DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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FOLIO OF THE AMBLER RIVER QUADRANGLE, ALASKA
MAYFIELD-GRYBECK MINERAL OCCURRENCES AND RESOURCES MAP

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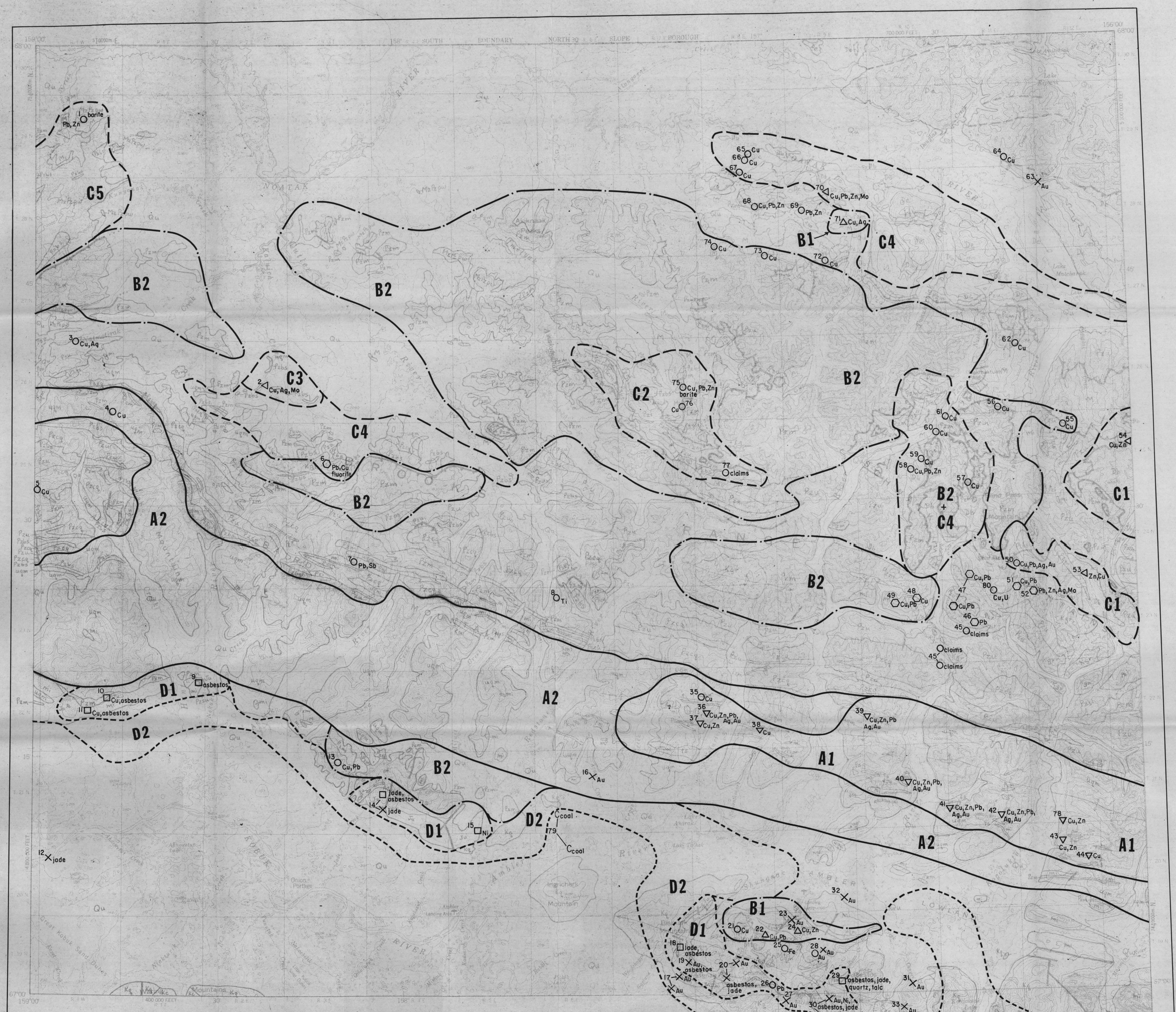
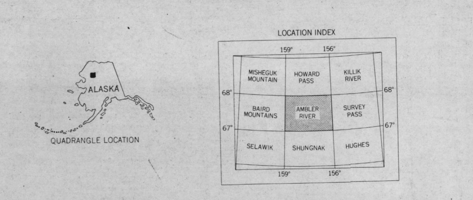


BASE BY U.S. GEOLOGICAL SURVEY, 1956

SCALE 1:250 000

CONTOUR INTERVAL 200 FEET
DATUM IS MEAN SEA LEVEL

This report is preliminary and has not been edited or reviewed for conformity with Geological Survey standards and nomenclature.


LOCATION INDEX
QUADRANGLE LOCATION

EXPLANATION FOR MINERAL RESOURCE MAP

Types of mineral deposits and occurrences

- ▽ (e.g. 43 Cu,Zn) Stratabound volcanogenic sulfide deposits
- △ Stratabound sulfide deposits in carbonate breccia zones
- ◁ Stratabound pyrite deposits in black siliceous phyllite or semischist having base metal geochemical anomalies
- □ Minerals associated with serpentinized ultramafic rocks occurring in podform masses, veins, contact deposits, or disseminations
- ○ Minerals occurring in veins or along shear zones and fractures
- ⬡ Minerals occurring in contact metamorphic aureoles at or near granite contacts in veins, skarns, shear zones, or fractures
- × Placer deposits, mainly gold and jade
- C Coal occurrences

Number next to deposit symbol corresponds to map no. given in the accompanying descriptive table entitled "MINERAL OCCURRENCES OF THE AMBLER RIVER QUADRANGLE".

Chemical or mineral symbols at numbered locations indicate principal commodities of interest.

FAVORABLE MINERAL RESOURCE AREAS

Map Area* Symbols

Stratabound volcanogenic Cu-Zn-Pb sulfide deposits

A1 — Favorable terrane with highest potential for discovery of new deposits or additional reserves.
(Criteria used to define area)
a. Known mineral deposits
b. Close spacial association of sulfides with felsic schist (rhyolite to dacite composition)
c. Base metal stream sediment geochemical anomalies
d. Linear belt of pelitic and graphitic schists
e. Mineralogy similar to other volcanogenic deposits found throughout the world
f. Stratabound and lenticular character of sulfide mineral concentrations

A2 — Favorable terrane with lower potential for discovery of new deposits.
(Criteria used to define area)
a. Same linear belt of pelitic and graphitic schists as map area A1 except for an absence of known felsic schist.
b. Stratigraphic horizon similar to map area A1

Stratabound Cu-Zn sulfide deposits in carbonate breccia

B1 — Favorable terrane with highest potential for discovery of new deposits or additional reserves.
(Criteria used to define area)
a. Known mineral deposits or mineral occurrences
b. Stream sediment, soil, or rock geochemical anomalies
c. Gossan zones
d. Dolomite breccia

B2 — Favorable terrane with lower potential for discovery of new deposits.
(Criteria used to define area)
a. Outcrops containing rocks of similar lithology and age as host rocks of known mineral deposits

Stratabound pyrite deposits in black siliceous phyllite having Zn-Cu geochemical anomalies

