice boxes. In the summer of 1969, a placer deposit was being worked on Woods Creek near the mouth of Brophy Creek, and another placer mine was in operation on Canyon Creek several miles north of the project area (*figs 1 and 2*). There is no recorded production from lode deposits in the region.

ACKNOWLEDGEMENTS

Tom Bundtzen took the responsibility of collecting stream sediment samples and doing field analyses as well as performing other duties of a field assistant. His services are gratefully acknowledged. Jack Corbett of Boundary and many other residents of the Fortymile country extended courteous and hospitable treatment to the field party during the course of the work and their help aided greatly in completion of the project.

PREVIOUS WORK

Because of placer gold discoveries on the Fortymile in 1886 and discoveries at Circle (*fig 1*) in 1893, the Yukon gold district received attention from the U. S. Geological Survey as early as 1898, when J. E. Spurr published "Geology of the Yukon Gold District, Alaska" in the 18th Annual Report of the U. S. Geological Survey, part 3, p 87-392

(Mertie, 1938, p 135). After Spurr's work a number of investigations dealing with the Yukon-Tanana area were conducted by the federal government. Mertie (1938, p 135) includes a list of the more important of these. Prindle (1905, 1909) and Mertie (1937, 1938) did extensive work in the Fortymile country and their publications include studies of the map area.

In 1966 Saunders made a geochemical study along the Taylor Highway that included part of the map area. In 1969 Foster published the first geologic study of the area since Mertie's 1937 work.

G E O L O G Y

REGIONAL SETTING

The Fortymile country is in the Yukon-Tanana uplands section of the Northern Plateaus geomorphic province (*fig 1*). This province is part of the larger Intermontane Plateaus province, a major geomorphic subdivision (Wharhaftig, 1965, p 22). The Intermontane Plateaus are between the Rocky Mountain system on the north and the Pacific Mountain system on the south. In Alaska these mountain systems are represented by the Brooks Range and the Alaska Range respectively. The Yukon-Tanana uplands are bordered on the north by the Tintina valley and on the south by the Yukon-Tanacross lowland (Wharhaftig, 1965).

The north side of the Yukon-Tanana upland consists of highly deformed Paleozoic sedimentary and volcanic rocks with conspicuous limestone units. The rocks in the northern part are overturned and overthrust to the north. The remainder of the upland is mostly Precambrian(?) schist or gneiss with scattered granitic intrusions in the northwest part. Large irregular batholiths make up the southeast part (Wharhaftig, 1965, p 24). Wind blown silt mantles the lower slopes of the hills in the western part of the upland and deep accumulations of muck overlie stream gravels (Wharhaftig, 1965, p 24).

The schists and gneisses that make up much of the bedrock in the upland were collectively called Birch Creek schist by Mertie and assigned a Precambrian age (Mertie, 1937, p 46). Foster (1969, p 3, 4) cites Roddick (1967) and points out that the original basis for assigning these rocks to the Precambrian may no longer be valid because of structural complications. The Tintina fault, which is north of the map area (*fig 1*), separates unmetamorphosed rocks of known age on the north side of the fault from metamorphic rocks of unknown age on the south side. Green and Roddick (1962, p 18) state that in the vicinity of the Tintina fault age relationships based on differences in metamorphism cannot be considered valid.

Foster (1969, p 4) cites several other reasons why the name Birch Creek schist is undesirable. It includes many different lithologies of several origins and probably different ages so that workers in different areas have different concepts of the Birch Creek schist.

Foster (1969) mapped the Eagle A-1 and A-2 quadrangles in reconnaissance fashion. The metamorphic rocks were broken down into a gneiss and schist unit, a quartz-graphite schist unit, and metamorphic rocks of the Chicken area. The first two units were what Mertie called the Birch Creek schist and are Precambrian or Paleozoic in age. The metamorphic rocks of the Chicken area are Paleozoic in age. Foster also mapped two sedimentary formations of Tertiary age, granitic intrusive rocks of Mesozoic age, and ultramafic rocks of Paleozoic or Mesozoic age.

GEOLOGY OF THE MAP AREA

Metamorphic Rocks

Foster's gneiss and schist unit and the quartz-graphite schist unit are present in the map area. Foster grouped several rock types together in each of the above units. Because lithology may be an important ore control some of the rock types included in the quartz-graphite schist unit were mapped separately for this report. Table 1 is a comparison of the units established by Foster and the units used in this report.

Table 1 - Comparison of Precambrian or Paléozoic rock units mapped by Foster (1969) and the rock units used in this report. Boundary Area, Eagle A-1 quadrangle, Alaska.

Units Mapped by Foster (1969)	Units Used in This Report
Quartz-Graphite-Schist Unit: Quartz graphite schist, quartzite, quartz muscovite and quartz sericite schists, phyllite and cataclastic gneiss.	Quartzite-Graphite Schist Unit: (Pzp€q) Quartz-Chlorite-Muscovite Schist Unit: (Pzp€s) Biotite Schist and Gneiss Unit: (Pzp€b)
Gneiss and Schist Unit: Quartz-biotite gneiss, quartz-mica schist, amphibolite, hornblende gneiss, quartzite and marble	Gneiss-Amphibolite Unit: (Pzp€g) Includes biotite gneiss with granitic phases, hornblende-biotite gneiss, amphibolite, quartzite, muscovite schist and recrystallized limestone

Gneiss-Amphibolite Unit (Pzp€g)

The gneiss-amphibolite unit is present throughout the western half of the map area. According to Foster's map (1969) the eastern contact swings easterly just north of Brophy Creek (*fig 2*), slightly beyond the north edge of the map area, and the unit makes up almost all of the bedrock to the northern boundary of the Eagle A-1 quadrangle.

Dark biotite gneiss and locally hornblende-biotite gneiss are the predominant rock types. Lenses and layers of quartz, aplite, alaskite, pegmatite, and granite are interbedded in the gneiss as dikes and sills. Many exposures are highly garnetiferous. Just north of the Taylor Highway near the head of the east fork of Baby Creek are good exposures of these rocks.

The biotite gneiss is made up of hornblende, biotite, quartz, and garnet. At places, as near the mouth of Camp Creek, magnetite and specular hematite are fairly abundant. Pyrite is common as disseminations along foliation planes.

In general the gneisses are dark gray to black and weather dark green to black. At some places gneiss grades into muscovite schist and is lighter in color. Throughout the map area, gradational contacts are common.

Lesser amphibolite, minor quartzite or chert, recrystallized limestone and muscovite schist are also included in this unit. Foster (1969, p 6) notes that mapping to date suggests that there may be only one main group of quartzites and marbles interbedded in the gneiss.

The amphibolites are made up of hornblende, minor chlorite, quartz, and some muscovite or sericite. Locally magnetite and hematite are common. They are generally fine-grained schistose rocks, but may be massive to granular. The amphibolites are dark grayish green rocks that weather light tan.

The quartzite is composed mainly of quartz but minor sericite, limonite, and sparse pyrite are not uncommon. The quartzite is associated with the recrystallized limestone, and the two are gradational from quartzite through limy quartzite and siliceous recrystallized limestone to recrystallized limestone. The quartzites are granular fine-grained rocks. At places they are so fine-grained that they lose their granular appearance and they resemble chert. Commonly the quartzite is light gray to light tan and weathers silvery gray or light brown.

The recrystallized limestones are present as complexly folded, discontinuous beds within the gneiss. Some layers are up to 50 feet thick. The limestones are white or light gray; they weather darker gray. Calcite and more or less quartz are the principal constituents. Flakes of graphite are present in some specimens.

Muscovite schist makes up a minor part of the gneiss-amphibolite unit. It is composed essentially of quartz and muscovite or sericite, with sparsely disseminated pyrite. These are fine-grained, schistose, brown rocks that weather light gray.

The biotite gneiss can be difficult to distinguish from the biotite schist and gneiss unit or the quartz-chlorite-muscovite schist unit. In general it is coarser grained and likely to be garnetiferous. Foster (1969, p 5-9) discusses the petrography and mineralogy of the unit in more detail. Foster (p 5) also points out that the metamorphic grade is mostly middle or upper amphibolite facies and is higher than that of the other metamorphic rocks in the area. The rocks in the unit are polymetamorphic but details of the metamorphic history are unknown (Foster, 1969, p 5).

Biotite Schist and Gneiss Unit (Pzp€b)

The biotite schist and gneiss unit forms a narrow belt that trends northerly across the area. It is bordered on the west by the gneiss-amphibolite unit and on the east by the quartz-chlorite-muscovite schist unit. Rocks in this unit are not well exposed except near the north end of the map area. Because its presence was determined mostly from float, contacts are mainly inferred.

The biotite schist and gneiss unit is made up of dark brown to black quartz-biotite schist that is gneissic in part. There is also sparse greenish white, coarse-grained sillimanite schist. Foster (1969, p 5) cites the presence of sillimanite and abundant biotite as a distinguishing feature of the gneiss and schist unit, and the biotite schist and gneiss might more properly belong with the gneiss-amphibolite unit. However, the contact with the quartz-calcite-muscovite schist to the east appears to be gradational, therefore the biotite schist and gneiss unit is included as a member of Foster's quartz-graphite schist unit (*table 1*).

A typical specimen of quartz-biotite schist is a dark brown to black foliated rock with quartz, biotite, and minor sericite. Pyrite is fairly common as disseminations along foliation planes.

Quartz-Chlorite-Muscovite Schist Unit (Pzp€s)

East of the biotite schist and gneiss unit is a belt made up of light colored quartz-chlorite-muscovite schist with minor actinolite. There is also minor gray to white or tan fine-grained, quartz-biotite-muscovite gneiss, minor phyllite and a gossan zone. Pyritization is common. Contacts within the unit are gradational as is the contact with the biotite schist and gneiss unit to the west. It is in contact with the quartzite-graphite schist unit to the east and south. On Davis Creek the contact between the two units is formed by a fault (*fig 2*).

Rocks included in this unit are variable in texture and composition. On the ridge between Camp and Brophy Creeks the rocks are fine-grained foliated schists composed of quartz and sericite that are light gray and weather tan or brown. Farther down the ridge the rocks are composed of quartz, muscovite, and sericite with abundant limonite. There are numerous sulfide casts that are lined with dark red limonite.

At the head of Camp Creek quartz, muscovite, chlorite, and sparse biotite are the megascopic minerals. Quartz is present as small rounded pods or "eyes". The rocks are foliated and dark gray with a faint greenish cast. Disseminated pyrite is common.

To the south the belt of quartz-muscovite schist narrows because a mass of ultramafic rocks is intruded into the sequence. The rocks on the ridge north of Minnesota Peak are made up of abundant quartz, biotite, and sericite. The rocks are fine-grained with a gneissic texture, and are grayish brown to light tan.

Quartzite-Graphite Schist Unit (Pzp€q)

Except for a small part of the map area at the north end, quartzite and graphite schist were mapped along the Canadian boundary (*fig 2*). The unit is made up of white to gray quartzite, that is locally a banded gray quartzite or gray schistose, muscovite quartzite. The quartzite contains varying amounts of graphitic material and grades into graphitic quartzite and graphitic schist. There are sparse black biotite gneiss, dark, grayish-green, biotite gneiss, and siliceous muscovite schist.

The quartzites form rugged cliffs like on the north side of the Taylor Highway near the customs station at the Canadian border and elsewhere. At Ptarmigan Peak they form a steep sided peak with elongated projecting ridges (*fig 2*). Long scree slopes of slabby graphitic quartzite are common on hillslopes in the southeastern part of the area.

Age Relationships

In regard to the age of the gneiss and schist unit Foster (1969, p 9) presents isotopic age dates for some of the rocks in the area and reaches the following conclusion:

> Although Mertie (1937, p 55) considered these rocks (his Birch Creek Schist) as Precambrian, a Paleozoic age is also a possibility for all or part of it.

The quartz-graphite schist unit, of which the quartz-chlorite-muscovite schist unit, the quartzite-graphite schist unit, and possibly the biotite schist and gneiss unit are a part, is of unknown age. According to Foster (1969, p 11):

> Although of lower metamorphic grade, they could be part of the same sequence of metamorphosed rocks as is the gneiss and schist unit. However there are sufficient differences in lithology and mineralogy to suggest that they coul(be from an entirely different part of the stratigraphic section.

Igneous Rocks

Ultramafic Rocks (MzPzu)

In the south-central part of the map area there is a large body of ultramafic rocks. It is irregular in outline, and varies from about a mile to a mile and three-quarters in width east to west; it is about three miles long north to south.

In hand specimen magnetite, serpentine, and minor magnesite were noted. The rock is fine-grained and compact; at places it is layered. Fresh surfaces are dark green to black; it weathers light tan to brown.

According to Foster (1969, p 12, 13) magnetite occurs as large grains surrounded by alteration rims of brucite and chlorite in a matrix of antigorite with relicts of olivine. There are late veins of magnetite and magnesite and no evidence of pyroxene. Foster (1969, p 13) concludes that the rock is a metamorphosed serpentinized dunite. The age of the ultramafic body is probably Paleozoic or possibly Mesozoic.

About two-tenths of a mile southeast of the confluence of Brophy and Camp Creeks there is probably a small ultramafic dike. At the locality mentioned the waters of both streams are rusty red. Minor serpentinite float in the vicinity leads to the conclusion that these streams intersect an iron-rich ultramafic body.

Silicic Intrusive Rocks

Silicic intrusive rocks are abundant in the Eagle A-2 quadrangle to the west, and they are not uncommon in the western part of the Eagle A-1 quadrangle. In the remainder of the A-1 quadrangle silicic intrusive rocks are sparse.

On Woods Creek, just above the mouth of Camp Creek, granitic rocks are abundant in old dredge tailings (*fig 2*). This probably indicates the presence of a small intrusive in the vicinity. At various localities throughout the area igneous rubble and a few outcrops indicate the presence of dikes of monzonite or aplite. In general these were too small to show on the map.

Alluvial Deposits

The valleys of larger streams in the region are floored by alluvial gravel deposits. In addition, high-level gravel-covered terraces border Walker Fork. These materials were not mapped for this report.

STRUCTURAL GEOLOGY

Regional Setting

Foster (1969, p 24-26) discusses the regional structure of the Yukon-Tanana upland. The following is a brief summary of Foster's remarks.

The Eagle A-1 quadrangle is a minor part of a structurally complex metamorphic terrain that is bounded on the north by the Tintina fault and on the south by the Denali fault (*fig 1*). Both of these faults are structures of regional extent. The Tintina fault or trench is a possible continuation of the Rocky Mountain trench, and it separates metamorphic rocks of the Yukon-Tanana upland from unmetamorphosed Precambrian and Paleozoic rocks. It is estimated that there are 220 to 260 miles of right-lateral displacement along the Tintina fault (Roddick, 1967, p 29). The Denali fault (St. Amand, 1957, p 1351) separates metamorphosed and unmetamorphosed rocks in the Alaska Range. St. Amand (1957, p 1343) estimates over 150 miles of right lateral movement on the Denali fault.

In the eastern part of the Yukon-Tanana upland are some of the highest grade metamorphic rocks recognized in this metamorphic terrain. These are the sillimanite-bearing amphibiolite facies rocks of the Eagle A-1 and A-2 quadrangles. The amphibolite facies rocks are bordered on either side by lower metamorphic grade, greenschist facies rocks. Foster (1969, p 26) presents two possible explanations:

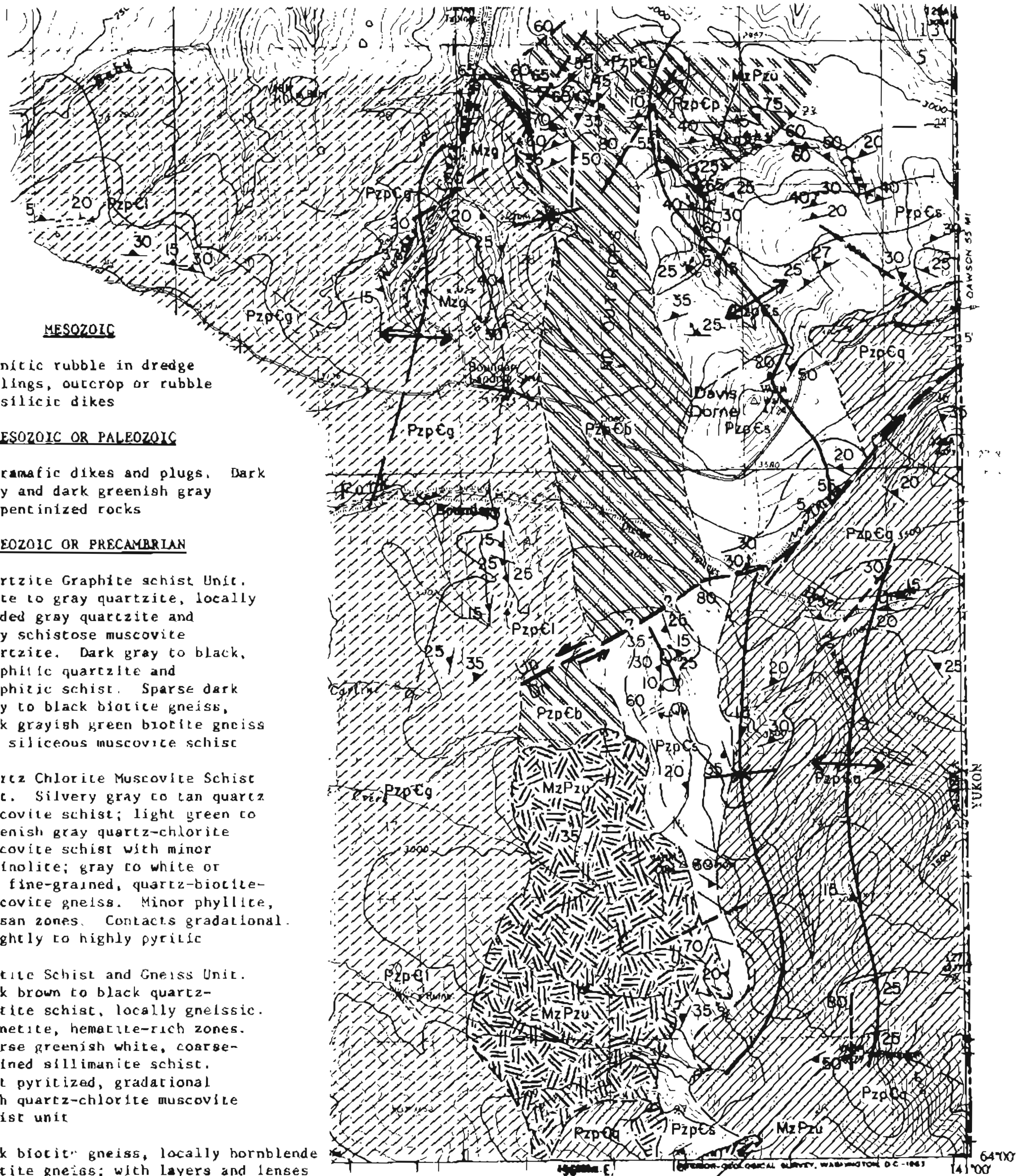
1. The rocks in the eastern part of the metamorphic terrain between the Denali and Tintina faults are different metamorphic facies of the same general stratigraphic sequence, and the age of the rocks is not related to their degree of metamorphism.

2. The area of the metamorphic terrain may be a geanticline with older higher grade metamorphic rocks near the center and younger lower grade metamorphic rocks on the flanks.

Structure in the Map Area

In the map area the structural pattern appears to be tight, small-scale isoclinal folds. There may be large-scale isoclinal folds as well because strong foliation is evident and bedding is generally obliterated. Tight minor folds and crinkles are common; in some outcrops multiple minor fold axes are developed. There are at least three sets of minor folds in the area.

Figure 3 is a form contour map that was constructed to depict the locations of fold axes. Lack of outcrops necessitated generalizing the form contour lines in some portions of the map, but it gives a general idea of the structure.



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PzpЄs - Quartz Chlorite Muscovite Schist Unit. Silvery gray to tan quartz muscovite schist; light green to greenish gray quartz-chlorite muscovite schist with minor actinolite; gray to white or tan fine-grained, quartz-biotite-muscovite gneiss. Minor phyllite, gossan zones. Contacts gradational. Slightly to highly pyritic

PzpЄb - Biotite Schist and Gneiss Unit. Dark brown to black quartz-biotite schist, locally gneissic. Magnetite, hematite-rich zones. Sparse greenish white, coarse-grained sillimanite schist. Unit pyritized, gradational with quartz-chlorite muscovite schist unit

PzpЄg - Dark biotite gneiss, locally hornblende biotite gneiss; with layers and lenses of quartz, aplite, alaskite pegmatite and granite. Some exposures garnetiferous. Black to dark green amphibolite with chlorite; minor quartzite, muscovite schist and recrystallized limestone. Locally pyritic

0 1 2 Miles

Contour interval 100 Feet

10 Strike and dip of foliation

35 Strike and dip of layering or bedding

Contacts (inferred, approximate)

80 Fault showing dip

25 Minor fold axis with plunge

5 Minor folds showing plunge of axes

PzpЄl, Limestone ; Qv, Quartz vein

Base from U.S. Geological Survey Eagle A-1 Quadrangle, 1956

Form line structure contour, 500 Foot interval

Fold axis

32°

TRUE NORTH

Approximate mean Declination, 1956

Figure 3 Form line structure contour map, Boundary area, Eagle A-1 Quadrangle, Alaska

The southern part of the area shows folds that plunge north with minor folds on the limbs that are oriented west or northwest. These fold axes are offset near Davis Creek by a left-lateral fault that probably extends completely across the map area.

On the north side of the Davis Creek fault, the fold axes continue north in the same manner, but the flanks are more crinkled by minor folds than on the south.

The Davis Creek fault appears to be a fault that strikes N 30° to 50° E and dips 80° S, and has a left lateral movement of about a mile. The amount of vertical movement is not known. There are parallel faults and fractures in the map area that can be traced for short distances. Another prominent fault direction is N 40° to 50° W. Fractures of this trend are not well exposed and can be traced for relatively short distances.

The Davis Creek fault post-dates the major folding in the area. This folding was probably caused by east-west compression and could be related to movement along the Tintina and Denali faults. After development of the Davis Creek fault a northwest-directed force caused minor folding on the flanks of the major folds and probably caused the flexure or bend in the Davis Creek fault.

E C O N O M I C G E O L O G Y

In the project area mineral production has been derived from placer gold deposits. There is no recorded production from lode deposits nor are there any lode prospects. However, placer deposits must have bedrock sources and one objective of this project was to investigate the lode possibilities in the area.

Thick brush in valley bottoms and on hillslopes hampers conventional methods of ore search in the map area, consequently a heavy reliance was placed on geochemical sampling techniques. Early in the study it became evident that pyritization of the rocks is a widespread feature. To determine its significance rock samples were taken from the various units for analysis.

Rock samples were analyzed in the Division's laboratory for gold, copper, lead, and zinc by atomic absorption. Samples were also analyzed by semiquantitative emission spectrographic methods. Results of the atomic absorption analyses and selected elements from the emission spectrograph analyses are shown in table 2. Rock sample locations are shown in figure 4.

ROCK SAMPLES, GNEISS-AMPHIBOLITE UNIT

Rock samples from the gneiss-amphibolite unit include quartzite, gneiss, limestone, and schist. All of the twenty-two selected samples taken from this unit showed some feature suggesting the presence of ore minerals, such as pyritization or limonite, silicification, brecciation, or other alteration.

Table 2 - Rock sample analyses, Boundary area, Eagle A-1 quadrangle, Alaska

Map No.	Field No.	Au(1) ppm	Cu(1) ppm	Pb(1) ppm	Zn(1) ppm	Ni(1) ppm	Mo(2) ppm	Ag(2) ppm	Co(2) ppm	Cr(2) ppm	Ni(2) ppm	Remarks
						GNEISS-AMPHIBOLITE UNIT						
1	9A227rf	ND(3)	9	9	50	NA(4)	5	ND	20	100	20	Gossan with quartz, limonite, manganese
1A	9A227Arf	ND	5	24	18	NA	ND	ND	ND	50	5	Limestone with manganese, limonite
2	9A24rf	ND	55	15	100	NA	5	ND	20	50	10	Altered muscovite schist with limonite, calcite, fine disseminated pyrite
3	9A143rf	0.08(5)	7	3	100*	NA	10	ND	10	200	20	Granular quartzite, red limonite, pyrite
4	9A26rf	0.08	12	13	45	NA	5	ND	ND	100	10	Brecciated quartzite, minor limonite
5	9A27rf	0.12	15	10	48	NA	ND	ND	10	50	10	Altered quartzite, disseminated pyrite
6	9A28rf	ND	10	8	40	NA	ND	ND	10	100	10	Altered quartzite with fine spongy limonite
7	9A1rf	ND	14	13	27	NA	5	ND	10	100	20	Quartzite with sparse pyrite, minor limonite
8	9A109rf	0.12	44	13	105	NA	5	ND	50	50	10	Quartz biotite gneiss, pyrite along folia
9	9A111rf	0.10	170	10	70	NA	10	ND	100	200	20	Quartz biotite gneiss, pyrite along folia, from debris along creek
10	9A2rf	ND	18	14	15	NA	10	ND	10	200	20	Cherty brecciated quartzite, disseminated pyrite
11	9A4rf	0.08	18	15	60	NA	10	ND	100	1000	500	Amphibolite
12	9A5rf	0.08	45	10	45	NA	10	ND	50	200	20	Biotite gneiss with pyrite along folia
13	9A6rf	ND	22	11	38	NA	ND	ND	10	100	10	Altered felsic dike, sparse pyrite
14	9A115rf	0.10	30	12	100*	NA	5	ND	20	50	10	Brecciated quartz sericite schist, sulphide casts
15	9A8rf	ND	40	7	28	NA	5	ND	10	100	20	Quartz biotite gneiss with sparse pyrite
16	9A17rf	ND	52	18	122	NA	10	ND	20	200	20	Quartz biotite gneiss, sparse pyrite

Map No.	Field No.	Au(1) ppm	Cu(1) ppm	Pb(1) ppm	Zn(1) ppm	Ni(1) ppm	Mo(2) ppm	Ag(2) ppm	Co(2) ppm	Cr(2) ppm	Ni(2) ppm	Remarks
17	9A9rf	ND	10	12	15	NA	5	ND	ND	100	20	Quartz sericite schist, sparse pyrite
18	9A16rf	ND	110	20	85	NA	20	ND	20	200	50	Quartz muscovite schist, with ¼ inch granitic stringers, disseminated pyrite
19	9A114rf	ND	11	23	40	40	5	ND	20	200	50	Altered quartz biotite gneiss, abundant pyrite
19A	9A114Arf	0.08	7	22	100*	57	5	ND	50	200	50	Altered quartz biotite gneiss with calcite veinlets
20	9A11rf	0.08	12	7	36	NA	5	ND	20	500	20	Brecciated quartzite, vuggy with secondary quartz
21	9A12rf	0.08	11	17	35	NA	5	ND	10	200	20	Altered quartzite, secondary quartz veinlets
22	9A14rf	0.08	10	20	85	NA	5	ND	10	200	20	Silicified quartzite breccia, finely disseminated sulphides
						BIOTITE SCHIST AND GNEISS UNIT						
24	9A213rf	NA	14	7	100*	NA	5	ND	10	100	10	Biotite gneiss with magnetite, 2% iron
25	9A215rf	0.08	24	10	7	NA	10	ND	50	100	10	Amphibolite with pyrite
26	9A217rf	0.28	28	42	85	NA	5	ND	20	200	20	Biotite gneiss with pyrite
27	9A218rf	ND	125	8	32	14	50	ND	50	100	20	Sheared, brecciated biotite gneiss
28	9A68rf	ND	64	13	180	NA	10	ND	50	500	20	Biotite schist minor pyrite along folia
29	9A74rf	ND	27	29	170	NA	5	ND	50	50	20	Biotite schist, minor disseminated pyrite
						QUARTZ-CHLORITE-MUSCOVITE SCHIST UNIT						
30	9A212rf	0.08	17	35	145	NA	5	ND	100	20	500	Quartz sericite schist, limonite, pyrite casts, weak gossan
31	9A50rf	0.10	48	10	28	NA	5	ND	20	100	20	Phyllite with minor pyrite
32	9A45rf	ND	45	50	80	NA	10	ND	ND	100	20	Weak gossan in quartz muscovite schist
33	9A40rf	0.12	290	720	130	NA	5	2	ND	500	20	Composite grab sample from gossan in quartz muscovite schist

Map No.	Field No.	Au(1) ppm	Cu(1) ppm	Pb(1) ppm	Zn(1) ppm	Ni(1) ppm	Mo(2) ppm	Ag(2) ppm	Co(2) ppm	Cr(2) ppm	Ni(2) ppm	Remarks
34	9A39rf	0.12	195	80	210	NA	5	2	10	500	20	Quartz muscovite schist with indigenous limonite
35	9A41rf	0.08	170	57	120	NA	5	ND	ND	200	20	Grab sample, gossan in quartz muscovite schist
36	9A42rf	0.08	63	26	110	NA	5	ND	10	100	10	Composite grab sample, gossan in quartz muscovite schist
37	9A85rf	0.10	19	140	29	NA	20	5	10	200	20	Quartz muscovite schist, disseminated pyrite crystals
38	9A81rf	0.08	6	14	63	NA	5	ND	10	200	20	Biotite gneiss, disseminated pyrite
38A	9A81Arf	0.08	7	24	15	NA	5	ND	10	100	10	Silicified quartz sericite schist, disseminated pyrite
39	9A95rf	0.08	25	12	60	NA	5	ND	10	100	10	Quartz sericite schist, limonite pseudomorphs after pyrite
40	9A209rf	0.08	16	27	100*	NA	10	ND	ND	200	20	Quartz sericite schist, spongy yellow limonite
41	9A33rf	0.10	115	20	100	NA	10	ND	20	200	50	Quartz muscovite schist, sulphide casts, limonite
42	9A129rf	ND	10	8	100*	NA	5	ND	10	200	20	Vein quartz
43	9A128rf	ND	5	6	100*	NA	5	ND	10	200	20	Fine grain biotite gneiss, sparse pyrite
44	9A131rf	ND	6	7	100*	NA	5	ND	10	100	10	Biotite gneiss with pyrite, calcite
45	9A132rf	0.08	7	7	100*	NA	5	ND	10	100	10	Altered biotite gneiss with muscovite, pyrite
						QUARTZITE-GRAPHITE SCHIST UNIT						
46	9A187rf	0.08	16	18	100*	NA	10	ND	20	200	10	Banded gray quartzite with pyrite veinlets up to 1/8 inch, calcite
47	9A184rf	ND	30	12	200*	NA	20	ND	20	500	20	Biotite gneiss, sparse pyrite
47A	9A184Arf	0.08	30	8	200*	NA	5	ND	20	500	20	Biotite gneiss, sparse pyrite
48	9A140rf	0.12	8	4	100*	NA	ND	ND	ND	100	5	Vein quartz very sparse stibnite
49	9A157rf	0.08	43	11	100*	NA	10	ND	ND	200	20	Brecciated quartzite, yellow limonite

Map No.	Field No.	Au(1) ppm	Cu(1) ppm	Pb(1) ppm	Zn(1) ppm	Ni(1) ppm	Mo(2) ppm	Ag(2) ppm	Co(2) ppm	Cr(2) ppm	Ni(2) ppm	Remarks
						ULTRAMAFIC DIKES AND PLUGS						
50	9A165rf	ND	360	10	100*	NA	ND	ND	100	5000	5000	Contact, ultramafic rocks--biotite schist, magnetite, 5% iron
51	9A200rf	0.08	10	20	100*	1900	5	ND	200	5000	5000	Ultramafic rocks with magnetite, 7.6% iron
52	9A65rf	0.08	15	12	30	NA	ND	ND	100	5000	5000	Ultramafic rock
53	9A220rf	ND	56	12	75	NA	5	ND	100	50	10	Ultramafic rock, serpentine, magnetite, 8.0% iron

(1) Analysis by atomic absorption

(2) Analysis by emission spectrograph

(3) ND - None detected because concentration below detection limit of anlaytical apparatus

(4) NA - Not analyzed

(5) 0.08 = lower detection limit for gold; for detection limits and analytical intervals of emission spectrograph see appendix I

* Zinc analysis by emission spectrograph

Metal values are generally low. Many samples show a trace of gold, but hardly in amounts sufficient to yield the rich placers on some of the creeks in the area. Sample 9 contains 170 ppm (parts per million) copper and 10 ppm molybdenum. These are relatively low values, but are significantly higher than the values for copper and molybdenum in most of the other rock samples from the unit. Sample 9 consisted of scattered fragments of float littering a moss-covered area near a small draw about a half mile north of Boundary (*fig 4*). Because of the limited exposure and lack of outcrop its full significance is not known.