C1 — Favorable terrane with highest potential for discovery of new deposits.
(Criteria used to define area)
a. Stream gravels stained red from iron oxides
b. Thin pyrite layers parallel bedding
c. Base metal stream sediment geochemical anomalies
d. High sulfate content of host phyllite
e. High carbon content of host phyllite

C2, C3, C4, C5 — Favorable terrane with lower potential for discovery of new deposits.
(Criteria used to define area)
a. Zn geochemical anomalies (C2)
b. High pyrite content of phyllite (C3)
c. High sulfate content of phyllite (C2,C4)
d. High carbon content of phyllite (C2,C3,C4, C5)

Podform chromite, asbestos vein, and contact jade deposits

D1 — Favorable terrane with highest potential for discovery of new deposits or additional reserves.
(Criteria used to define area)
a. Serpentinized ultramafic host rock
b. Visible chromite, jade, or asbestos minerals in outcrop or stream float
c. Anomalous stream sediment or pan concentrate samples
d. Aeromagnetic anomalies

D2 — Favorable terrane with lower potential for discovery of new deposits.
(Criteria used to define area)
a. Serpentinite or ultramafic host rock
b. Aeromagnetic anomalies

*Footnote to resource map area symbols
Letter symbols identify terrane favorable for a corresponding mineral deposit type. Numbers following letter symbols identify potential of terrane (1=highest potential). Delineated areas are generalized and may enclose small areas that are unfavorable for discovery of the specific deposit type shown.

EXPLANATION FOR GENERALIZED GEOLOGIC MAP

CORRELATION OF MAP UNITS

SURFICIAL DEPOSITS: Qu — QUATERNARY
SEDIMENTARY AND METASEDIMENTARY ROCKS: Kq, Kc — CRETACEOUS; Unconformity; M — MISSISSIPPIAN; Unconformity; De, Db — DEVONIAN; Pzm — DEVONIAN AND OLDER
METASEDIMENTARY ROCKS OF UNCERTAIN AGE: MzPzpw — MESOZOIC OR PALEOZOIC; Pzcq, Pzbs, Pzu — PALEOZOIC; pCgm — PALEOZOIC AND OLDER (?)
IGNEOUS AND META-IGNEOUS ROCKS: Kgr — CRETACEOUS; Ju — JURASSIC; mi, fs, Pzi — MESOZOIC AND/OR PALEOZOIC

DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS
- Qu — UNCONSOLIDATED SURFICIAL DEPOSITS (QUATERNARY)

SEDIMENTARY AND METASEDIMENTARY ROCKS
- Kq — QUARTZ CONGLOMERATE, SANDSTONE, AND MUDSTONE (CRETACEOUS)
- Kc — IGNEOUS PEBBLE-COBBLE CONGLOMERATE (CRETACEOUS)
- M — LISBURNE GROUP AND UPPER PART OF ENDICOTT GROUP (MISSISSIPPIAN)—INCLUDES KAYAK SHALE AND KEKIKTUK CONGLOMERATE
- De — LOWER PART OF ENDICOTT GROUP (DEVONIAN)—MAINLY SLATE AND SANDSTONE
- Db — DARK CALCAREOUS SCHIST, LIMESTONE, AND SILICEOUS PHYLLITE (DEVONIAN)
- Pzm — LIMESTONE AND MARBLE (DEVONIAN AND OLDER)

METASEDIMENTARY ROCKS OF UNCERTAIN AGE
- MzPzpw — PHYLLITE AND MAFIC VOLCANIC WACKE (MESOZOIC OR PALEOZOIC)
- Pzcq — CHLORITIC QUARTZITE AND SCHIST (PALEOZOIC)—LOCALLY INCLUDES FELDSPATHIC ORTHOGNEISS
- Pzbs — GRAPHITIC PHYLLITE AND SCHIST (PALEOZOIC)
- Pzu — UNDIFFERENTIATED METAMORPHIC ROCKS (PALEOZOIC)—INCLUDES MARBLE, QUARTZITE, CALC-SCHIST, AND LESSER QUARTZ-MICA SCHIST
- pCgm — GRAY PHYLLITE AND QUARTZ-MICA SCHIST (PALEOZOIC AND OLDER(?))

IGNEOUS AND META-IGNEOUS ROCKS
- Kgr — META-GRANITIC PLUTONIC ROCKS (CRETACEOUS)
- Ju — ULTRAMAFIC ROCKS AND SERPENTINITE (JURASSIC)
- mi — BASALT, DIABASE, AND GREENSTONE (MESOZOIC AND/OR PALEOZOIC)
- fs — FELSIC SCHIST (MESOZOIC AND/OR PALEOZOIC) MAY BE, IN PART, VOLCANIC
- Pzi — INTERMEDIATE META-IGNEOUS ROCKS (MESOZOIC AND/OR PALEOZOIC) MAY BE PLUTONIC AND (OR) VOLCANIC, MOSTLY GRANODIORITE OR DIORITE IN COMPOSITION

LITHOLOGIC CONTACT, dashed where uncertain
HIGH ANGLE FAULT, dashed where uncertain, dotted where concealed
THRUST FAULT, dotted where concealed

ACKNOWLEDGEMENTS

Study of the geology and mineral resources of the Ambler River quadrangle is a cooperative effort between the U.S. Geological Survey and the Alaska Division of Geological and Geophysical Surveys. Special thanks are given to Irv Tailleur of the U.S. Geological Survey for making available his unpublished records and firsthand knowledge of the geology of the mineral occurrences in the Ambler River quadrangle. The following geologists have contributed to the compilation of the list of mineral occurrences by making available their notes and field samples: from the U.S. Geological Survey - W. P. Brosgé, W. W. Patton, and I. L. Tailleur, and from the Alaska Division of Geological and Geophysical Surveys - G. R. Eakins, C. E. Fritts, R. E. Garland, G. H. Pessel, and M. A. Wiltse. The following companies graciously provided information and helpful discussion: the Anaconda Mining Company, Bear Creek Mining Company, Noranda Exploration, Inc., and WGM Inc. D.A. Singer and W.D. Menzie assisted with the statistics related to estimates of undiscovered volcanogenic deposits.

INTRODUCTION

This section is intended to provide the reader with a list of the potentially important mineral commodities in the Ambler River quadrangle and to describe how each commodity occurs, where it occurs, and if possible, its resource potential.

The term mineral "deposit" is used in this report to indicate a resource with enough potential to encourage exploration. The term mineral "occurrence" is used to indicate a source of minerals of unknown potential or small size.

HISTORY

The Ambler River quadrangle has had a limited history of mineral resource exploitation. The first prospecting in the area was done by the gold seekers at the turn of the century. Gold was located in placer deposits in the Cosmos Hills and mined intermittently for the next 50 to 60 years. This is the principal commodity that has been mined from the area. During the prospecting activity brought on by the gold rush, other commodities such as asbestos, jade, and numerous base metal occurrences were reported. Several asbestos deposits were evaluated and a few tons were mined for testing purposes at the Ing-Ihk Mine when shortages developed near the end of World War II. Most of Alaska's jade has come from deposits located within the quadrangle. These deposits have continued to support small scale mining operations for the last 25 to 30 years. There has been a great amount of interest in the exploration of copper since the discovery of large high grade breccia deposits at Ruby Creek (24) in 1956 and the volcanogenic deposit at Arctic Camp (42) in 1965. Subsequently there have been additional encouraging discoveries of volcanogenic deposits which are not fully explored. Mining of these deposits has not yet begun, but preliminary reserve estimates at the largest known deposit, Arctic Camp, are approximately 30 million metric tons of +10 percent combined Cu, Zn, Pb, Ag.

METALLIC MINERAL RESOURCES

Chromium

Small podiform concentrations of chromite are likely to be found in serpentinized ultramafic rocks along the southern edge of the Brooks Range, but there is thus far little indication of large high grade deposits. Chromium is found in stream sediment geochemical samples from streams draining ultramafic rocks along the southeast side of the Jade Mountains (Ellersieck, 1978f). Small amounts of chromite have also been found in concentrates from the gold placers on Dahl Creek (30) where some specimens of chromite reach .5 m in diameter and are probably from the weathering of serpentinite outcrops upstream. Rapid rock analysis of the Cr and Fe content from two samples collected at Dahl Creek are given below:

Field no.	% Cr_2O_3	Total Fe as % FeO	% SiO_2	Cr/Fe ratio
55ATr106a	46.4	21.3	3.3	1.92
55ATr106b	41.2	15.1	6.9	2.41

Copper

Copper is the most important resource in the quadrangle. It is found in six types of occurrences: 1) volcanogenic sulfide deposits; 2) sulfide deposits in carbonate breccia zones; 3) untested geochemical anomalies from pyritic black phyllites; 4) occurrences associated with serpentinized ultramafic rocks; 5) veins, shear zones, and fracture coatings in metasediments, and 6) disseminations at granitic contacts.

Volcanogenic type

Stratabound copper deposits closely associated with felsic schist have the greatest economic potential. The felsic schists are believed to be derived from rhyolitic domes and volcaniclastic piles that have been regionally metamorphosed in the Cretaceous (Wiltse, 1975; Sichermann and others, 1976; Smith and others, 1977). Little detailed information is available about the size and grade of most of the deposits, but from what is publicly known copper and zinc are the most important metal commodities. There are also recoverable amounts of lead and silver. At the largest known deposit at Arctic Camp (42), sulfides occur in echelon on different foliation planes which are mostly parallel to the metamorphic foliation, which is also considered to be parallel to original bedding (Wiltse, 1975). Zones of sulfide minerals are sometimes found in repetitive cycles, but may sometimes be caused by shear fractures and isoclinal folds. The most abundant sulfides are pyrite, sphalerite, and chalcopyrite.

The deposits occur in a belt 5 to 10 km wide following the regional strike of the foliation extending from Cross Creek east 110 km to the Reed River in the Survey Pass quadrangle. Further to the west the country rocks consist of pelitic schist which is lithologically similar to those rocks in areas where deposits have been found except for the absence of felsic schist. Although no volcanogenic deposits have been identified west of Cross Creek, this area seems worthy of future detailed exploration. East of Cross Creek, within the zone of known felsic schist, the potential for future discoveries of large high grade base metal deposits is considered high.

The base metal resources of the volcanogenic deposits in the Brooks Range are difficult to precisely assess, because this is a previously unexplored area and only recent discoveries have been made. However, a rough approximation of the total Cu, Zn, Pb, Ag volcanogenic resources in the quadrangle can be made by estimating the number, grade, and tonnage of the deposits based upon available exploration data from private companies, favorable host rocks, and geochemical anomalies.

There are 9 known volcanogenic deposits (36-45) in the quadrangle. One of the deposits has published reserves and the other 8 are of unknown size and grade. It is likely that there are more deposits yet to be discovered. Using Cu, Zn, Pb, and Ag stream sediment geochemical anomalies (Ellersieck, 1978b,c,e) from streams draining areas of favorable geology with no known deposits, a subjective probability for the number of as yet undiscovered deposits at or near the surface is given below:

90% chance that there are 7 or more undiscovered deposits

50% chance that there are 10 or more undiscovered deposits

10% chance that there are 12 or more undiscovered deposits

In arriving at the probability estimates, it is assumed that a geochemical anomaly or group of anomalies located in a favorable geologic setting can be used to indicate the likelihood of a deposit upstream. Multiple metal anomalies or particularly high anomalies from a sample site were judged to give a better chance of a deposit upstream than smaller ones. Estimates of the numbers of undiscovered deposits may be too low, because the stream sediment geochemical samples do not quite cover all the areas of favorable geology, and single samples occasionally fail to give indication of deposits that are known to exist upstream.

The only volcanogenic deposit which has received detailed exploration and with tonnage and grade figures that have been made public is the Arctic deposit (42). It is estimated to have 27 to 32 million metric tons (30 to 35 million short tons) of 4% Cu, 5.5% Zn, 1% Pb, and 51.4 g/ton Ag (1.5 oz/short ton) (Sichermann and others, 1976). Reported grades from drill samples at the Smucker prospect (36) have indicated 3-8% Zn, 1.2-1.6% Pb, and from 69 to 514 g/ton Ag (2 to 15 oz/short ton); copper values have not been released (Petroleum Information, 1978). The average grade of 67 deposits of phanerozoic age from Canadian volcanogenic deposits is approximately 1.2% Cu, 3.4% Zn, 1% Pb (Sangster, 1977). Using the data above, it seems likely that the grade of the Brooks Range volcanogenic deposits falls between 6 to 10% combined Cu, Zn, Pb. The Canadian study further suggests that there is a tendency toward an inverse relationship between the grade of Cu and Pb, a direct relationship between the grade of Zn and Pb, and no relationship between the grade of Zn and Cu in this type of deposit.

A rough estimate of the tonnage of deposits of unknown size can be also made using the data compiled from Canadian volcanogenic deposits of phanerozoic age (Sangster, 1977). It is suspected that most occurrences which are too small to be of economic interest are not included in the Canadian data, which may make the following tonnage estimates slightly high.

95% chance a deposit will be greater than 200,000 metric tons

55% chance a deposit will be greater than 1,000,000 metric tons

12% chance a deposit will be greater than 10,000,000 metric tons

<2% chance a deposit will be greater than 100,000,000 metric tons

Carbonate breccia type

A significant stratabound sulfide deposit in carbonate breccia is located on Ruby Creek (24) in the Cosmos Hills. The deposit is both structurally and stratigraphically controlled to a host rock of Devonian dolomite and limestone interlayered with calcareous phyllite. Sulfide minerals fill open spaces and occur as replacement bodies in brecciated carbonate rocks. Mineralized zones generally have their greatest dimension parallel to bedding. Wall rocks typically do not show alteration. The most common sulfide minerals are pyrite, chalcopyrite, bornite, and sphalerite. Known reserves have not been made public.

The origin of the Ruby Creek deposit is speculative. Sulfur isotope studies by Runnels (1964) suggest that it is of magmatic hydrothermal origin. He thought that the copper may have come from nearby mafic intrusive rocks. Fritts (1970) believed the deposit is allochthonous and related to the solutions responsible for serpentinization of mafic rocks in the Cosmos Hills. The similarity of metals at Ruby Creek (24) and the Arctic deposit (42) also suggests a possible similar origin. Magmatic solutions from granitic rocks underlying the Cosmos Hills dome may also have been responsible for the concentration of metals at Ruby Creek.

Since the origin of the Ruby Creek deposit is not clearly understood, it is difficult to predict the likelihood that other similar deposits will be found in the quadrangle. Areas with outcrops of similar lithology and age are regarded as being the most favorable terrane for this type of deposit. Mapped units having these characteristics include the Baird Group and Skajit Limestone (mapped as unit Pzm) which crop out on the south side and in the northern half of the metamorphic belt.