Samples 16 and 18 are from Woods Creek about a mile and a half northwest of Boundary (*fig 4*). Sample 16 shows 122 ppm zinc and 10 ppm molybdenum. Sample 18 contains 110 ppm copper and 20 ppm molybdenum. Again these values are relatively low for rock samples but are higher than most other samples from the unit.

Samples 16 and 18 were collected from an outcrop in Woods Creek just upstream from an abandoned cabin and are about 500 feet apart. The outcrop shows quartz-biotite gneiss with sulfides along foliation planes through 3 feet. A small stringer of granitic rock about 2 inches wide is exposed in the outcrop. It is thought that the values in these samples are related to local enrichment associated with the minor granitic intrusive and are of little significance. There is a possibility that other granitic stringers cut the gneiss below surface and the zone may be extensive vertically. Values would also be higher below the zone of surface leaching.

ROCK SAMPLES, BIOTITE SCHIST AND GNEISS UNIT

In the map area the biotite schist and gneiss is the most poorly exposed rock unit. Consequently only six samples were collected. Along lower Camp Creek near the point where Camp and Brophy Creeks join (*fig 4*) the biotite schist and gneiss unit is in fault contact with the quartz-chlorite-muscovite schist unit. Rock samples 27, 28, and 29 were collected near this contact. Sample 27 contains 125 ppm (parts per million) copper and 50 ppm molybdenum. Samples 28 and 29 show 180 and 170 ppm zinc respectively. These values are probably related to weak mineralization along the fault zone and do not represent an important ore occurrence. Stream sediment samples from this general area are anomalous in lead and zinc, but the anomalies are thought to be related to a gossan zone in quartz sericite schist in the vicinity of sample 32 through 36 (*fig 4*). The fault however may have exerted some control on the localization of any ore associated with the gossan zone.

ROCK SAMPLES, QUARTZ-CHLORITE-MUSCOVITE SCHIST UNIT

On the ridge between Camp and Brophy Creeks (*samples 33 through 36, fig 4*) a gossan is developed in quartz-muscovite schist. Outcrops are sparse and most of the sampling was done by collecting float fragments that litter the surface.

In this gossan zone the rocks show isolated cubical pseudomorphs filled by black limonite with a vitreous luster. In some of these, vertical striations are present, and it appears that the limonite replaces pyrite. The surface of the rock between the crystal psuedomorphs is stained by light tan to red smeary limonite. Some sulfide casts are present that are lined by a thin hair-like fibrous mineral that was not identified.

Sample 33 is a composite sample of rock fragments taken across the gossan zone. The sample contains 290 ppm (parts per million) copper, 720 ppm lead, 130 ppm zinc, and 2 ppm silver. Samples 34 through 36 represent grab samples from several places within the gossan zone. Values range from 63-290 ppm copper, 26-80 ppm lead, 110-210 ppm zinc, and less than 1 (ND) to 2 ppm silver. This gossan zone may be a leached cap overlying a lead-zinc deposit.

Lead is less mobile in a weathering environment than either copper or zinc, and copper is less mobile than zinc. Thus if the gossan overlies a lead-zinc deposit a higher concentration of lead in the leached zone is expected. Further testing of this zone is warranted.

Outcrops in the vicinity are too sparse to determine any structural control for the deposit. There is faulting in the vicinity and at least two faults trend in the general direction of the gossan zone. One of these faults (samples 27, 28, and 29) is known to be weakly mineralized. It is also possible that a favorable horizon in the unit carries lead and zinc minerals rather than the usual pyrite and the deposit is not related to faulting.

Sample 37 in the same general area but farther west carries 140 ppm copper and 20 ppm molybdenum. It is on the trend of the fault mentioned in connection with samples 27, 28, and 29 and probably represents a southern extension of the same fracture zone.

Sample 41 was collected on the crest of the ridge that forms the main drainage divide in the area (*fig 4*). It contains 115 ppm copper and 10 ppm molybdenum. Loose rubble at the locality is composed of rocks that are transitional from quartz muscovite schist to graphitic schist. The rocks are stained by limonite and they contain casts formerly occupied by sulphide minerals, probably pyrite. This probably represents a local enrichment of bedrock and is not significant.

ROCK SAMPLES, QUARTZITE-GRAPHITE SCHIST UNIT

Sample 47 (*fig 4*) was collected from a local occurrence of pyritized, chloritic, siliceous biotite gneiss (quartzite-graphite schist unit) on Poker Creek. Sample 47 contains 20 ppm molybdenum. Sample 47A, taken in the same general locality, contains only 5 ppm molybdenum. It is concluded that the rocks at this locality are only weakly mineralized.

ROCK SAMPLES, ULTRAMAFIC DIKES AND PLUGS

Chromium and nickel are concentrated to a much greater degree in the ultramafic rocks in the area than in the metamorphic rocks. Samples 50 and 51 are from the ultramafic body in the southern part of the map area (*fig 4*). Both samples indicated contain 5000 ppm chromium and 5000 ppm nickel. According to the atomic absorption results the nickel value for sample 51 is 1900 ppm, and this is probably the more accurate value. Iron, in the form of magnetite, is also an abundant constituent of these samples. These samples do not indicate ore grade concentrations of metallic minerals. However sample 50 was taken at the contact of the ultramafic body and biotite schist (quartz-chlorite-muscovite schist unit).

There are visible sulfides in the sample and it contains 360 ppm copper in addition to relatively high nickel, chromium, and iron. Further prospecting in the vicinity of the contact might be worthwhile.

CONCLUSIONS, ECONOMIC GEOLOGY

1. Lode deposits of gold in bedrock of sufficient size to yield the placer deposits formed in the creeks of the vicinity were not recognized. The source of the placer deposits is unknown.

2. Pyritization of the rocks in the area is common, and at a few places base metals are associated with the pyrite. Such localities may be fault zones, areas where there are small granitic stringers, or areas where there is no obvious connection between mineralization and structure or between mineralization and intrusive rocks.

3. Based on rock samples, only the gossan zone between Brophy and Camp Creeks is thought to be significant. Stream sediment sampling indicated several additional areas however, and these are discussed in the chapter on geochemistry.

4. Ultramafic rocks in the vicinity are enriched in chromium, nickel, and iron, but no ore grade concentrations were found. Copper may be concentrated at ultramafic contacts.

G E O C H E M I S T R Y

SAMPLING METHOD, FIELD ANALYSES

A total of 170 stream sediment samples were gathered in the map area from the active beds of most streams. Samples were taken at one-quarter mile intervals. Sample locations are shown on figure 5.

At each site a composite sample was taken from an area about 50 feet in length on both sides of the stream. Where possible fine sand or silt was taken and organic material avoided. Samples were collected in cloth bags which in turn were placed in plastic sandwich bags to prevent contamination from other samples during transportation.

All samples were tested by a colorimetric dithizone field test described by Hawkes (1963). If a sample required 6 or more milliliters of dye to reach an end point, it was tested at least three more times for certainty. Subsequent laboratory analyses show a good correlation of the field test and samples with a high zinc content. The field test is less sensitive to copper and lead.

LABORATORY ANALYSES

Samples were analyzed by atomic absorption techniques for copper, lead, and zinc in the Division laboratory at College. They were then run for 30 elements by emission spectrograph at the University of Alaska Mineral Industry Research Laboratory. L. E. Heiner, MIRL mining engineer, supervised the work; Larry Shafford and Jane Bryant performed the analyses. Laboratory analytical results were not available to the field party until the field season was over.

Appendix I shows the limits of detection and estimating intervals for the emission spectrograph. Appendix II is a computer printout that shows the analytical results, results of field tests, and field notes. There are two sets of values for copper, lead, and zinc. One set is atomic absorption data; the other is emission spectrograph data.

COMPUTER PROGRAM AND CALCULATION OF ANOMALOUS VALUES

All analytical and field results including field tests and notes taken at the sample site were punched on IBM cards for computer data processing. The computer program was written and managed by L. E. Heiner, Mining Engineer, University of Alaska. The computer tabulated the printout shown in Appendix II.

The computer program was also designed to compute the average value, the standard deviation, the threshold value, and the anomalous value for each element. For computing the average, values below the detection limit of the spectrograph (ND) were taken as the crustal average for the element or one half of the lower detection limit, whichever was smaller. Threshold or the possibly anomalous value was taken as the average plus two standard deviations. The highly anomalous value was taken as the average plus three standard deviations. This technique is described in Hawkes and Webb (1962, p 30). The average, standard deviation, threshold, and highly anomalous value were calculated using the given concentration of an element and also using the logarithm of the concentration.

The computer plotted frequency histograms for atomic absorption values of copper, lead, and zinc. The histograms were plotted using the numerical data and the logarithmic data. Through study of these histograms it was possible to determine if the sample population was normally or lognormally distributed for a given element. Histograms were not plotted for elements determined by emission spectrograph because the reading intervals increase geometrically.

Because the data for copper, lead, and zinc by atomic absorption were neither normally nor lognormally distributed a cumulative frequency diagram was constructed to determine the threshold and anomalous value for each of these elements (*figs 6, 7, and 8*). For elements determined by emission spectrograph the threshold and anomalous values used are those calculated by the Hawkes and Webb (1962, p 30) method using numerical rather than logarithmic data. The average, standard deviation, threshold, and anomalous values for each element are given in table 3. The locations of threshold and anomalous samples are shown on figure 5.

DISCUSSION OF ANOMALIES

The geochemistry of the area can be discussed in terms of anomalous samples related to variations in lithology and anomalous samples related to ore mineral occurrences.

Table 3, Threshold and anomalous values, stream sediment samples, Boundary area, Eagle A-1 quadrangle, Alaska (all values in parts per million unless indicated otherwise; for discussion of methods of calculating threshold and anomalous value see text).

Element	Average Value	Standard Deviation	Threshold Value	Anomalous Value
		ATOMIC ABSORPTION DATA		
Copper	30.65	16.6	56	90
Lead	18.75	7.9	36	50
Zinc	116.70	85.5	180	260
		EMISSION SPECTROGRAPH DATA		
Copper	31.49	22.5	77	100
Lead	19.51	13.1	46	50
Zinc	127.26	98.0	323	500
Molybdenum	8.72	4.8	18	20
Silver	0.11	0.2	0.5	1
Cobalt	27.83	17.4	50	100
Chromium	498.57	588.1	1000	2000
Nickel	90.11	164.9	420	500
Manganese	1328.57	1411.9	4152	5000
Titanium	4985.71	2059.7	9105	10000
Iron %	4.61	1.9	8	10
Magnesium %	1.93	1.4	5	5
Calcium %	1.33	1.0	3	5
Barium	903.43	464.5	1832	2000
Strontium	167.71	150.6	468	500
Boron	25.60	28.0	82	100
Beryllium	1.87	1.3	4	5
Tin	2.19	1.6	5	5
Tungsten	1.50	0.0	2	2
Zirconium	168.40	95.9	360	500
Lanthanum	37.66	15.9	70	100
Niobium	19.37	4.4	28	50
Scandium	18.23	5.3	29	50
Yttrium	25.26	21.5	68	100
Vanadium	104.29	25.1	154	200
Arsenic	1.80	0.0	2	2
Antimony	68.85	107.6	283	500
Bismuth	0.34	0.9	2	2
Cadmium	0.20	0.0	0.2	1

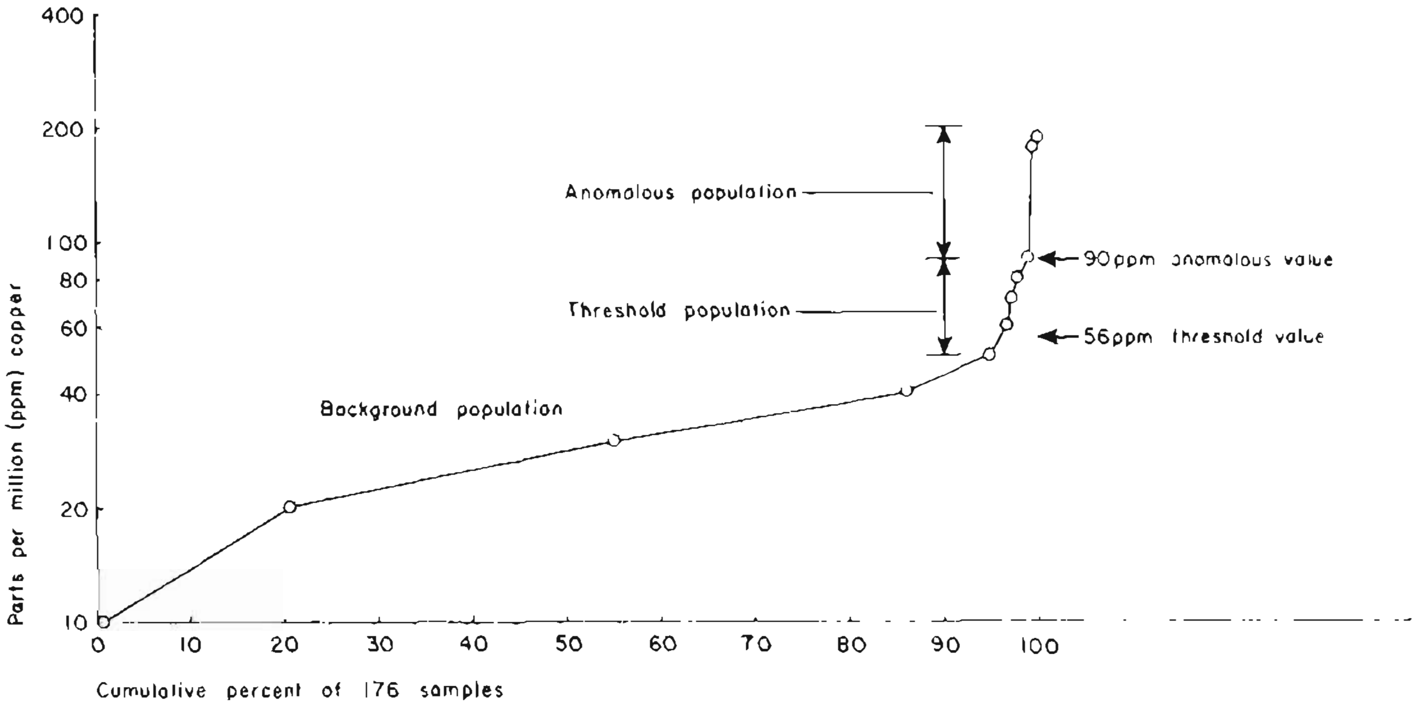

Figure 6 Cumulative frequency curve for copper. Plotted on 5 cycle X 10 divisions semi-logrithmic grid. Shows threshold and anomalous values. Atomic absorption data, stream sediment samples, Boundary area, Eagle A-1 Quadrangle, Alaska.