Black pyritic phyllite type

Stratabound pyrite zones occurring in black carbonaceous phyllite along the eastern edge of the quadrangle in places contain moderately high geochemical anomalies in both copper and zinc. At the headwaters of the Igning and Kogoluktuk River valleys some stream gravels are stained red from iron oxides, and the adjacent phyllite contains abundant thin pyritic lenses less than 2 cm thick parallel to foliation. Geochemical stream sediment anomalies of up to 290 ppm copper and 1100 ppm zinc come from some of these areas (Ellersieck, 1978b,c). No copper or zinc minerals have been found in outcrop, but the geochemical anomalies and the textures of pyrite in the host rock suggest that copper and zinc may be finely disseminated within the carbonaceous phyllite.

The rock unit in which these anomalies occur consists of black siliceous phyllite, black calcareous schist, and dark gray limestone. One distinctive characteristic of the calcareous part of this unit is best seen on steep well exposed slopes where leaching and reprecipitation by ground water action commonly develops a white surficial precipitate crust composed of dolomite, epsomite (hydrated magnesium sulfate) and hexahydrite (hydrated magnesium zinc iron sulfate). Because of the carbonaceous appearance and stratigraphic extent of the host rocks, the sulfur is probably of sedimentary origin. Sulfide mineral occurrences are not as widespread as sulfate minerals; however, sporadic geochemical anomalies from stratabound pyrite zones can be traced along strike for a distance of more than 3 km west of the Igning River (54) and over several kilometers at the head of the Kogoluktuk River (53). These areas probably have not been closely prospected. This stratigraphic zone may have potential for sizeable base metal deposits because of the large size of the anomalous areas and the apparent stratabound nature of the occurrences.

Occurrences associated with serpentinized ultramafic rock

Small amounts of copper occur as both stains on fracture surfaces and as disseminated chalcopyrite in mafic igneous rock near serpentinite outcrops west of the Hunt River (10, 11). The copper occurrences are thought to be related to the emplacement of serpentinite and probably do not represent an exploitable resource.

Vein type occurrences

Veins, shear zones, and fracture coatings containing copper minerals are found in many areas, throughout the quadrangle. Mineralized veins and shear zones are usually less than 1 m thick and less than a few meters in strike length. Copper occurrences are also present at many places near the contact of the Skajit Limestone and overlying Kekiktuk Conglomerate. The significance of this stratigraphic horizon for possible mineral deposits is not known, but the known mineral occurrences appear to be small. Vein type occurrences are probably formed from hydrothermal solutions of igneous or metamorphic origin.

Disseminations at granitic contacts

Small amounts of disseminated copper minerals occur near the contacts of a granitic pluton at the head of Kaluich Creek (6). Copper is found with galena, sphalerite, and fluorite. Small skarn zones are also common at many granitic contacts throughout the central part of the quadrangle, but their copper content appears to be negligible.

Gold

Historically gold has been the most important commodity produced from the quadrangle. Placer gold was first discovered on the lower Shungnak River in 1898. For the next 16 years there was steady activity on some of the most productive streams in the Cosmos Hills. Intermittent mining activity continued from 1915 to 1961. There were three important producing streams: the Shungnak River (17, 19), Dahl Creek (30), and California Creek (34). Small operations with minor production were located on Lynx and Riley Creeks. Other streams with reported low grade finds and insignificant production are Bismark Creek (17), Cosmos Creek (20), Wesley Creek (27), Ruby Creek (24), Jay Creek (23), Pearl Creek (32), and Canyon Creek (31). Total production figures are not available, but isolated estimates (Brooks, 1907, Smith, 1913, and Fritts, 1970) indicate the region has probably produced between 460 and 1200 kg (15,000-40,000 troy oz.) of gold with the lower figure probably being more accurate.

Gold placer potential in the Cosmos Hills is considered to be low. Most of the gold comes from stream gravels older than the last glacial stage. Pay streaks of rough coarse gold are commonly buried by many feet of barren gravel and are considered to be on or near the source. Placer streams are small and narrow. As a result, they lack large quantities of untested promising gravel. It is unlikely that gold produced in the future from the Cosmos Hills will exceed what has already been produced there.

Midas Creek (63) and Agnes Creek (16) are two other streams outside the Cosmos Hills where gold has been reported. At Midas Creek the gold is sparse, in fine particles, and well worn. The bedrock of upper Midas Creek does not appear to be auriferous, and gold may have come from glacial gravel derived from the Noatak Valley. It is doubtful that this creek has any significant production or potential. Little is known about the placer gold occurrence on Agnes Creek except that the work done was more in the nature of prospecting than mining. The country rock from the vicinity of Agnes Creek is lithologically similar to that in the Cosmos Hills, and for this reason other small occurrences of gold may be present in some of the streams draining the south side of the Baird Mountains.

Little if any mining of lode gold has taken place. The ridge between Dahl and Riley Creeks has low grade disseminated gold in small milky quartz veins within phyllitic schist, and these have yielded insignificant amounts of gold (Smith and Eakin, 1911; Smith, 1913; Reed, 1931; Fritts, 1970). Reports of coarse angular gold come from most producing streams in the Cosmos Hills, and it is likely that the source is within nearby quartz veins; however, there has been little or no attempt at mining them.

The resource potential for gold in the quadrangle probably depends most upon its concentration in volcanogenic deposits and the carbonate breccia deposit at Ruby Creek (24). Although the concentration of gold appears to be low, its presence in these base metal ores could have significant by-product value.

Iron

Iron probably does not occur in exploitable quantities in the quadrangle. The highest concentrations of iron occur in the mineral pyrite (FeS_2) found in the base metal deposits at Ruby Creek (24) and the volcanogenic deposits. However, because of the relatively small quantity involved and high cost of extraction, this resource will be unprofitable in the foreseeable future. Magnetite (Fe_3O_4) occurs as small bodies near limestone/schist contacts in the vicinity of Iron Mountain in the Cosmos Hills (25), but the surface expression of these deposits does not appear to be large. Magnetite is also the most common accessory mineral in mafic igneous and metamorphic rocks. Pervasive dissemination of magnetite in ultramafic rocks gives strong regional aeromagnetic expression.

Lead

The most important concentrations of lead occur as galena (PbS) in volcanogenic copper-zinc deposits (35-44) and the carbonate breccia deposit at Ruby Creek (24). In these deposits lead will constitute an important by-product. Average grades of 1 to 1.5% Pb can be expected in volcanogenic deposits based upon tested sulfides in drill samples from the quadrangle and from grades of similar types of deposits in Canada (see section on volcanogenic copper). Galena also commonly occurs in many scattered vein deposits and near some granitic contacts (46-51) where it is commonly associated with copper minerals. Known amounts of lead minerals from these areas are believed to be small.

Molybdenum

Molybdenum minerals are not common in the quadrangle. Small amounts of molybdenite (MoS_2) have been found in granite near a schist contact in the vicinity of Shishakshinovik Pass (52), and there are also high molybdenum geochemical anomalies from granite contacts at the headwaters of Kaluich Creek (6). These occurrences appear to be of limited extent and grade and were probably caused by granitic intrusion.