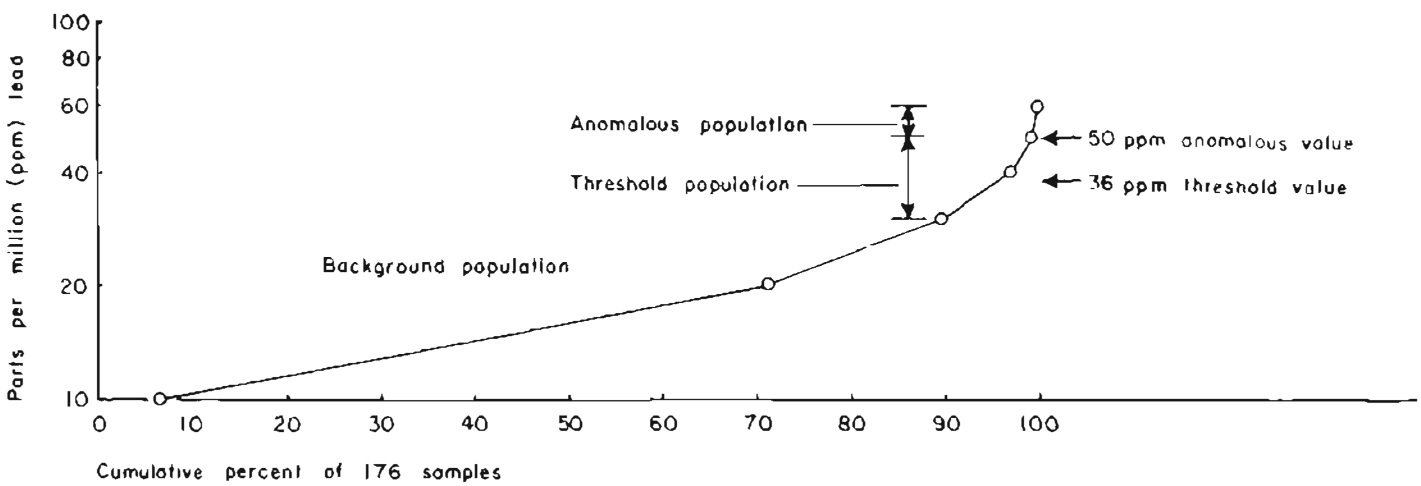

Figure 7 Cumulative frequency curve for lead. Plotted on 5 cycle X 10 divisions semi-logrithmic grid. Shows threshold and anomalous values. Atomic absorption data, stream sediment samples, Boundary area, Eagle A-1 Quadrangle, Alaska.

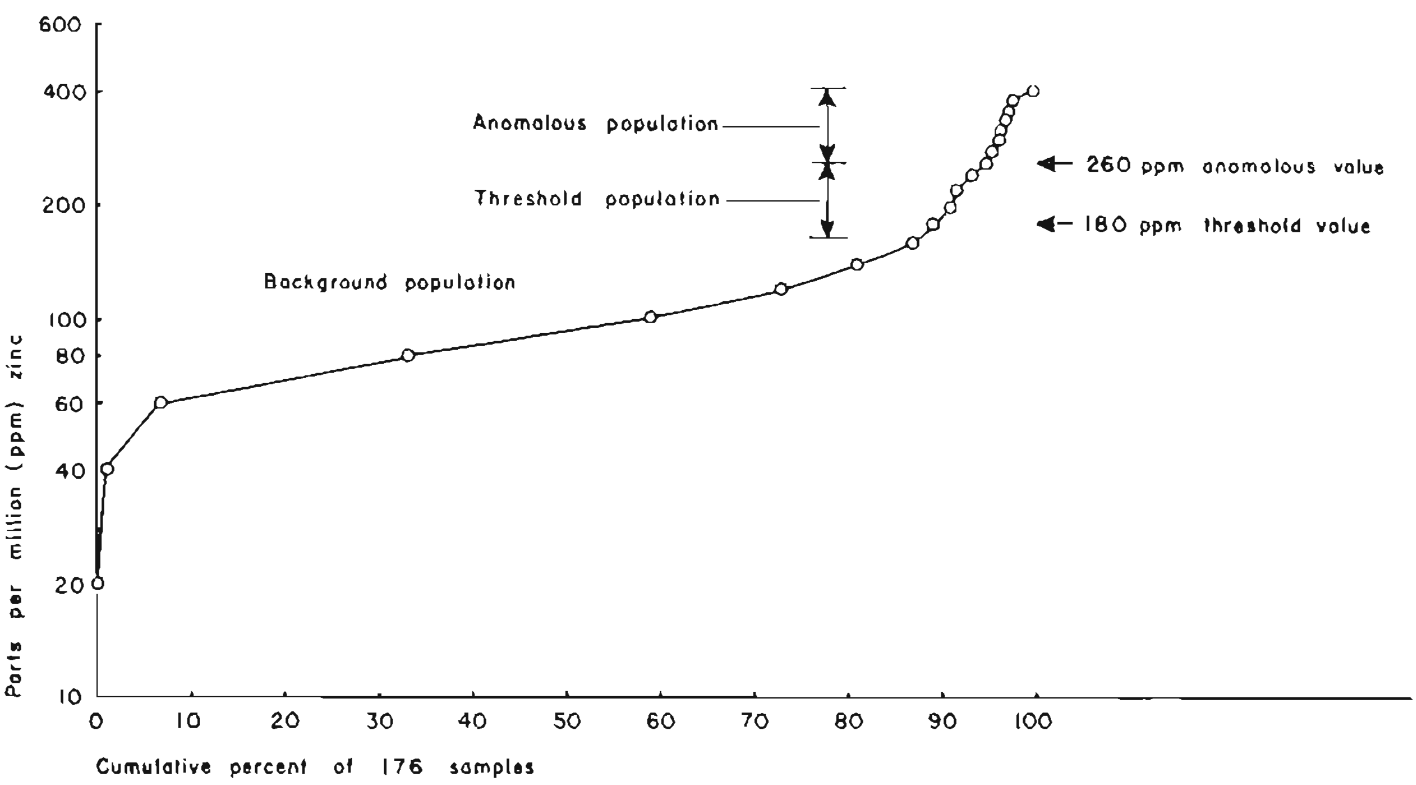

Figure 8 Cumulative frequency curve for zinc. Plotted on 5 cycle X 10 divisions semi-logrithmic grid. Shows threshold and anomalous values. Atomic absorption data, stream sediment samples, Boundary area, Eagle A-1 Quadrangle, Alaska.

ANOMALOUS STREAM SEDIMENT SAMPLES RELATED TO LITHOLOGY

Metamorphic rocks

Sediment samples from streams flowing across the metamorphic rocks of the Boundary area tend to be anomalous in elements such as vanadium, titanium, iron, magnesium, and manganese (*fig 5*) unless they are influenced by probable ore mineral occurrences or bodies of ultramafic rocks. Less commonly samples are anomalous in tin, bismuth, zirconium, calcium, barium, and rare earth elements. Lead, molybdenum, and chromium are present as anomalous elements in a very few samples.

Most of these anomalies are related to variations in lithology of the metamorphic rock units. Granitic and pegmatitic phases in the gneiss are not uncommon and local occurrences of these rock types are probably reflected by anomalous titanium, tin, zirconium, and rare earths in stream sediment samples. Vanadium may be related to the amount of organic matter in stream sediment samples; the mobility of vanadium is limited by organic material, and its dispersion thus prevented. Calcium and magnesium reflect local beds of limestone and dolomite; magnesium is also derived from ultramafic rocks.

Molybdenum may be related to igneous intrusions, and chromium is almost certainly related to unexposed ultramafic dikes or small plugs. Samples anomalous in lead are isolated and do not persist from one sample to the next. Consequently local isolated lead anomalies are not considered important.

Ultramafic rocks

Turk and Cherry Creeks drain the west side of the ultramafic intrusive body exposed in the southern part of the area, and samples from these streams are enriched in nickel, chromium, and lesser cobalt. No sulfides were noted in association with the ultramafic body, and the nickel is probably derived from the decomposition of rock silicates. Lack of associated copper adds strength to this conclusion. Chromium is probably derived from chromite in the ultramafic body.

Sample 140 is at the head of Cherry Creek near the east contact of the ultramafic body with a gneissic phase of the quartz-chlorite muscovite schist unit. The sample is anomalous in copper, zinc, lead, and silver. No sulfides were noted at the sample site, but a rock sample from this contact contained an uncommonly high copper value. Further checking might be justified.

Samples 149 and 150 on the north fork of Cherry Creek and several samples on Turk Creek are anomalous in antimony. No stibnite was found when the area was mapped, but according to Hawkes and Webb (1962, p 363) antimony is associated with nickel and cobalt in sulfide deposits. Thus the possibility of a sulfide deposit in the vicinity based on an association of nickel, cobalt, and antimony, cannot be completely discounted.

ANOMALOUS SAMPLES ASSOCIATED WITH POSSIBLE ORE OCCURRENCES

Camp and Brophy Creeks

From the mouth of Camp Creek to the head of Brophy Creek samples are anomalous in lead and zinc. Sample 28 at the mouth of Camp Creek contains 220 parts per million (ppm) zinc. The concentration of zinc increases gradually upstream to 600 ppm in sample 34 at the confluence of Camp and Brophy Creeks. The zinc value decreases to 230 ppm on upper Brophy Creek. Sample 44, which is on Camp Creek about a quarter of a mile above its confluence with Brophy Creek, shows 530 ppm zinc.

Lead has a distribution pattern similar to that of zinc. Lead values range from 30 ppm at the mouth of Camp Creek to a high of 55 ppm at the head of Brophy Creek. Values cited above were determined by atomic absorption. These values are most likely derived from the gossan on the ridge between Camp and Brophy Creeks.

Some of the anomalous samples noted above show high values in chromium and cobalt that is related to a small ultramafic dike that is intersected by both creeks. Other anomalous elements in these samples are also related to lithology.

Poker Creek, Davis Creek, Younger Creek

Samples from Poker Creek, Davis Creek, and the east branch of upper Younger Creek are anomalous in copper, lead, and zinc. At the head of Younger Creek molybdenum and silver are anomalous. These creeks head in the Yukon Territory, Canada and mapping did not extend across the boundary. The source of the samples is probably on the ridge just east of the border.

CONCLUSIONS, GEOCHEMISTRY

Geochemical sampling in the area leads to the following conclusions;

1. There is probably an occurrence of lead and zinc minerals on the ridge between Camp and Brophy Creeks.

2. The source of the anomalies on Davis, Poker, and Younger Creeks is probably in Canada.

3. The geochemical samples differentiate the metamorphic rocks from the ultramafic rocks. Nickel is present in samples influenced by the ultramafic body, but it is probably derived from rock silicates rather than sulfide minerals.

4. On the west side of the ultramafic body there is an association of nickel and antimony with minor cobalt that could be indicative of a sulfide orebody.

5. Minor copper occurs at the eastern contact of the ultramafic body, but its significance is not known.

CONCLUSIONS AND EXPLORATION SUGGESTIONS

As a result of this study the following conclusions are reached:

1. The mapping of more restricted rock units than has been done previously makes faults and other structures more apparent. However, reconnaissance-scale mapping such as that done by Foster (1969) is the most efficient for interpretation of regional geology.

2. The area is a polymetamorphic terrain with at least three folding directions. East-west compression was followed by a stress that caused faulting and a north or north-west directed force caused further folding.

3. A gossan zone between Camp and Brophy Creeks probably overlies a deposit of lead and zinc, but the economic potential cannot be predicted without further work. The ore controls are not known, but the quartz-muscovite schist unit is probably the most favorable lithology for prospecting in this area.

4. Nickel is associated with an ultramafic plug in the area, but the nickel is probably not present in economic concentrations. There are indications of copper mineralization near the eastern contact of the ultramafic body.

5. Broad scale reconnaissance geochemical sampling such as that done by Saunders (1966) is an effective exploration technique if more detailed work is done where anomalies are indicated.

6. In geochemical sampling too heavy a reliance must not be placed on field tests. Laboratory analyses are essential to extract maximum information from the samples.

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Appendix I

INTERVALS OF ESTIMATION AND DETECTION LIMITS

SEMIQUANTITATIVE SPECTROGRAPHIC ANALYSES

Copper ppm*	Lead ppm	Zinc ppm	Molybdenum ppm	Silver ppm	Cobalt ppm	Chromium ppm	Nickel ppm	Manganese ppm	Titanium ppm	Iron (%)	Magnesium (%)	Calcium (%)	Barium ppm	Strontium ppm
20,000	20,000	10,000	2,000	5,000	2,000	5,000	5,000	5,000	10,000	20	10	20	5,000	5,000
10,000	10,000	5,000	1,000	2,000	1,000	2,000	2,000	2,000	5,000	10	5	10	2,000	2,000
5,000	5,000	2,000	500	1,000	500	1,000	1,000	1,000	2,000	5	2	5	1,000	1,000
2,000	2,000	1,000	200	500	200	500	500	500	1,000	2	1	2	500	500
1,000	1,000	500	100	200	100	200	100	200	500	1	0.5	1	200	200
500	500	200	50	100	50	100	50	100	200	0.5	0.2	0.5	100	100
200	200	100	20	50	20	50	20	50	100	0.2	0.1	0.2	50	50
100	100	L	10	20	10	20	10	20	50	0.1	0.05	0.1	20	L
50	50		5	10	L	10	5	L	L	L	L	0.05	L	
20	20		L	5		5	L					L		
10	10			2		L								
5	L			1										
2				L										
L**														

Boron ppm	Beryllium ppm	Tin ppm	Tungsten ppm	Zirconium ppm	Lanthanum ppm	Niobium ppm	Scandium ppm	Yttrium ppm	Vanadium ppm	Gold ppm	Bismuth ppm	Cadmium ppm	Antimony ppm	Arsenic ppm
2,000	1,000	1,000	10,000	1,000	1,000	2,000	100	200	10,000	500	1,000	500	10,000	10,000
1,000	500	500	5,000	500	500	1,000	50	100	5,000	200	500	200	5,000	5,000
500	200	200	2,000	200	200	500	20	50	1,000	100	200	100	2,000	2,000
200	100	100	1,000	100	100	200	10	20	500	50	100	L	1,000	1,000
100	50	50	500	50	50	100	5	10	200	20	50		500	500
50	20	20	200	20	20	50	L	L	100	10	20		200	L
20	10	10	100	L	L	20			50	L	10		100	
10	5	L	50			10			20		5		50	
L	2		L			L			10		L		L	
	1								L					
	L													

*ppm indicates parts per million
**L = Lowest limit of detection

Appendix II Analytical Results (1), Results of Field Test (2), and Field Data.