Nickel

Nickel is a minor constituent of serpentinized ultramafic rock cropping out along the south side of the Brooks Range. Samples taken near the Lower Ambler River are reported to contain garnierite (hydrated nickel magnesium silicate) or a related mineral (15), and small amounts of nickel are reported from the Dahl Creek area (30) (Anderson, 1945). There is little evidence for a deposit of economic significance, and the nickel mainly occurs in amounts consistent with its normal geochemical background in these rocks.

Silver

Significant amounts of silver occur in both the brecciated carbonate deposit at Ruby Creek (24) and the volcanogenic deposits. Grades of 51.4 to 514 g/ton Ag (1.5 to 15 oz/short ton) can be expected from volcanogenic deposits based upon tested sulfides reported from drill samples in the quadrangle (see section on volcanogenic copper). Small amounts of native silver have also been found in placer concentrates from the Shungnak River (17) and Dahl Creek areas (30) where it was probably derived from nearby auriferous quartz veins. A high proportion of stream sediment geochemical samples have anomalous values of .5-5 ppm silver in the volcanogenic copper belt. In the north half of the metamorphic belt, stream sediments having silver values of 1-3 ppm are concentrated around some of the granitic plutons and from pyritic carbonaceous shale on Kaluich Creek (Ellersieck, 1978e).

Tin

The tin mineral, cassiterite (SnO_2) probably is locally disseminated in or near plutonic granitic rocks in the central part of the quadrangle. Some stream sediment samples from streams draining granitic rocks in the area of Shishakshinovik Pass give values of 15-50 ppm Sn and in the headwaters of Kaluich Creek give values of 15-50 ppm (Ellersieck, 1978d). Granite intrusives are of the type which are commonly associated with tin deposits. High concentrations of fluorine and boron minerals are also considered to be favorable indicators of tin enrichment. However, except for a zone of disseminated fluorite (CaF_2) which occurs on the northeast side of the pluton at the head of Kaluich Creek, concentrations of other indicator minerals such as tourmaline, topaz and certain beryllium minerals have not been observed. Although tin deposits have not been found in bedrock, it is probable that at least some cassiterite exists in veins, but from the available evidence, prediction of the amount of tin in veins and disseminations is not possible.

Titanium

Titanium minerals are widely disseminated but not in economic concentrations. Although sphene $CaTiO(SiO_4)$ and, to a lesser extent, rutile (TiO_2) commonly occur as accessory minerals in most metamorphosed mafic igneous rocks in the quadrangle, there are probably no significant concentrations of these minerals. Ilmenite ($FeTiO_3$) occurs more rarely as an accessory mineral in mafic rocks and also occurs in a small quartz vein cutting orthogneiss at the headwaters of the Cutler River (8).

Tungsten

Tungsten minerals are rare in the quadrangle. A small amount of scheelite ($CaWO_4$) is reported to have been found in placer concentrates in the Cosmos Hills (Anderson, 1947); elsewhere, it has not been reported. The occurrence of skarn near granitic plutonic rocks in the central part of the metamorphic belt suggests the possibility that tungsten minerals may be present there, but none have yet been found.

Vanadium

Black carbonaceous phyllite (lithologic units Pzbs or Db) in the northern half of the quadrangle locally contains high geochemical values in vanadium. Selected rock and stream sediment samples contain 1000-2000 ppm V (Ellersieck, 1978a).

Zinc

Zinc is one of the most important metal commodities in the quadrangle. The greatest concentrations of zinc occur as the mineral sphalerite (ZnS) in volcanogenic copper-zinc rich deposits in the southeastern part of the schist belt (36-43). Average grades of 3 to 8% Zn can be expected in volcanogenic deposits based upon tested sulfides reported from drill samples in the quadrangle and from grades of similar types of deposits in Canada (see section on volcanogenic copper). Sphalerite also has significant by-product value at the copper deposit at Ruby Creek (24) where reserves have not been made public. Minor occurrences of sphalerite are also found in vein deposits in the northern half of the map area (1,52,68,69,75). A few high geochemical anomalies have been detected from some streams draining pyritiferous black phyllite (see discussion of copper) in the east central part of the quadrangle (53,54). These anomalous areas are untested but the relationship of zinc and other metals to black phyllite has similarites to significant stratabound base metal occurrences found in the Selwyn Basin of the Canadian Cordillera.

NONMETALLIC MINERAL RESOURCES

Asbestos

The term asbestos is used for a variety of minerals of fibrous structure which have resistance to heat, tensile strength, and flexibility of the fibers. Tremolite and chrysotile are the principal asbestos minerals in the quadrangle. They occur in either the cross-fiber type, with the fibrous crystals elongate perpendicular to the sides of the vein; or the slip-fiber type, with the fibers aligned parallel to the sides of the vein or shear surface.

Known asbestos deposits are low grade, and unless larger, higher grade deposits can be discovered, the remoteness of the area gives this resource low potential for profitable mining in the near future. The U.S. Bureau of Mines sampled and tested two of the most promising outcrops of asbestos in the Cosmos Hills from 1944-1946 (Heide and others, 1949). One of these areas is on the south side of Bismark Mountain (18) and the other is on the west side of Cosmos Creek (20). Trenching at both localities discovered low grade networks of asbestos in veins less than 3 cm wide cross cutting serpentinite. Another fibrous mineral called nemalite (iron magnesium oxide), a ferroan variety of brucite, commonly occurs at the Bismark Mountain locality. Between 1944 and 1945 there was an unsuccessful attempt at mining asbestos from the Ing-Ihk Mine on Asbestos Mountain (29). Here the asbestos minerals mostly consist of slip-fiber tremolite. Development consisted of surface trenching and a 76 meter adit designed to intersect projected surface veins at 20 meters depth, but failed to disclose promising amounts of asbestos. A total of 47 tons of mostly tremolitic asbestos was mined and shipped for testing purposes from this location.

Local asbestos veinlets are found in most of the serpentinites cropping out along the south edge of the mountain front. In the Cosmos Hills widely spaced veinlets occur in serpentinites from the Kogoluktuk to the Shungnak Valleys. In the Jade Mountains veinlets of fibrous tremolite and chrysotile in serpentinite occur more rarely. Serpentinite outcrops located in the area where the Hunt River flows into the Kobuk Valley (9,10,11) also have small amounts of tremolite asbestos in surface float.

Results of tests conducted by the U.S. Bureau of Mines (Heide, and others, 1949) indicate that in comparison to Canadian ores, asbestos from the Cosmos Hills is characterized by: 1) very closely matted fiber; 2) unusually high dust or fines content; 3) high loose density; 4) short staple length; and 5) a fast rate of filterability. Asbestos with these characteristics is unsuitable for spinnable grade material, but has the possibility of being used as a filter medium because of the ease at which water passes through the finer sizes.

Barite

The known occurrences of barite ($BaSO_4$) are small and scattered. Single isolated barite veins in marble or phyllite occur at two widely separated localities (1, 75) in the quadrangle. These veins have small amounts of Cu, Pb, or Zn minerals. Barium also has local geochmically high concentrations in stream sediments apparently coming from black carbonaceous phyllite in the northern half of the quadrangle (Ellersieck, 1978e).

Carbonate Rocks

Large quantities of partly marbleized limestone and to a lesser extent dolomite are found in many localities throughout the quadrangle. The largest deposits of carbonate rock occur in the Skajit Limestone on the south edge of the Noatak Valley, the Baird Group in the Cosmos Hills to Jade Mountains trend (both part of map unit Pzm), and in the marble and quartzite unit of the central metamorphic belt (part of map unit Pzu). This resource has low value outside of the immediate area.