Stream Sediment Samples, Boundary Area, Eagle A-1 Quadrangle, Alaska

Map No.	Sample No.	Gold (3)	Copper (3)	Lead (3)	Zinc (3)	Copper	Lead	Zinc	Molybdenum	Silver	Cobalt	Chromium	Nickel	Manganese	Titanium	Iron (%)	Magnesium (%)	Calcium (%)	Barium	Strontium	Boron	Beryllium	Tin	Tungsten
1	9J580	NA	15	10	65	20	20	100	5	ND	20	500	20	1000	5000	5	2	2	500	200	10	1	ND	ND
2	9J579	NA	15	15	65	20	10	100	5	ND	20	200	20	500	5000	5	2	1	500	200	20	1	ND	ND
3	9J578	NA	10	15	55	20	20	100	10	ND	50	500	50	1000	5000	5	2	1	500	200	20	1	ND	ND
4	9J577	NA	15	20	70	20	20	100	20	ND	50	500	50	2000	5000	5	2	2	1000	200	10	ND	ND	ND
5	9J576	NA	15	15	60	20	20	100	10	ND	20	500	50	1000	5000	5	2	2	500	200	10	1	ND	ND
6	9J581	NA	15	10	75	20	10	100	10	ND	20	500	20	1000	5000	5	1	2	1000	200	10	ND	ND	ND
7	9J582	NA	20	30	100	20	10	100	10	ND	20	500	20	1000	5000	2	1	2	500	200	10	ND	ND	ND
8	9J583	NA	20	20	80	10	10	100	5	ND	10	200	20	1000	2000	2	0.5	2	500	200	10	1	ND	ND
9	9J575	NA	15	15	60	20	20	100	5	ND	20	200	20	1000	5000	5	2	2	500	200	20	1	ND	ND
10	9J574	NA	10	10	45	20	10	100	20	ND	20	500	20	1000	5000	5	2	2	1000	200	10	1	ND	ND
11	9J573	NA	15	15	60	20	20	100	5	ND	20	200	20	1000	5000	5	2	2	1000	200	10	1	ND	ND
12	9J572	NA	15	15	60	20	20	100	10	ND	50	500	20	1000	5000	5	2	2	1000	200	10	1	ND	ND
13	9J571	NA	20	20	95	20	20	100	5	ND	20	500	20	1000	2000	2	1	1	500	200	10	1	ND	ND
14	9J570	NA	20	25	90	10	10	100	ND	ND	10	200	20	500	2000	2	0.5	2	500	100	10	1	ND	ND
15	9J569	NA	15	15	65	20	20	100	5	ND	20	200	20	1000	5000	5	1	2	1000	200	20	1	ND	ND
16	9J565	NA	15	15	65	20	20	100	10	ND	20	1000	20	1000	5000	5	1	2	1000	200	20	ND	ND	ND
17	9J566	NA	15	15	60	20	20	100	10	ND	20	500	50	1000	5000	5	2	2	1000	200	10	1	ND	ND
18	9J567	NA	20	15	65	20	10	100	5	ND	20	500	20	500	2000	2	1	2	500	100	10	1	ND	ND
19	9J568	NA	15	20	85	20	10	100	5	ND	20	500	20	1000	2000	5	2	1	1000	200	10	ND	ND	ND
20	9J561	NA	25	10	65	20	20	100	10	ND	50	500	50	1000	*1.0	5	2	2	1000	200	20	2	20	ND
21	9J562	NA	20	10	65	20	20	ND	5	ND	50	200	20	1000	5000	5	2	2	1000	200	20	ND	ND	ND
22	9J563	NA	20	40	95	20	50	100	5	ND	20	200	20	1000	5000	5	1	2	1000	200	20	1	ND	ND
23	9J564	NA	15	15	65	20	20	100	5	ND	20	500	50	1000	5000	5	1	2	1000	200	20	1	ND	ND
24	9J448	NA	20	15	80	20	20	100	5	ND	20	200	20	1000	*1.0	10	5	1	500	200	10	1	ND	ND
25	9J447	NA	20	15	75	20	20	100	10	ND	50	200	20	1000	*1.0	5	5	2	500	200	10	1	ND	ND
26	9J434	NA	30	15	75	20	10	100	5	ND	20	200	20	1000	*1.0	5	2	2	1000	200	50	1	ND	ND
27	9J449	NA	35	15	85	20	20	100	5	ND	20	200	20	1000	5000	5	2	2	1000	200	20	1	ND	ND
28	9J450	NA	30	20	220	20	50	200	10	ND	20	1000	50	1000	*1.0	5	2	0.5	2000	100	10	ND	ND	ND
29	9J451	NA	45	45	250	50	50	500	10	ND	50	500	50	1000	5000	5	2	1	1000	200	10	1	ND	ND
30	9J452	NA	30	30	250	20	50	200	20	ND	20	500	100	1000	5000	5	5	0.5	1000	200	10	1	ND	ND
31	9J453	NA	15	5	60	20	20	100	10	ND	20	200	10	1000	5000	5	2	2	500	200	10	1	ND	ND
32	9J454	NA	30	30	335	50	50	500	20	ND	50	500	100	1000	5000	5	5	0.5	1000	200	10	1	ND	ND
33	9J455	NA	25	15	120	20	10	100	5	ND	20	200	20	2000	2000	5	0.5	2	500	100	10	1	ND	ND
34	9J456	NA	35	35	600	50	50	1000	20	ND	100	500	100	1000	5000	5	2	0.5	1000	100	10	1	ND	ND
35	9J457	NA	35	40	285	50	50	200	10	ND	20	500	200	1000	*1.0	5	5	1	1000	200	10	1	ND	ND
36	9J458	NA	35	40	370	50	50	500	10	ND	50	500	100	1000	5000	5	5	1	1000	200	10	1	ND	ND
37	9J459	NA	35	40	195	50	50	200	10	ND	20	200	20	1000	5000	5	2	1	1000	200	10	1	ND	ND
38	9J460	NA	35	40	230	50	50	200	10	ND	20	500	50	1000	5000	5	5	1	1000	200	10	2	ND	ND
39	9J461	NA	35	30	160	20	20	100	5	ND	10	200	50	1000	5000	5	2	1	1000	200	10	1	ND	ND
40	9J462	NA	40	55	180	50	100	100	5	ND	20	500	50	1000	5000	5	5	0.5	1000	100	10	2	ND	ND
41	9J466	NA	30	20	[illegible]	20	10	100	10	ND	20	500	50	1000	5000	2	1	0.5	1000	100	20	2	ND	ND
42	9J465	NA	30	30	120	50	50	200	20	ND	20	500	20	1000	*1.0	5	5	0.5	2000	100	10	2	ND	ND
43	9J464	NA	30	35	150	20	50	100	10	ND	20	200	20	1000	*1.0	5	2	0.5	1000	100	10	2	ND	ND
44	9J463	NA	40	40	530	20	50	500	5	ND	20	200	50	500	5000	5	1	0.5	1000	100	10	1	ND	ND
45	9J439	NA	30	45	95	10	50	200	20	ND	10	50	10	500	500	20	0.5	10	200	2000	10	10	ND	ND
46	9J438	NA	30	15	85	20	10	100	5	ND	20	200	20	2000	5000	5	2	2	500	100	10	ND	ND	ND
47	9J437	NA	25	15	80	10	ND	200	5	ND	10	100	20	1000	2000	2	0.5	1	500	100	10	ND	ND	ND
48	9J436	NA	25	15	75	20	20	100	5	ND	20	200	20	500	5000	5	2	2	1000	200	20	1	ND	ND
49	9J435	NA	25	15	75	50	20	100	5	ND	20	200	20	1000	5000	5	2	2	1000	200	20	1	ND	ND
50	9J431	NA	35	15	80	50	20	100	10	ND	20	500	20	1000	5000	5	2	2	1000	200	20	ND	ND	ND
51	9J432	NA	30	15	75	50	20	100	10	ND	50	500	50	1000	5000	5	2	2	1000	200	20	1	ND	ND
52	9J433	NA	30	15	80	20	20	100	10	ND	20	500	50	1000	*1.0	5	2	2	1000	200	50	1	ND	ND
53	9J430	NA	15	20	40	20	10	100	5	ND	20	200	20	1000	5000	5	2	2	1000	200	10	ND	ND	ND
54	9J429	NA	30	15	85	50	20	100	10	ND	20	500	20	1000	5000	5	1	1	1000	200	20	ND	ND	ND
55	9J469	NA	30	10	80	20	10	100	5	ND	20	500	20	1000	5000	5	1	2	500	200	10	ND	ND	ND
56	9J468	NA	25	10	70	20	10	100	5	ND	20	200	20	1000	5000	5	1	2	500	200	10	ND	ND	ND
57	9J467	NA	30	10	60	20	10	100	5	ND	20	200	20	500	5000	5	2	2	500	200	10	1	ND	ND
58	9J428	NA	25	10	80	20	20	100	10	ND	20	500	50	1000	5000	5	2	1	1000	100	20	1	ND	ND
59	9J427	NA	25	15	115	20	10	100	5	ND	20	200	20	1000	5000	5	2	1	500	200	10	1	ND	ND
60	9J426	NA	35	10	60	20	20	100	5	ND	50	200	20	500	5000	5	2	1	500	200	10	ND	ND	ND
61	9J440	NA	40	15	55	50	10	100	5	ND	20	200	20	1000	5000	5	2	1	1000	100	10	ND	ND	ND
62	9J441	NA	45	15	95	50	10	100	10	ND	20	500	20	1000	*1.0	5	2	1	500	100	10	ND	ND	ND
63	9J442	NA	35	15	100	20	10	100	5	ND	20	100	20	500	5000	5	1	1	500	100	10	ND	ND	ND
64	9J443	NA	35	15	90	50	20	100	10	ND	50	500	50	1000	5000	5	5	2	500	200	10	1	ND	ND
65	9J444	NA	30	20	55	50	20	100	10	ND	20	500	50	1000	5000	5	5	2	1000	200	10	ND	ND	ND
66	9J445	NA	25	20	80	20	20	100	10	ND	50	500	200	1000	5000	5	5	1	1000	200	10	ND	ND	ND
67	9J446	NA	30	25	110	20	50	100	10	ND	50	1000	200	1000	5000	5	5	1	2000	100	ND	1	ND	ND
68	9J584	NA	20	15	100	20	20	100	5	ND	20	200	20	5000	5000	5	1	1	1000	200	10	ND	ND	ND
69	9J585	NA	15	15	75	20	20	100	5	ND	20	200	50	5000	5000	5	1	1	1000	200	10	1	ND	ND
70	9J586	NA	15	20	55	10	10	100	5	ND	20	200	20	2000	2000	5	0.2	1	500	100	10	1	ND	ND
71	9J587	NA	25	15	60	50	20	100	5	ND	20	200	20	1000	5000	5	2	2	1000	200	20	1	ND	ND
72	9J590	NA	20	20	75	20	10	100	5	ND	20	100	20	1000	5000	5	0.5	1	500	200	10	1	ND	ND
73	9J591	NA	25	30	80	20	10	100	5	ND	20	100	10	2000	2000	5	0.5	1	500	100	10	1	ND	ND
74	9J592	NA	20	10	60	20	20	100	5	ND	20	200	20	1000	5000	5	2	2	1000	200	20	1	ND	ND
75	9J588	NA	25	15	65	50	20	100	10	ND	50	500	20	2000	5000	5	2	2	1000	200	20	ND	ND	ND
76	9J589	NA	30	15	65	20	10	100	5	ND	20	100	20	2000	5000	5	1	1	500	200	20	ND	ND	ND
77	9J596	NA	20	15	55	50	20	100	5	ND	20	200	20	*1.0	5000	5	1	2	1000	200	10	ND	ND	ND
78	9J595	NA	45	15	40	20	ND	100	5	ND	10	100	10	5000	1000	2	0.2	2	500	200	10	1	ND	ND
79	9J594	NA	30	15	75	20	20	100	5	ND	20	200	20	2000	5000	5	2	2	500	200	10	ND	ND	ND
80	9J593	NA	25	20	80	20	10	100	5	ND	50	100	20	5000	2000	5	1	1	1000	100	ND	1	10	ND
81	9J601	NA	10	15	35	10	20	100	10	ND	20	500	20	1000	*1.0	10	2	5	1000	200	ND	2	ND	ND
82	9J600	NA	20	15	65	10	10	100	5	ND	10	200	20	1000	2000	2	0.5	2	500	200	10	1	ND	ND
83	9J599	NA	25	15	70	20	20	100	5	ND	20	200	50	1000	5000	5	2	2	1000	200	10	ND	ND	ND
84	9J598	NA	15	15	45	20	20	100	5	ND	20	500	20	1000	5000	5	2	5	1000	500	10	ND	ND	ND
85	9J597	NA	20	15	65	10	10	100	5	ND	20	200	20	2000	5000	5	1	2	500	200	ND	1	ND	ND
86	9J523	NA	30	15	85	20	10	100	10	ND	20	200	20	1000	5000	2	1	1	1000	100	20	1	ND	ND
87	9J522	NA	30	15	95	20	20	100	10	ND	50	200	20	*1.0	2000	10	0.5	1	500	200	10	1	ND	ND
88	9J521	NA	35	15	90	20	10	100	5	ND	10	200	20	1000	5000	2	1	1	5000	100	20	ND	ND	ND
89	9J520	NA	30	15	85	20	20	100	10	ND	10	500	100	1000	5000	5	1	1	2000	100	20	ND	ND	ND
90	9J516	NA	35	15	85	50	20	100	10	ND	20	200	20	1000	5000	5	1	1	1000	100	20	1	ND	ND
91	9J517	NA	30	15	115	20	10	100	5	ND	10	100	20	2000	2000	5	1	2	500	100	10	1	ND	ND
92	9J518	NA	15	15	90	10	10	100	5	ND	20	100	20	2000	5000	5	0.5	1	200	200	10	ND	ND	ND
93	9J519	NA	15	10	75	20	10	100	5	ND	50	100	20	*1.0	5000	5	1	2	500	200	10	ND	ND	ND
94	9J515	NA	35	15	95	50	10	100	20	ND	20	500	50	500	5000	2	1	1	1000	100	20	1	ND	ND
95	9J514	NA	35	15	100	50	10	100	10	ND	20	200	50	1000	5000	2	1	1	1000	100	20	1	ND	ND