Jade

Almost all of Alaska's jade production has come from the quadrangle. Alaskan jade mining cannot be considered a large industry, but for the past 15 to 20 years there has been a steady demand which has supported a one and and a two man summer operation on the claims in the Jade Mountains and Cosmos Hills. The jade that is mined is composed of the mineral nephrite (calcium magnesium iron amphibole).

The desirability of a single piece of jade can vary widely depending upon the amount of impurities, degree of foliation, density of fractures and color of a particular sample. Most nephrite shipped from the mined areas is dark green and contains small black inclusions, usually magnetite, giving most specimens a moderate quality. There are often varying amounts of fractures which lower the grade. The most highly valued nephrite has been found in small quantities from the lower Shungnak River (17, 19) and in the Jade Mountains (14). It is light apple green and has a minimum of impurities.

Most of the jade has come from placer deposits on Jade Creek (14), Dahl Creek (30), and the Shungnak River (17, 19). Large boulders of nephrite weighing several tons are visible as accumulations near serpentinite in the Jade Mountains and on the west bank of the Shungnak River. There appears to be enough reserves at these locations to support continued mining for many years to come. Small quantities of nephrite also crop out on Wesley Creek (27) and on Asbestos Mountain (29).

Sand, Gravel, and Rock Talus

Large quantities of sand, gravel, and broken rock exist in the quadrangle. Because few if any of the lowland areas have escaped the effects of glaciation, outwash and gravel exist on all the major streams in the mountains. These deposits coalesce and cover much of the lowland areas of the Kobuk and Noatak River Valleys. In the higher mountains there are large quantities of broken fragmental rocks found locally on talus slopes. As a result, there is a large resource of these commodities to support local construction needs.

Talc

A small occurrence of soapstone is located in serpentinized ultramafic rock west of the lower Hunt River (11). There are also talc veins in serpentinite at Asbestos Mountain (29), and north of Stout Mountain in the Cosmos Hills. Prospecting of these occurrences and other serpentinite bodies might result in the discovery of large enough concentrations to support a soapstone carving industry run by local native artists.

ENERGY RESOURCES

Coal

Cretaceous clastic rocks bordering the south side of the Brooks Range locally contain small isolated coal beds. Smith (1913) and Barnes (1967) report that small lense(s?) of bituminous coal occur in outcrops along the lower Ambler River (79). Coal in stream gravel has also been found on the lower Kogoluktuk and Hunt Rivers, but the source has not been located. These occurrences probably do not comprise a large economically exploitable resource; however, they may prove to be useful to the local inhabitants of the area.

Geothermal Energy

The potential for significant exploitable geothermal power is considered to be low. An unconfirmed small sulfurious hot spring was reported to be located at the headwaters of the Kogoluktuk River (written communication Lewis Lloyd, 1908).

Nuclear Fuels

Cretaceous granitic plutonic rocks in the quadrangle contain some radioactive minerals, but their potential is uncertain. Matsko and Freeman (1963) report finding a radioactive anomaly from an airplane survey over the granitic gneissic rocks cropping out in the lower Kogoluktuk Valley, but a ground traverse indicated the radioactive minerals were probably disseminated throughout the rock in low concentrations. A sample of quartzite talus containing metatorbernite (copper uranyl phosphate hydrate) was found near a granite contact in the Ulaneak Creek drainage (80).

Small amounts of radioactivity have also been detected in the copper deposit at Ruby Creek (24). The unidentified radioactive material consists of tiny particles in carbonate breccia and sometimes irregular stringers parallel to bedding in micaceous rocks (Runnels, 1963).

REFERENCES CITED

Anderson, Eskil, 1945, Asbestos and jade occurrences in the Kobuk River region, Alaska: Alaska Department Mines Pamphlet 3-R, 26p.

Anderson, Eskil, 1947, Mineral occurrences other than gold deposits in northwestern Alaska: Alaska Department Mines Pamphlet 5-R, 48p.

Brooks, A. H., 1914, The Alaskan mining industry in 1913: U.S. Geological Survey Bulletin 592, p.45-74.

Brooks, A. H., 1925, Alaska's mineral resources and production, 1923: U.S. Geological Survey Bulletin 773, p. 3-52.

Brosgé, W. P., Reiser, H. N., and Tailleur, I. L., 1967, Copper analysis of selected samples, southwestern Brooks Range, Alaska: U.S. Geological Survey Open-file Report 274, 1 sheet.

Cobb, E. H., 1972, Metallic mineral resources map of Ambler River quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-454, 1 sheet.

Cobb, E. H., 1973, Placer deposits of Alaska: U.S. Geological Survey Bulletin 1374, 213p.

Ellersieck, I. F., 1978a, Analytical results for stream sediment geochemical samples, Ambler River quadrangle, Alaska: U.S. Geological Survey Open-file Report 120C, 6 sheets.

Ellersieck, I. F., 1978b, Lead and zinc stream sediment geochemical anomalies, Ambler River quadrangle, Alaska: U.S. Geological Survey Open-file Map 120D, 1 sheet, scale 1:250,000.

Ellersieck, I. F., 1978c, Copper and molybdenum stream sediment geochemical anomalies, Ambler River quadrangle, Alaska: U.S. Geological Survey Open-file Map 120E, 1 sheet, scale 1:250,000.

Ellersieck, I. F., 1978d, Tin and beryllium stream sediment geochemical anomalies, Ambler River quadrangle, Alaska: U.S. Geological Survey Open-file Map 120F, 1 sheet, scale 1:250,000.

Ellersieck, I. F., 1978e, Barium, silver, and arsenic stream sediment geochemical anomalies, Ambler River quadrangle, Alaska: U.S. Geological Survey Open-file Map 120G, 1 sheet, scale 1:250,000.

Ellersieck, I. F., 1978f, Chromium, nickel, and cobalt stream sediment geochemical anomalies, Ambler River quadrangle Alaska: U.S. Geological Survey Open-file Map 120H, 1 sheet, scale 1:250,000.

Fritts, C. E., 1970, Geology and geochemistry of the Cosmos Hills, Ambler River and Shungnak quadrangles, Alaska: Alaska Division Mines and Geology Report 39, 69p.

Heide, H. E., Wright, W. S., and Rutledge, F. A., 1949, Investigations of the Kobuk River asbestos deposits, Kobuk district, northwestern Alaska: U.S. Bureau Mines Report of Investigations, R.I. 4414, 25p.

Matzko, J. J., and Freeman, V. L., 1963, Summary of reconnaissance for uranium in Alaska, 1955: U.S. Geological Survey Bulletin 1155, p. 33-49.

Patton, W. W., Jr., Miller, T. P., and Tailleur, I. L., 1968, Regional geologic map of Shungnak and southern part of the Ambler River quadrangles, Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations, Map I-554.

Reed, Irving, 1931, Report on the placer deposits of the upper Kobuk goldfields: Alaska Department Mines unpublished report, 33p.

Runnells, D. D., 1963, The copper deposits of Ruby Creek, Cosmos Hills, Alaska: Cambridge, Mass., Harvard University, unpublished PhD dissertation, University Microfilms, Ann Arbor, Michigan, 274p.