Zirconium	Lanthanum	Niobium	Scandium	Yttrium	Vanadium	Arsenic	Antimony	Bismuth	Cadmium	Field Test	Stream Width	Location (4)	Organic Content	Sediment Size	Bedrock (4)	Sediments in Stream Bed in Percent (4)	Map No.
200	20	20	20	20	100	ND	50	ND	ND		1	B	HI	C		FINE SEDS ONLY	1
200	50	20	20	20	100	ND	50	ND	ND		1	B	HI	C		FINE SEDS WITH OCCASIONAL SCHIST FLOAT	2
200	20	20	20	20	100	ND	50	ND	ND		1	B	HI	M		ONLY FINE ORGANIC SEDS PRESENT	3
200	20	20	20	50	100	ND	100	ND	ND		4	B	MO	M		SANDY ORGANIC MUD	4
200	20	20	20	20	100	ND	50	ND	ND		4	B	MO	M		SCHIST 40 QTZ-MONZ 30 SEDS 20 GNST OTHER 10	5
100	50	20	20	20	100	ND	50	ND	ND		2	B	HI	C		FINE SEDS ONLY	6
100	20	20	20	20	100	ND	50	ND	ND		2	B	HI	C		FINE SEDS SOME SCHIST GRAVELS	7
100	50	10	10	10	50	ND	50	ND	ND		1	B	HI	C		FINE ORGANIC SEDS ONLY	8
200	50	20	20	50	100	ND	50	ND	ND		4	B	MO	M		SCHIST 45 QTZ-MONZ 40 SEDS 10 GNST 5	9
200	ND	20	20	20	100	ND	50	ND	ND			B	MO	M		LS 10 QTZ MONZ 30 SCHIST 50 SEDS-GNST 10	10
200	20	20	20	20	100	ND	50	ND	ND		4	B	MO	M		LS5 QTZ-MONZ 25 SCHIST 50 GNST&OTHER&SEDS 20	11
200	20	20	20	20	100	ND	100	ND	ND		5	B	LO	F		LS 20 GNST 20 QTZ-MONZ 20 SCHIST 40	12
100	50	20	20	20	100	ND	ND	ND	ND		6	B	MO	M		SCHIST 30 QTZ-MONZ 40 GNST 20 SEDS 10	13
100	50	10	10	20	50	ND	ND	ND	ND		6	B	LO	F		QTZ-MONZ 15 SCHIST 50 MIXED SEDS 35	14
100	20	20	20	20	100	ND	ND	ND	ND		5	B	MO	M		SCHIST 40 QTZ-MONZ 30 SEDS 20 GNST&OTHER 10	15
200	50	20	20	20	100	ND	50	ND	ND		4	B	MO	M		MAINLY FINE TO COARSE GRAVELS	16
200	20	20	20	20	100	ND	50	ND	ND		3	B	MO	F		FINE TO COARSE GRAVELS ONLY	17
100	50	20	20	20	100	ND	ND	ND	ND		3	B	MO	F		QTZ-MONZ&SCHIST GRAVELS	18
100	20	20	20	20	100	ND	ND	ND	ND		2	B	MO	M		SCHIST 60 QTZ-MONZ 20 SEDS&OTHER 20	19
1000	100	20	50	50	200	ND	50	5	ND		2	B	LO	F		FINE TO COARSE GRAVELS-SCHIST QTZ-MONZ	20
100	20	20	20	20	100	ND	ND	ND	ND		2	B	MO	M		COARSE SCHIST AND QTZ-MONZ GRAVELS	21
200	50	20	20	20	100	ND	50	ND	ND		4	B	MO	M		SCHIST 45 QTZ-MONZ 35 GNST,LS,OTHER 20	22
200	20	20	20	20	100	ND	50	ND	ND		4	B	MO	M		SCHIST 50 QTZ-MONZ 25 SEDS, OTHER 25	23
200	20	20	20	20	100	ND	50	ND	ND	0	2	B	MO	M		QTZ-GR 20 MICA-SCHIST 50 GNST 20 OTHER 10	24
100	ND	20	20	20	100	ND	50	ND	ND	0	3	B	MO	F		QTZ-GR 20 MICA-SCHIST 70 OTHER SEDS 10	25
200	50	20	20	20	100	ND	50	ND	ND	1	8	B	MO	M		MICA-SCHIST 60 QTZ-MONZ 20 GNST-SED 20	26
200	50	20	20	20	100	ND	ND	ND	ND	0	10	B	MO	C		QTZ-GR 35 SCHIST 35 GNST 10 ALTERED UNKNOWN 20	27
200	50	20	20	20	100	ND	50	ND	ND	3	6	B	MO	M		QTZ-GR 40 SCHIST 50 GNST, UNKNOWN 10	28
200	50	20	20	20	100	ND	100	ND	ND	4	5	B	MO	M	SCH	SCHIST 75 QTZ-GR 10 GNST OTHER 15	29
100	50	20	20	20	100	ND	50	ND	ND	6	4	B	MO	M	SCH	SCHIST 55 QTZ-GR 30 GNST LS OTHER 15	30
200	ND	20	20	20	100	ND	ND	ND	ND	0	2	B	HI	C		FINE TO COARSE GRAVELS ONLY	31
200	20	20	10	50	100	ND	100	ND	ND	19	4	B	MO	M	SCH	QTZ-GR 45 SCHIST 35 GNST 10 LS, OTHER 10	32
100	50	10	10	20	100	ND	50	ND	ND	1	1	B	MO	M		COARSE TO FINE GRAVELS 80 SCHIST CHIPS 20	33
200	50	50	20	50	100	ND	100	ND	ND	20	4	B	MO	M		MICA-SCHIST 65 QTZ-GR 20 GNST, OTHER 15 FE STAIN	34
200	20	20	20	20	100	ND	100	ND	ND	20	4	B	MO	M	SCH	QTZ-GR 25 SCHIST25 GNST 30 OTHER 20 SULFIDES-MANY	35
100	20	20	20	50	100	ND	50	ND	ND	20	3	B	MO	M	SCH	QTZ-GR 20 MICASCHIST 60 GNST LS OTHER 20 SULFIDES	36
200	50	20	20	20	100	ND	50	ND	ND	16	3	B	MO	M	SCH	QTZ-GR 25 MICA-SCHIST WITH SULFIDES 65 OTHER 10	37
200	50	20	20	20	100	ND	100	ND	ND	9	3	B	MO	M	SCH	QTZ-GR 20 MICA-SCHIST 60 OTHER LS 20	38
200	50	20	20	20	100	ND	50	ND	ND	12	2	B	MO	M	SCH	QTZ-GR 15 MICA-SCHIST 75 LS 10	39
100	20	20	20	20	100	ND	50	ND	ND	0	2	B	MO	M		QTZ-GR 15 MICA-SCHIST 75 LS 10	40
100	50	20	20	20	100	ND	50	ND	ND	4	3	B	MO	M		QTZ-GR 40 SCHIST 30 GNST 20 OTHER 10	41
200	50	20	20	20	100	ND	50	ND	ND	6	3	B	MO	M		SCHIST 65 QTZ-GR 20 OTHER LS 15	42
100	50	20	20	20	100	ND	50	ND	ND	2	4	B	MO	M		QTZ-GR 10 SCHIST 70 GNST 10 OTHER 10	43
200	50	20	10	20	100	ND	50	ND	ND	20	4	B	MO	M	SCH	QTZ-GR 15 SCHIST 60 GNST OTHER 25 FE STAIN IN CR	44
20	20	20	10	200	50	ND	ND	ND	ND	2	2	B	MO	C		FINE SEDS PRESENT	45
100	20	20	20	20	100	ND	ND	ND	ND	0	2	B	MO	M		RESIDUAL MICA-SCHIST FINE SEDS PRESENT	46
100	50	10	20	10	100	ND	ND	ND	ND	0	2	B	HI	C		MICA-SCHIST 70 COARSE TO FINE GRAVELS	47
200	20	20	20	20	100	ND	ND	ND	ND	2	3	B	MO	M	SCH	MICA-SCHIST 75 QTZ-GR 10 GNST 15	48
200	20	20	20	20	100	ND	50	ND	ND	4	4	B	MO	M		GNST 30 MICA-SCHIST 30 QTZ-GR 30 SEDS 10	49
200	20	20	20	20	100	ND	50	ND	ND	1	8	B	MO	M		MICA-SCHIST 50 QTZ-GR 20 QTZ-SED 20 GNST 10	50
200	50	20	20	20	100	ND	50	5	ND	1	8	B	MO	M		MICA-SCHIST 60 QTZ-GR 20 GNST 10 QTZ-SED 10	51
20	20	20	20	50	200	ND	50	ND	ND	0	8	B	MO	M		MICA-SCHIST 70 QTZ-GR 20 GNST 10 BLACK SANDS	52
100	20	20	20	20	100	ND	ND	ND	ND	10	5	B	MO	M	SCH	MICA-SCHIST 80 ALTERED ROCK 20 SULPHIDES PRESENT	53
200	50	20	20	20	100	ND	50	ND	ND	0	4	B	MO	M		MICA-SCHIST 65 GR 15 QTZ 10 GNST 10	54
10	50	20	20	20	100	ND	ND	ND	ND	0	4	B	MO	F		QTZ-GR 25 MICA-SCHIST 50 SEDS OTHER 25	55
100	20	20	20	20	200	ND	ND	ND	ND	0	4	B	MO	F		QTZ-GR 15 MICA-SCHIST 60 SEDS OTHER 25	56
100	20	20	20	20	200	ND	ND	ND	ND	0	2	B	MO	M		QTZ-GR 20 MICA-SCHIST 70 SEDS OTHER 10	57
200	50	20	20	20	100	ND	50	ND	ND	0	4	B	MO	M		QTZ 5 GR 20 MICA-SCHIST 55 GNST 20	58
100	20	20	20	20	100	ND	ND	ND	ND	0	2	B	MO	F		QTZ 5 GR 5 MICA SCHIST 60 SEDS OTHER 20	59
100	20	20	20	10	200	ND	ND	ND	ND	0	1	B	MO	F		FINE SAND AND ORGANIC SEDS PRESENT ONLY	60
100	20	20	20	20	200	ND	ND	ND	ND	0	4	B	MO	M	GNST	GNST 50 MICA-SCHIST 30 LIMEST 10 OTHER10 SLUICED	61
100	20	20	20	20	100	ND	50	ND	ND	0	4	B	MO	M	SCH	QTZ-GR 30 MICA-SCHIST 40 GNST 20 SEDS,OTHER 10	62
100	50	20	20	20	100	ND	ND	ND	ND	2	2	B	MO	M	SCH	MICA-SCHIST 60 GNST 15 QTZ-GR 15 SEDS,OTHER 10	63
200	20	20	20	50	200	ND	50	ND	ND	0	3	B	MO	M	SCH	QTZ-GR 30 MICA-SCHIST 50 GNST 10 OTHER 10	64
200	20	20	20	20	100	ND	50	ND	ND	0	3	B	MO	M		SCHIST 40 QTZ-GR-MONZ 30 SEDS,OTHER 30	65
200	20	20	20	20	100	ND	100	ND	ND	0	2	B	MO	M	LS	QTZ-GR 35 MICA-SCHIST 35 GNST 20 SEDS,OTHER 10	66
100	50	20	20	20	100	ND	100	ND	ND	0	2	B	MO	M		QTZ-GR 20 MICA-SCHIST 60 SEDS,LS,OTHER 20	67
100	20	20	20	20	100	ND	50	ND	ND		1	B	HI	F		COARSE TO FINE SCHIST QTZ-MONZ GRAVELS	68
100	20	10	20	20	100	ND	ND	5	ND		2	B	HI	C		FINE SEDS ONLY	69
100	50	10	10	50	100	ND	ND	ND	ND		2	B	MO	M		FINE TO COARSE SEDIMENTS	70
200	50	20	20	50	100	ND	50	ND	ND		4	B	HI	C		FINE SEDS ONLY VEGATATION THICK IN VALLEY	71
100	50	20	20	20	100	ND	ND	ND	ND		4	B	HI	C		FINE SEDS ONLY HEAVY VEGATATION IN DRAW	72
100	50	20	10	20	100	ND	ND	ND	ND			B	HI	C		FINE SEDS ONLY	73
200	20	20	10	20	100	ND	ND	ND	ND		5	B	MO	M		BASIC ROCKS WITH QTZ-GR AND FINE ORGANIC SEDS	74
200	20	20	20	20	100	ND	50	ND	ND		3	B	HI	C		FINE SEDS ONLY	75
200	50	20	20	20	100	ND	ND	ND	ND		2	B	HI	C		COARSE SCHIST GRAVELS AND FINE ORGANIC SEDS	76
200	20	20	20	20	100	ND	ND	ND	ND		2	B	MO	M		ONLY FINE SEDS PRESENT	77
50	50	10	10	50	100	ND	ND	ND	ND		2	B	HI	C		FINE SEDS ONLY	78
200	50	20	20	50	100	ND	50	ND	ND		2	B	MO	M		FINE SEDS WITH SOME GRAVELS	79
100	50	20	10	20	100	ND	ND	5	ND		2	B	MO	M		FINE SEDS WITH COARSE SCHIST GRAVELS	80
500	20	50	50	50	100	ND	50	ND	ND		4	B	MO	F		BASIC MICA-SCHIST WITH QTZ-MONZ AND SEDS	81
100	50	10	10	10	100	ND	ND	ND	ND		4	B	MO	M		SCHIST 50 QTZ-GR-MONZ 25 GNST 10 SEDS,OTHER 15	82
100	20	20	10	20	100	ND	50	ND	ND		2	B	HI	C		FINE SEDS ONLY	83
200	20	20	20	20	100	ND	50	ND	ND		1	B	LO	F		COARSE SCHIST GRAVEL	84
200	50	20	20	20	100	ND	ND	ND	ND		1	B	HI	C		FINE SEDS ONLY	85
200	20	20	20	20	100	ND	50	ND	ND		20	B	MO	M		SCHIST 25 QTZ-GR-MONZ 25 SEDS,LS,GNST 50	86
100	50	20	20	20	100	ND	50	ND	ND		20	B	MO	M		QTZ-MONZ 40 BLACK SCHIST 40 LS,GNST 20	87
200	50	20	10	200	100	ND	ND	ND	ND		20	B	MO	M	SCH	SCHIST 45 QTZ-MONZ 45 OTHER 10	88
100	50	20	10	10	100	ND	50	ND	ND		20	B	MO	M		QTZ-MONZ 50 BLACK SCHIST 40 OTHER 10	89
200	50	20	20	20	100	ND	50	ND	ND		15	B	MO	M	SCH	SCHIST 20 QTZ-MONZ 55 SEDS,LS,OTHER 25	90
100	50	10	20	20	100	ND	ND	ND	ND	1	4	B	LO			MICA SCHIST 80 GRANITIC 20	91
100	50	20	20	20	100	ND	ND	ND	ND		2	B	HI	C		ONLY FINE ORGANIC SEDS PRESENT	92
100	20	20	20	20	100	ND	ND	ND	ND		2	B	HI	C		ONLY FINE ORGANIC SEDS PRESENT	93
100	20	20	10	20	100	ND	100	ND	ND		15	B	MO	M		SCHIST 60 QTZ-GR-MONZ 20 GNST,OTHER 20	94
200	50	20	10	20	100	ND	50	ND	ND		15	B	MO	M		SCHIST 60 QTZ-GR-MONZ 30 OTHER 10 DREDGE TAILINGS	95

Appendix II (continued)