Sangster, D. F., 1977, Some grade and tonnage relationships among Canadian volcanogenic massive sulfide deposits: Report of Activities, Part A; Geological Survey of Canada, Paper 77-1A, p. 5-12.

Sichermann, H. A., Russell, R. H., and Fikkan, P. R., 1976, The geology and mineralization of the Ambler district, Alaska: unpublished address to the Pacific Northwest Metals and Minerals Conference, American Institute of Mining Engineers, Cour d'Alene, Idaho, April 9, 22p.

Smith, P. S., and Eakin, H. M., 1911, The Shungnak region, Kobuk Valley: U.S. Geological Survey Bulletin, 480, p.271-305.

Smith, P. S., and Mertie, J. B., Jr., 1930, Geology and Mineral resources of northwestern Alaska: U.S. Geological Survey Bulletin 815, 351p.

Smith, P. S., 1933, Mineral industry of Alaska in 1931: U.S. Geological Survey Bulletin 844-A, p.1-82.

Smith, P. S., 1934, Mineral Industry of Alaska in 1933: U.S. Geological Survey Bulletin 864-A, 94p.

Smith, T. E., Proffett, J. M., Heatwole, D. A., and Seklemian, R., 1977, Geologic setting of base-metal massive sulfide deposits, Ambler District, Northwest Alaska: Abstract of address given at the Alaska Geological Society Symposium, April 4, p.41-42.

Wiltse, M. A., 1975, Geology of the Arctic Camp prospect, Ambler River quadrangle, Alaska: Alaska Division of Geological and Geophysical Surveys Open-file Report 60, 41p.