Map No.	Sample No.	Gold (3)	Copper (3)	Lead (3)	Zinc (3)	Copper	Lead	Zinc	Molybdenum	Silver	Cobalt	Chromium	Nickel	Manganese	Titanium	Iron (%)	Magnesium (%)	Calcium (%)	Barium	Strontium	Boron	Beryllium	Tin	Tungsten
96	9J470	NA	35	15	95	20	10	100	5	ND	20	200	50	500	5000	2	1	1	1000	100	20	1	ND	ND
97	9J471	NA	35	15	90	50	20	100	20	ND	20	500	50	1000	5000	5	2	1	1000	100	50	1	ND	ND
98	9J472	NA	30	15	85	20	20	100	10	ND	20	500	50	1000	*1.0	5	2	1	1000	200	50	1	ND	ND
99	9J473	NA	35	20	110	50	20	100	10	ND	20	200	20	1000	5000	5	5	1	1000	100	20	1	ND	ND
100	9J474	NA	30	15	90	50	20	100	10	ND	20	200	20	1000	5000	5	2	1	1000	200	20	1	ND	ND
101	9J475	NA	25	15	70	20	20	100	5	ND	20	500	20	500	5000	5	2	2	1000	200	20	1	ND	ND
102	9J476	NA	45	25	150	50	20	100	20	ND	20	1000	100	1000	5000	5	1	1	2000	100	50	1	ND	ND
103	9J507	NA	50	15	110	50	10	100	10	ND	20	200	50	2000	5000	5	1	0.5	1000	100	20	1	ND	ND
104	9J508	NA	60	15	120	50	10	200	10	ND	20	500	50	1000	*1.0	5	1	0.5	1000	100	50	1	ND	ND
105	9J509	NA	45	15	110	50	10	100	5	ND	20	200	50	1000	5000	5	2	0.5	1000	100	20	1	ND	ND
106	9J510	NA	75	15	140	100	10	100	5	ND	50	200	50	2000	*1.0	5	2	1	1000	100	20	ND	ND	ND
107	9J511	NA	75	20	190	100	20	200	10	ND	50	500	50	2000	5000	5	2	0.5	1000	100	20	1	ND	ND
108	9J512	NA	40	10	140	100	10	100	10	ND	20	500	50	1000	5000	2	0.5	0.5	1000	100	50	ND	ND	ND
109	9J513	NA	45	15	150	50	20	100	10	ND	20	500	50	1000	5000	5	1	0.5	1000	100	50	1	ND	ND
110	9J506	NA	50	30	550	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
111	9J505	NA	180	30	450	200	50	500	20	ND	50	500	50	5000	5000	10	2	0.5	1000	100	50	1	ND	ND
112	9J504	NA	75	20	365	50	10	200	5	ND	20	200	50	1000	2000	2	0.5	0.5	1000	100	50	ND	ND	ND
113	9J503	NA	45	20	230	50	20	200	10	ND	50	500	100	1000	5000	5	2	0.5	2000	100	50	1	ND	ND
114	9J502	NA	35	15	165	50	20	100	5	ND	20	500	50	1000	5000	5	2	0.5	1000	100	50	1	ND	ND
115	9J501	NA	35	20	160	20	20	100	10	ND	50	500	50	1000	5000	5	2	1	1000	100	20	ND	ND	ND
116	9J477	NA	65	30	150	100	20	200	20	1	20	200	20	1000	5000	10	2	0.5	2000	100	20	5	ND	ND
117	9J478	NA	30	15	105	50	20	100	10	ND	20	200	20	500	5000	5	0.5	0.2	1000	50	50	1	ND	ND
118	9J479	NA	20	15	110	20	20	100	10	ND	50	500	50	1000	5000	5	2	1	1000	200	50	1	ND	ND
119	9J480	NA	25	15	120	20	10	100	5	ND	20	500	50	1000	5000	2	0.5	1	1000	100	20	1	ND	ND
120	9J481	NA	30	15	130	20	20	100	10	ND	20	500	50	2000	5000	5	2	1	1000	200	20	1	ND	ND
121	9J482	NA	35	15	125	50	20	100	20	ND	20	500	50	500	5000	2	1	0.5	1000	100	50	ND	ND	ND
122	9J483	NA	30	15	125	20	10	100	10	ND	20	500	50	500	5000	2	1	0.2	1000	100	50	1	ND	ND
123	9J484	NA	30	25	120	50	20	100	20	ND	20	500	50	500	5000	5	1	1	1000	100	20	1	ND	ND
124	9J492	NA	30	20	145	20	10	100	5	ND	10	200	20	500	2000	2	0.2	0.5	500	50	20	1	ND	ND
125	9J493	NA	30	20	200	20	10	100	10	ND	20	500	100	2000	2000	2	1	1	1000	100	50	1	ND	ND
126	9J500	NA	25	25	170	20	20	200	10	ND	20	200	20	1000	5000	2	1	0.5	1000	100	50	1	ND	ND
127	9J499	NA	40	25	160	20	10	100	5	ND	10	200	20	1000	2000	2	0.2	0.5	500	100	20	1	ND	ND
128	9J498	NA	40	20	200	50	50	200	20	1	20	500	100	1000	5000	2	1	0.5	1000	100	100	1	ND	ND
129	9J497	NA	50	20	270	50	20	200	5	1	20	500	100	1000	5000	5	1	1	1000	100	100	2	ND	ND
130	9J494	NA	35	20	155	50	20	100	20	ND	50	500	50	2000	5000	5	1	1	1000	100	100	1	ND	ND
131	9J495	NA	30	15	90	10	10	100	ND	ND	10	200	20	500	2000	2	0.2	0.2	500	100	20	1	ND	ND
132	9J496	NA	30	15	120	20	10	100	20	ND	20	500	50	1000	5000	5	1	0.5	1000	100	50	1	ND	ND
133	9J485	NA	30	15	100	20	20	100	10	ND	20	500	50	500	5000	2	0.5	0.5	1000	100	50	ND	ND	ND
134	9J491	NA	20	15	55	20	10	100	10	ND	20	200	20	500	5000	2	1	1	500	200	20	ND	ND	ND
135	9J486	NA	30	20	120	20	20	100	10	ND	20	500	50	500	5000	2	1	0.5	1000	100	20	1	ND	ND
136	9J487	NA	30	20	110	20	ND	200	10	ND	10	200	50	500	2000	2	0.5	0.5	1000	100	20	1	ND	ND
137	9J488	NA	35	20	100	50	20	100	5	ND	10	100	20	500	5000	5	1	0.2	1000	50	50	1	ND	ND
138	9J489	NA	55	25	135	50	20	100	10	1	20	500	50	1000	5000	5	1	0.2	1000	100	50	1	ND	ND
139	9J490	NA	50	25	130	50	20	100	20	ND	20	500	50	1000	5000	5	1	0.5	1000	200	50	ND	ND	ND
140	9J560	NA	85	35	270	100	50	200	10	1	20	500	100	1000	*1.0	5	1	1	2000	200	200	2	10	ND
141	9J559	NA	40	25	130	20	10	100	10	ND	50	500	500	1000	5000	2	2	1	1000	100	20	ND	ND	ND
142	9J558	NA	40	25	125	50	20	100		1	50	1000	500	1000	5000	5	5	0.5	1000	100	100	1	ND	ND
143	9J557	NA	30	25	115	20	10	100	5	ND	20	1000	500	1000	2000	5	2	1	1000	100	100	ND	ND	ND
144	9J556	NA	35	25	150	50	20	100	20	ND	50	1000	500	1000	5000	5	5	1	1000	200	200	1	ND	ND
145	9J555	NA	35	20	140	20	20	100	10	ND	50	1000	500	2000	5000	5	5	1	1000	100	100	ND	ND	ND
146	9J554	NA	40	20	110	50	10	100	5	ND	20	500	100	1000	5000	5	1	1	1000	100	50	1	ND	ND
147	9J553	NA	40	20	135	50	20	200	10	ND	20	1000	100	1000	5000	5	5	1	1000	100	50	1	ND	ND
148	9J552	NA	35	20	120	20	10	100	5	ND	20	500	100	500	2000	2	1	1	1000	100	50	1	ND	ND
149	9J551	NA	30	15	105	50	20	100	10	ND	50	1000	100	1000	5000	5	2	1	1000	200	50	1	ND	ND
150	9J550	NA	25	15	100	20	20	100	5	ND	20	1000	100	1000	*1.0	5	2	1	1000	200	100	1	ND	ND
151	9J549	NA	35	20	110	20	10	100	5	ND	20	200	20	1000	5000	2	1	1	1000	100	20	ND	ND	ND
152	9J548	NA	25	15	90	20	10	100	5	ND	20	500	50	500	5000	2	1	1	500	200	20	1	ND	ND
153	9J547	NA	30	15	85	20	20	100	5	ND	20	500	50	500	*1.0	5	2	1	500	200	20	1	ND	ND
154	9J546	NA	30	15	125	20	20	100	10	ND	20	500	20	1000	5000	5	1	2	1000	200	20	1	ND	ND
155	9J545	NA	25	15	90	20	20	100	10	ND	20	500	50	1000	5000	5	2	1	1000	200	20	1	ND	ND
156	9J532	NA	30	15	85	50	10	100	10	ND	50	500	200	1000	2000	5	2	1	1000	100	20	ND	ND	ND
157	9J533	NA	30	15	80	50	20	100	5	ND	50	1000	200	1000	5000	5	5	2	500	200	20	ND	ND	ND
158	9J534	NA	30	15	75	20	10	100	5	ND	20	500	200	1000	5000	5	2	2	500	200	20	ND	ND	ND
159	9J535	NA	20	15	70	20	20	100	5	ND	100	1000	500	1000	5000	5	5	1	500	200	20	ND	ND	ND
160	9J540	NA	25	15	75	20	20	100	5	ND	50	1000	500	500	5000	5	2	1	500	200	20	1	ND	ND
161	9J541	NA	20	15	110	20	20	100	5	ND	50	5000	[illegible]	1000	5000	5	5	2	500	200	10	ND	ND	ND
162	9J542	NA	15	15	65	20	10	100	5	ND	50	2000	500	1000	5000	5	5	1	500	200	20	ND	ND	ND
163	9J543	NA	25	30	110	20	10	100	5	1	50	5000	1000	1000	2000	5	5	1	500	100	10	ND	ND	ND
164	9J544	NA	30	15	85	20	ND	100	ND	ND	20	2000	500	1000	2000	2	2	0.5	200	100	10	1	ND	ND
165	9J539	NA	30	15	70	20	10	100	10	ND	100	2000	1000	5000	2000	5	5	2	1000	200	20	1	ND	ND
166	9J538	NA	25	10	55	20	20	100	5	ND	100	2000	1000	1000	2000	5	5	2	500	200	10	ND	ND	ND
167	9J537	NA	25	10	70	20	10	100	5	ND	20	500	100	1000	2000	2	2	2	500	200	10	ND	ND	ND
168	9J536	NA	35	15	85	20	ND	100	ND	ND	20	500	200	1000	2000	2	1	2	500	100	10	1	ND	ND
169	9J531	NA	25	15	85	20	20	100	10	ND	50	500	100	1000	5000	5	2	2	1000	200	20	1	ND	ND
170	9J530	NA	25	15	85	20	20	100	10	ND	20	500	50	2000	5000	5	2	1	1000	200	20	1	ND	ND
171	9J529	NA	20	15	65	20	20	100	10	ND	50	500	50	2000	5000	5	2	2	500	200	10	1	ND	ND
172	9J528	NA	25	15	85	50	20	100	10	ND	50	500	100	1000	*1.0	5	2	2	1000	200	20	1	ND	ND
173	9J527	NA	20	15	75	20	10	100	10	ND	20	500	50	1000	5000	5	2	1	1000	200	20	1	ND	ND
174	9J526	NA	25	15	85	20	20	100	10	ND	50	500	100	1000	5000	5	2	1	500	200	20	1	ND	ND
175	9J525	NA	15	10	65	20	20	100	20	ND	20	500	50	1000	5000	5	2	2	1000	200	20	1	ND	ND
176	9J524	NA	30	15	90	20	10	100	10	ND	20	500	50	1000	5000	5	2	1	1000	100	20	1	ND	ND

(1) Values are in parts per million unless indicated otherwise

(2) Field test values in milliliters of dye

(3) Atomic absorption results; values for remaining elements are emission spectrograph results

(4) LS, Limestone; PEG, Pegmatite; SEDS, Sediments; GNST, Greenstone; GR, Granite; QTZ, Quartz

(5) NA indicates not analyzed

(6) ND indicates none detected

Zirconium	Lanthanum	Niobium	Scandium	Yttrium	Vanadium	Arsenic	Antimony	Bismuth	Cadmium	Field Test	Stream Width	Location (4)	Organic Content	Sediment Size	Bedrock (4)	Sediments in Stream Bed in Percent (4)	Map No.
100	20	20	10	20	100	ND	ND	ND	ND	3	14	B	MD	F		QTZ-GR25 MICA-SCHIST 45 GNST 10 SEDS,ULTRAMAFIC20	96
200	50	20	10	20	100	ND	50	ND	ND	3	15	B	MD	F		MICA-SCHIST 55 GNST 25 OTHER 20 SULFIDES IN ROCKS	97
200	50	20	20	20	100	ND	50	ND	ND	0	15	B	MD	F		QTZ-MONZ 25 MICA-SCHIST 50 OTHER 25 SULFIDES ROCK	98
100	50	20	20	20	100	ND	50	ND	ND	2	14	B	MD	F		QTZ-GR 25 MICA-SCHIST 65 SEDS 10 SULFIDES	99
200	50	20	20	20	100	ND	50	ND	ND	3	12	B	MD	F		QTZ-GR 25 MICA-SCHIST 70 ULTRAMAFIC 5 SULFIDES	100
200	20	20	20	20	100	ND	ND	ND	ND	2	12	B	MD	F		QTZ-GR 25 MICA-SCHIST 40 ULTRAMAFIC 35	101
100	50	20	10	20	100	ND	100	ND	ND	4	10	B	LO	F		QTZ-GR 40 MICA-SCHIST 40 OTHER 20 SULFIDES	102
200	50	20	20	50	100	ND	100	ND	ND	0	8	B	MD	M	SCH	SCHIST 45 QTZ-GR-MONZ 30 SEDS GNST 25	103
100	50	20	20	20	100	ND	50	ND	ND	0	8	B	MD	M	SCH	SCHIST 75 QTZ-GR-MONZ 15 OTHER 10	104
100	50	20	20	20	100	ND	50	ND	ND	1	8	B	MD	M	SCH	SCHIST 70 QTZ-GR-MONZ 15 GNST,OTHER 15	105
100	20	20	20	20	100	ND	ND	ND	ND	0	6	B	MD	F		SCHIST 60 QTZ-MONZ 20 SEDS,GNST,OTHER 20	106
200	50	20	20	20	100	ND	50	ND	ND	1	6	B	MD	M	SCH	SCHIST 60 QTZ-GR-MONZ 15 GNST,OTHER 25	107
200	50	20	10	20	100	ND	50	ND	ND	0	4	B	MD	M		SCHIST 40 QTZ-GR-MONZ 40 SEDS,OTHER 20	108
200	50	20	20	20	100	ND	50	ND	ND	1	4	B	LO	F		SCHIST 30 QTZ-GR-MONZ 30 SEDS,GNST,OTHER 40	109
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5	4	B	MD	M		QTZ SCHIST CONTACTS MINERALIZATION PRESENT	110
200	20	20	20	20	100	ND	50	ND	ND	5	6	B	MD	M		SCHIST 30 QTZ-GR-MONZ 30 GNST SEDS 40	111
100	50	20	10	20	100	ND	ND	ND	ND	3	6	B	MD	F		SCHIST 50 QTZ-GR-MONZ 20 GNST20 OTHER10 CU STAIN	112
200	20	20	20	20	100	ND	50	ND	ND	4	6	B	MD	M		SCHIST 60 QTZ-GR-MONZ 10 GNST 20 OTHER10 CU STAIN	113
100	20	20	20	20	100	ND	100	ND	ND	1	8	B	MD	F	SCH	SCHIST 25 QTZ-GR-MONZ 35 GNST 30 OTHER 10	114
200	20	20	20	20	100	ND	100	ND	ND	2	8	B	MD	F		SCHIST 40 QTZ-GR-MONZ 30 GNST 20 OTHER 10	115
200	50	20	20	50	200	ND	ND	5	ND	0	10	B	MD	M	SCH	QTZ-GR 25 MICA-SCHIST 50 SEDS OTHER 25 SULFIDE	116
200	50	20	10	20	100	ND	50	ND	ND	0	8	B	MD	F		QTZ-GR 30 MICA-SCHIST 30 SEDS 30 OTHER10 SULFIDES	117
200	20	20	20	20	100	ND	50	ND	ND	2	CR	B	MD	C		FINE SEDS ONLY	118
100	50	20	20	20	100	ND	50	ND	ND	5	2	B	HI	C	SCH	BASIC MICA-SCHIST WITH SOME QTZ GR-MONZ	119
500	50	20	20	50	100	ND	100	ND	ND	1	2	B	MD	C	SCH	BASIC MICA-SCHIST QTZ-GR-MONZ	120
200	50	20	20	50	100	ND	100	ND	ND	0	7	B	LO	F		QTZ-GR 35 MICA-SCHIST 35 SEDS-OTHER 30	121
100	50	20	10	20	100	ND	100	ND	ND	0	6	B	LO	M		QTZ-GR 40 MICA-SCHIST 30 SEDS 20 OTHER 10	122
200	50	20	20	20	100	ND	100	ND	ND	0	6	B	LO	F		QTZ-GR 30 MICA-SCHIST 30 SEDS,OTHER40 SANDY SOIL	123
100	50	10	10	10	50	ND	ND	ND	ND	0	6	B	MD	M	SCH	SCHIST 35 QTZ-GR 30 SEDS 20 GNST-OTHER 15	124
200	50	20	10	20	100	ND	100	ND	ND	0	4	B	LO	F		BASIC SCHIST AND QTZ-MONZ OCCURANCES	125
100	50	20	20	50	100	ND	ND	ND	ND	2	4	B	LO	M		SCHIST 40 QTZ-GR-MONZ 30 SEDS 15 GNST-OTHER 15	126
100	50	10	10	20	100	ND	ND	ND	ND	2	3	B	LO	M		SCHIST AND QTZ-GR-MONZ	127
200	50	20	20	20	100	ND	100	ND	ND	1		B	LO	F		SCHIST, QTZ-GR-MONZ	128
200	50	20	20	20	100	ND	50	ND	ND	3	4	B	LO	F		SCHIST 30 QTZ-GR-MONZ 30 GNST-OTHER 40	129
200	50	20	20	20	100	ND	50	ND	ND	0	3	B	LO	F		SCHIST 30 QTZ-GR-MONZ 30 SEDS 20 GNST 20	130
100	50	10	10	20	100	ND	ND	ND	ND	0	4	B	LO	F		SCHIST 30 QTZ-GR-MONZ 30 GNST 20 SEDS,OTHER 20	131
200	20	20	20	20	100	ND	100	ND	ND	0	2	B	LO	M		SCHIST AND QTZ	132
200	50	20	10	20	100	ND	50	ND	ND	0	4	B	MD	F		QTZ MONZ	133
200	50	20	20	20	100	ND	ND	ND	ND	0	1	B	MD	M		SCHISTS AND QTZ-GR-MONZ PRESENT	134
100	50	20	20	20	100	ND	50	ND	ND	1	4	B	MD	F	SCH	SCHIST 30 QTZ-GR 30 GNST 10 SEDS 30	135
100	50	20	10	20	100	ND	100	ND	ND		3	B				QTZ-GR 30 MICA-SCHIST 40 SEDS 30	136
200	50	20	10	20	100	ND	ND	ND	ND	0	3	B	LO	F		SCHIST 30 QTZ-GR 30 GNST 20 SEDS-OTHER 20	137
200	50	20	20	20	100	ND	50	ND	ND	0	2	B	MD	F		QTZ-GR 30 MICA-SCHIST 30 MONZ 20 GNST 20	138
200	50	20	20	20	100	ND	50	ND	ND	0	2	B	LO	F		SCHIST 30 QTZ-GR 25 SEDS 25 GNST-OTHER 20	139
100	50	20	20	50	100	ND	50	ND	ND		4	B	LO	F		BASIC SCHIST,GNST,QTZ-MONZ BEDROCK	140
200	50	20	10	20	100	ND	100	ND	ND		4	B	MD	M		BASIC RX SCHIST-QTZ-MONZ BEDROCK	141
200	20	20	20	20	100	ND	200	ND	ND	4	2		MD	M		SCHIST 40 GR-QTZ 20 SEDS 20 GNST 20	142
200	50	10	10	20	200	ND	100	ND	ND		4	B	MD	M		GNST 25 QTZ-GR 25 SCHIST 30 SEDS-OTHER 20	143
100	50	20	20	20	100	ND	200	ND	ND		4	B	MD	M		SCHIST 40 GNST 20 QTZ-MONZ 20 OTHER 20	144
200	50	20	20	20	200	ND	200	ND	ND		6	B	LO	F		SCHIST 40 QTZ-MONZ 30 SEDS,CALCITE,OTHER 30	145
200	50	20	10	20	100	ND	50	ND	ND		5	B	MD	F		SCHIST 55 QTZ-GR 30 SEDS-CALCITE 15	146
200	50	20	20	20	100	ND	100	ND	ND		5	B	MD	M		CALCITE 70 SCHIST 25 OTHER 5	147
100	50	20	20	20	100	ND	50	ND	ND		6	B	MD	M		CALCITE 5 SCHIST 50 QTZ-GR20 SEDS 10 GNST-OTHER15	148
500	50	20	20	20	100	ND	200	ND	ND		6	B	MD	F		GREEN SCHIST 40 QTZ-MONZ 20 SEDS 15 LS-GNST 25	149
500	50	20	20	50	100	ND	200	ND	ND		6	B	MD	M		GREEN ULTRAMAFIC 20 QTZ-GR 25 SCHIST 40 OTHER 15	150
200	50	20	10	20	100	ND	50	ND	ND		9	B	MD	M		SCHIST 40 MICA-SCHIST 20 QTZ-GR20 LS,GNST-OTHER20	151
200	50	20	20	20	100	ND	50	ND	ND		9	B	MD	M	SCH	CALCITE 5 SCHIST 50 MICA-SCHIST 20 QTZ-MONZ 20	152
200	20	20	20	20	100	ND	50	ND	ND		10	B	MD	M	LS	CALCITE 50 SCHIST 40 OTHER 10	153
100	50	20	20	20	100	ND	ND	ND	ND		10	B	LO	F		SCHIST 30 LIGHT IGNEOUS 35 CALCITE 10 QTZ-GR 25	154
100	50	20	20	20	100	ND	100	ND	ND		10	B	MD	M		SCHIST 40 GNST 20 QTZ-GR-MONZ 25 CALCITE 15	155
100	50	20	20	20	100	ND	100	ND	ND		10	B	MD	M		GR-QTZ 15 MICA-SCHIST 45 GNST 25 SEDS,LS 15	156
200	50	20	20	20	100	ND	100	ND	ND		6	B	MD	M		LARGE-QTZ MONZ 20 SCHIST 30 GNST 30 SEDS,OTHER 20	157
100	20	20	20	20	100	ND	100	ND	ND		6	B	MD	M		QTZ-GR 25 MICA-SCHIST 35 GNST 20 SEDS 20	158
200	20	20	20	20	100	ND	100	ND	ND		6	B	MD	M		SCHIST 65 QTZ-GR 15 GNST 15 SEDS-OTHER 5	159
100	20	20	20	20	100	ND	200	ND	ND		CR	B	MD	M		ONLY FINE SEDS PRESENT ?	160
200	ND	20	20	50	100	ND	500	5	ND		4	B	LO	F		ULTRAMAFC 20 SCHIST 40 SEDS,GNST,OTHER 40	161
200	20	20	20	20	100	ND	500	ND	ND		4	B	MD	M		GREEN SCHIST WITH ULTRAMAFICS	162
100	50	10	10	10	100	ND	1000	ND	ND		CR	B	LO	F		GREEN SCHIST 60 ULTRAMAFIC 20 OTHER 20	163
100	50	10	10	10	50	ND	500	ND	ND		CR	B	LO	F		GREEN SCH 35 GNST 30 SEDS 30 OTHER 5	164
100	20	20	20	20	100	ND	200	ND	ND		3	B	LO	F		GNST 40 ULTRAMAFIC 20 SCHIST 40	165
100	ND	20	20	10	100	ND	500	ND	ND		4	B	LO	F	LS	ULTRAMAFC 45 LS 30 SCHIST-OTHER 25	166
200	50	20	20	20	100	ND	50	ND	ND		6	B	MD	M		SCHIST 50 QTZ-MONZ 20 SEDS 25 GNST 5	167
100	50	10	20	20	100	ND	50	ND	ND		4	B	MD	M		SCHIST 50 QTZ-MONZ 20 SEDS 20 GNST 10	168
200	20	20	10	20	100	ND	100	ND	ND		10	B	MD	F	SCH	QTZ-GR 30 MICA-SCHIST 30 GNST 15 SEDS 15 MONZ 10	169
200	20	20	20	20	100	ND	100	ND	ND		10	B	MD	F		QTZ-MONZ 20 MICA-SCHIST 40 SEDS 20 GNST,LS 20	170
200	20	20	20	20	100	ND	50	ND	ND		CR	B	MD	M		QTZ-MONZ AND SCHIST	171
200	50	20	20	20	100	ND	50	ND	ND		8	B	MD	M	SCH	SCHIST 40 QTZ-MONZ 50 SEDS-GNST 10	172
200	20	20	20	20	100	ND	100	ND	ND		8	B	LO	F		BASIC QTZ MONZ-GR WITH LIGHT SCHIST SEDS,GNST	173
200	20	20	20	50	100	ND	100	ND	ND		8	B	LO	F		SCHIST 35 QTZ-GR 30 SEDS,GNST 35	174
200	20	20	20	20	100	ND	50	ND	ND		10	B	LO	F	SCH	SCHIST 35 QTZ-MONZ 55 LS,GNST,SEDS OTHER 10	175
100	20	10	20	10	100	ND	50	ND	ND		22	B	MD	F		ULTRMAFIC 20 QTZ-MONZ 20 BLACK SCHIST 40 GNST 20	176

STATE OF ALASKA

Keith H. Miller - Governor

DEPARTMENT OF NATURAL RESOURCES

Thomas E. Kelly - Commissioner

DIVISION OF MINES AND GEOLOGY

James A. Williams - Director

PRELIMINARY REPORT TO GEOCHEMICAL REPORT NO. 23

A GEOCHEMICAL INVESTIGATION IN THE EAGLE A-1 QUADRANGLE, FORTYMILE DISTRICT, ALASKA

By

R. R. Asher

College, Alaska

May, 1970

PRELIMINARY REPORT ON A GEOCHEMICAL INVESTIGATION IN THE EAGLE A-1 QUADRANGLE, FORTYMILE DISTRICT, ALASKA

By

R. R. Asher

INTRODUCTION

The following is a brief summary of a geological and geochemical investigation in the Southeast quarter of the Eagle A-1 Quadrangle, Alaska. This preliminary report was prepared because a geochemical anomaly was found in the area, and it is desired to get this information to the public before the beginning of the 1970 prospecting season. A regular Division report is in preparation which will be published in due course. Figure 1 is a sketch map showing sample locations and the location of anomalous samples; it does not conform to Division editing standards.

GEOLOGY

Quartzite, phyllite, graphite schist, muscovite schist, biotite schist, biotite gneiss and amphibolite are the main rock types in the region. The rocks are crumpled and distorted and faulting is common. Pyrite is a common constituent of the rocks throughout the area. In the southeastern part of the area an ultramafic body intrudes these metamorphic rocks. The geologic setting and lithology are similar to those at Anvil in the Yukon Territory.

On the ridge separating Camp Creek and Brophy Creek (figure 1) a gossan is developed in quartz-muscovite schist. Sulphide casts and limonite are abundant in the debris that mantles the slope. The gossan covers an area about 2500 feet by 1500 feet.

GEOCHEMISTRY

Stream sediment samples are anomalous in lead and zinc in both Camp Creek and Brophy Creek downstream from the gossan zone. Because of the gossan and the anomalous samples it is thought that the area should be examined carefully.

Samples were analyzed by atomic absorption and by emission spectrograph. The emission spectrograph gave results for 30 elements but only atomic absorption copper, lead and zinc are presented in this preliminary report. In general the results from the separate methods correlate well.

Anomalous and threshold values for stream sediment samples were calculated by methods described in Hawkes and Webb, (1962, p. 30). The threshold is taken as the average plus two standard deviations and the anomalous value as the average plus three standard deviations. Table I shows the calculated threshold and anomalous values for copper, lead and zinc. Table II shows the value in parts per million for individual anomalous or threshold samples.

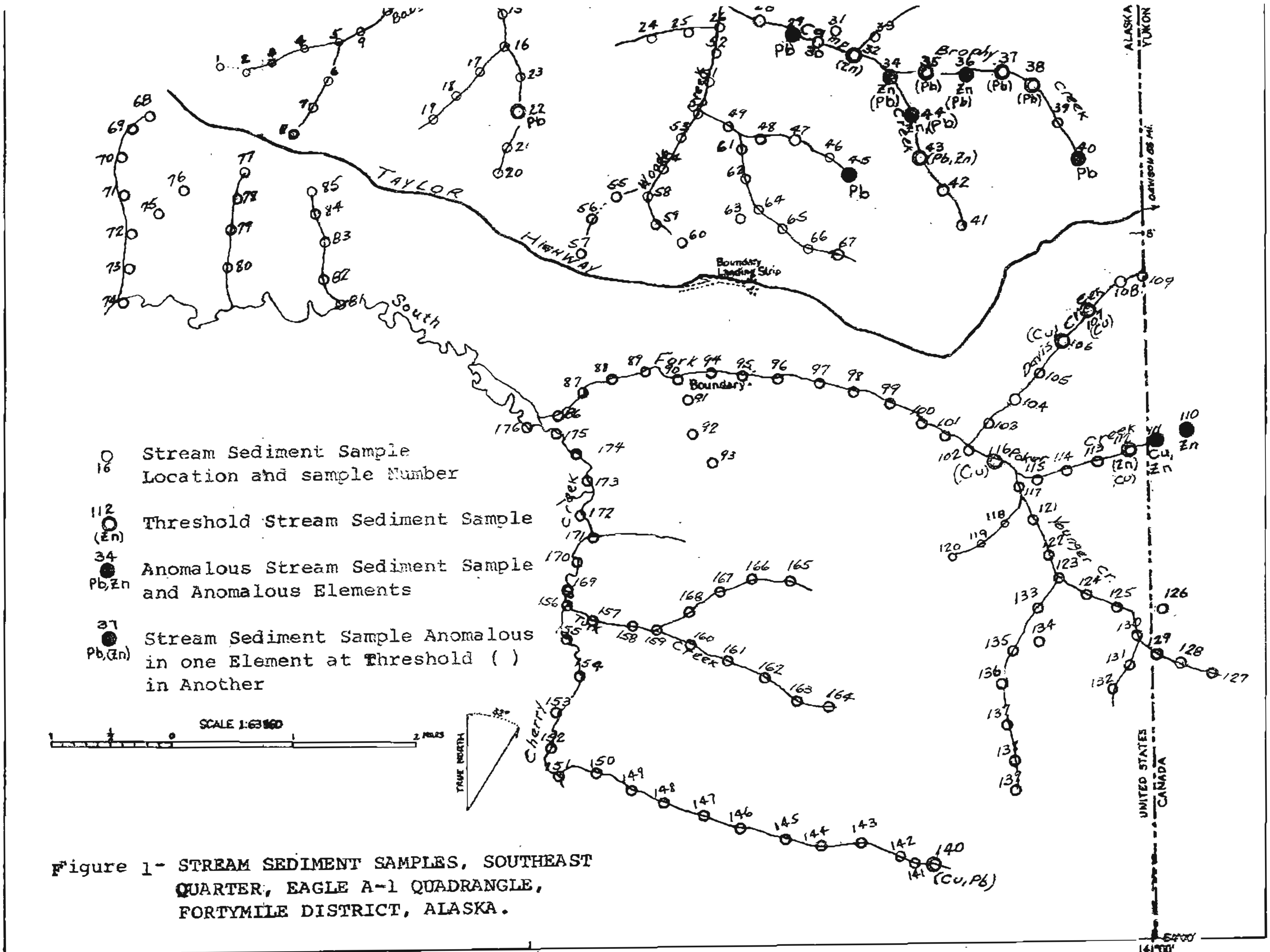

Figure 1- STREAM SEDIMENT SAMPLES, SOUTHEAST QUARTER, EAGLE A-1 QUADRANGLE, FORTYMILE DISTRICT, ALASKA.

Table I

Calculated Threshold and Anomalous Values for Copper, Lead and Zinc in Parts Per Million. Southeast Quarter, Eagle A-1 Quadrangle, Alaska.

	Atomic Absorption			
	Average	Standard Deviation	Threshold	Anomalous
Copper	30.65	16.58	63.81	80.39
Lead	18.75	7.92	34.59	42.51
Zinc	116.70	85.46	287.62	373.08

Table II

List of Anomalous and Threshold Samples, Copper, Lead and Zinc in Parts Per Million. Southeast Quarter, Eagle A-1 Quadrangle, Alaska.

Sample No.	Atomic Absorption		
	Copper	Lead	Zinc
22	20	40	95
29	45	45	250
32	30	30	335
34	35	45	600
35	35	40	285
36	45	40	370
37	35	40	195
38	35	40	230
40	45	55	180
43	30	35	150
44	40	40	530
45	30	45	95
106	75	15	140
107	75	20	190
110	50	30	550
111	180	30	450
112	75	20	365
116	65	30	150
140	85	35	270