MINERAL OCCURRENCES OF THE AMBLER RIVER QUADRANGLE

Compiled by C. F. Mayfield and Donald Grybeck

MAP NO.	NAME(S) (if known)	LOCATION	RESOURCE(S)[1]	FORM OF DEPOSIT OR OCCURRENCE	DEVELOPMENT[2] CATEGORY	BRIEF DESCRIPTION[3]	PRINCIPAL REFERENCE(S)[4]
1		T.29N.,R.1W.	Barite, (Pb),(Zn)	Vein	0	One meter thick barite vein in limestone; nearby Fe soil has 1000 ppm Pb and 5000 ppm Zn.	U.S. Geol. Survey field station 76Md34A
2		T.26N.,R.2E.	Cu,(Ag),(Mo),(Ba),(V)	Vein and disseminated	0	Small malachite stained quartz vein in Fe-rich black phyllite; phyllite anomalously high in Ag, Ba, Mo, and V; zone extends along strike for at least 2.5 km.	U.S. Geol. Survey field station 76EX394
3		T.26N.,R.1W.	Cu,(Ag)	Vein	0	Less than 1 m wide vein in limestone; visible chalcopyrite and malachite; rock sample has 10 ppm Ag.	U.S. Geol. Survey field station 76E361A
4		T.28N.,R.1W.	Cu	Vein	0	30 m long rusty zone having quartz rubble with few malachite stains.	U.S. Geol. Survey field station 74Be101A
5	Malfiatti	T.25N.,R.2W.	Cu	?	P	Copper minerals at contact between limestone and schist.	Brooks, 1914 p. 72
6		T.25N.,R.3E.	Pb,Cu, fluorite	Disseminated	0	Minor amounts of galena, fluorite, and malachite in granite near contact zone over a distance of about 1.6 km; area of 13 km² geochemically anomalous in Pb and Zn.	U.S. Bur. Mines unpublished data
7		T.24N.,R.3E.	Pb,Sb	Vein	0	Boulangerite ($Pb_5Sb_4S_{11}$) in reddish weathering dolomite.	U.S. Geol. Survey field station 73Tr96.2
8		T.23N.,R.6E.	Ti	Vein	0	Small amount of quartz rubble containing ilmenite; host rocks are felsic orthogneiss and quartzite.	U.S. Geol. Survey field station 76Md156D
9		T.22N.,R.1E.	Asbestos	Vein	0	Veinlets of tremolite asbestos in serpentine.	Anderson, 1947 p. 16, U.S. Geol. Survey field station 74Tr106
10		T.22N.,R.1W.	Asbestos,Cu	Vein and coating	0	Asbestos in serpentinite; chalcopyrite and malachite in mafic rocks.	Alaska Div. of Geol. and Geophys. Surveys field station 74Pe118
11		T.22N.,R.1W.	Asbestos,Cu	Vein and coating	0	Asbestos veinlets and Cu staining on fractures in serpentinite.	Alaska Div. of Geol. and Geophys. Surveys field station 74Pe99
12	Kobuk River	T.20N.,R.1W.	Jade ?	?	P	Unstated number (1-27) of claims staked 1968-1970; assessment work reports "jade cutting".	Alaska Div. of Geol. and Geophys. Survey Kardex File
13		T.21N.,R.3E.	Cu,Pb	Vein	0	Mineralized quartz vein containing malachite, azurite, and galena in limestone.	Brosgé and others, 1967
14	Jade Mountain	T.21N.,R.4E.	Nephrite jade, asbestos	Residual boulders	M	Highly serpentinized ultramafic body containing nephrite jade, and small amounts of chrysotile and tremolite asbestos; some gem quality nephrite mined; minor production of nephrite from stream gravels.	Anderson, 1945, p. 22-24; Anderson, 1947, p. 16
15		T.21N.,R.5E.	Ni	Coating	0	Small amounts of garnierite or a related mineral in ultramafic rocks.	Anderson, 1945, p. 24
16	Agnes Creek	T.21N.,R.6E.	Au	Placer	P	Creek has been prospected but without significant production.	Brooks, 1925, p. 51; Smith, 1933, p. 52; Cobb, 1973, p. 56
17	Bismark Creek (lower Shungnak River)	T.19N.,R.7E.	Au	Placer	P	Selected zones in creek gravels contain from 1.2-5.9 g (.04-.19oz) of Au per cubic meter; minor production	Reed, 1931, p. 12-16; Fritts, 1970, p. 54-55
18	Bismark Mountain	T.19N.,R.7E.	Asbestos, nephrite Jade	Vein and residual boulders	P	Serpentinized ultramafic body containing veins and veinlets of cross-and slip-fiber crysotile asbestos; local magnetite veinlets; small test shipment made during World War II but no production; some nephrite occurs near some serpentinite contacts.	Anderson, 1945, p. 18-20; Heide and others, 1949, p. 10
19	Shungnak River	T.19N.,R.7E.	Au,asbestos, nephrite jade, Cu,Ag	Placer	M	Intermittent gold placer mining from 1898 to 1940; may have produced as much as 311 kg (10,000 oz) of Au; concentrates mainly magnetite with rare nuggets of copper and silver; low grade asbestos occurs in greenstone and serpentinite along river; gravels also contain nephrite jade boulders weathered from west slope of valley.	Smith, 1913, p. 131-132; Reed, 1931, p. 12-16; Fritts, 1970, p. 54-55
20	Cosmos Creek	T.19N.,R.8E.	Au,asbestos, nephrite jade	Vein and placer	P	Sheared serpentinite with low-grade tremolite and chrysotile asbestos veinlets; gold in creek placer but no production; minor nephrite jade in creek gravels.	Reed, 1931, p. 16-17; Anderson, 1945, p. 20-21; Anderson, 1947, p. 15
21		T.19N.,R.8E.	Cu	Vein	0	Malachite and azurite in quartz vein cutting carbonate rocks; numerous lode claims staked in 1960.	U.S. Geol. Survey field station 55Tr92c; Alaska Div. of Geol. and Geophys. Surveys Kardex File
22	Pardners Hill	T.19N.,R.8E.	Cu,Pb,Zn,(Au),(Ag)	Breccia filling	P	Chalcopyrite and bornite in breccia of dolomitic limestone above dark slate and schist; minor galena; selected sulfide samples contain up to 1.37 g/ton Au (.04 oz/ton) and 47.9 g/ton Ag (1.4 oz/ton).	Smith and Eakin, 1911, p. 300-303; Smith, 1913, p. 149-150; Fritts, 1970, p. 39; Sichermann, Russell and Fikkan, 1976
23	Jay Creek	T.19N.,R.9E.	Au	Placer	0	A little gold recovered in 1931.	Reed, 1931, p. 18, 31; Fritts, 1970, p. 58
24	Bornite Ruby Creek	T.19N.,R.9E.	Cu,Zn,Pb,(Ag),(Au),(U)	Breccia filling	P	Deposit predominantly Cu and Zn but Pb, Ag and Au also found in significant quantities; mineralized zone within a 760 m thick Devonian carbonate sequence consisting of dolomite, limestone, phyllite, and calcareous phyllite; common ore minerals are pyrite, chalcopyrite, bornite, and lesser, tennantite-tetrahedrite, sphalerite, and galena; selected samples reach .02% eU but the U content of the ore is apparently negligible; current grade and tonnage figures not available but they are appreciable.	Smith, 1913, p. 147-148; Matzko and Freeman, 1963; Runnels, 1963; Fritts, 1970, p. 39-54; Sichermann, Russell and Fikkan, 1976
25	Iron Mountain	T.19N.,R.9E.	Fe	?	0	Magnetite masses up to 220 kg occur as float near contact of limestone and schist.	Smith, 1913, p. 153-154
26		T.19N.,R.8E.	Pb	Vein	0	Small amounts of galena in quartz vein and brecciated dolomite.	Smith and Mertie, 1930, p. 343; Cobb (1972)
27	Wesley Creek	T.18N.,R.9E.	Au	Placer	0	Low grade deposits of gold found in creek gravel; minor production.	Reed, 1931, p. 17
28	Riley Creek	T.19N.,R.9E.	Au	Placer and vein	M	Area mined was a high, steep, and dry tributary of Riley Creek; placer was 200 m long and less than 10 m wide; low grade gold occurs in quartz veins cutting schist on hillside above placer; minor production from placers.	Smith and Mertie, 1930, p. 336; Reed, 1930, p. 22-24, 30; Fritts, 1970, p. 58; Cobb, 1973, p. 55-58
29	Ing-Ihk Mine (Asbestos Mountain)	T.19N.,R.9E.	Asbestos, (nephrite jade), (quartz),(talc)	Vein	M	Serpentinized ultramafic body contains veinlets of cross- and slip-fiber tremolite and chrysotile asbestos; 33.3 tons of tremolite and about 13.7 tons of chrysotile shipped during World War II; small occurrences of soapstone and talc are common; small amount of optical quartz crystals shipped in 1943 from vicinity.	Anderson, 1945, p. 13-17; Anderson, 1947, p. 16-17; Heide and others, 1949, p. 1-13; Fritts, 1970, p. 55-56
30	Dahl Creek	T.18N.,R.9E.	Au,(asbestos),(Ni),(Jade),(Cr),(Ag)	Placer	M	Consists of an upstream deposit of coarse gold and a lower deposit of fine gold; upper deposit lies on or near its source; total production is the largest in the district, but probably less than 622 kg (20,000 oz).	Smith, 1913, p. 125-129; Reed, 1931, p. 18-22; Anderson, 1947, p. 18, 23; Fritts, 1970, p. 55-56
31	Canyon Creek	T.19N.,R.10E.	Au	Placer	P	Several prospect pits sunk in 1932 but minor production if any.	Reed, 1931, p. 29.
32	Pearl Creek	T.20N.,R.9E. (approximate location)	Au	Placer	P	Minor production in 1933; location uncertain.	Smith, 1934, p. 53.
33	Lynx Creek	T.18N.,R.10E.	Au	Placer	M	Small scale placer operation on stream gravels; mined intermittently from 1912 to 1940; no production records kept.	Reed, 1931, p. 27-28; Fritts, 1970, p. 57
34	California Creek	T.18N.,R.10E.	Au	Placer	M	Placer operations began in 1918 and continued steadily into the 1930's; gold is coarse and probably near its source; production figures not known but probably between 155.5 kg and 622 kg (5,000-20,000 oz).	Reed, 1931, p. 27-28; Fritts, 1970, p. 57
35		T.22N.,R.8E.	Cu	Coating	0	Malachite staining on discontinuous lense of marble.	U.S. Geol. Survey field station 72Tr9.2
36	Smucker	T.22N.,R.8E.	Zn,Pb,Ag,Cu	Massive and disseminated in layers [volcanogenic]	P	Abundant malachite, disseminated pyrite, chalcopyrite, and sphalerite in chlorite and graphitic muscovite-quartz schists; drill samples 820 m apart indicate layered sulfide zone(s?) 3 to 9 m thick, assaying 100 g to 255 g/ton Ag (3 to 15 oz/ton), 2-8% Zn, and 1-1.6% Pb.	Private industry
37	Sleet Creek	T.22N.,R.8E.	Cu,Zn	Massive and disseminated in layers [volcanogenic]	P	Malachite staining in muscovite-quartz schist.	Private industry
38		T.22N.,R.8E.	Cu,(Zn)	Massive and disseminated in layers [volcanogenic]	0	Malachite stain in small marble outcrop in saddle; high Cu and Zn stream sediment anomaly.	U.S. Geol. Survey field station 55Tr105
39	Horse Creek	T.22N.,R.10E.	Cu,Zn,Pb	Massive and disseminated in layers [volcanogenic]	P	Details and reserves not published but deposit similar to Arctic deposit (Map no. 42).	Sichermann, Russell, and Fikkan, 1976
40	Sunshine Creek	T.21N.,R.10E.	Cu,Zn,Pb	Massive and disseminated in layers [volcanogenic]	P	Details and reserves not published but deposit similar to Arctic deposit (Map no. 42).	Sichermann, Russell, and Fikkan, 1976
41	Dead Creek	T.21N.,R.11E.	Cu,Zn,Pb	Massive and disseminated in layers [volcanogenic]	P	Details and reserves not published but deposit similar to Arctic deposit (Map no. 42).	Sichermann, Russell, and Fikkan, 1976
42	Arctic	T.21N.,R.11E.	Cu,Zn,Pb,Ag,(Au)	Massive and disseminated in layers [volcanogenic]	P	Polymetallic, stratabound volcanogenic deposit within Devonian, low- to medium-grade igneous and pelitic schists; pyrite, chalcopyrite and sphalerite comprise 20-50% of a number of sulfur-rich horizons 3 to over 18 m thick that form a triangular shaped mineralized zone about 1030 x 730 m in plan and about 90 m thick. Deposit drilled and estimated to contain 27-32 million tons (30-35 million short tons) of rock averaging 4% Cu, 5.5% Zn, 1% Pb, 51.4 g/ton Ag (1.5 oz/ton), and a small amount of Au.	Wiltse, 1975; Sichermann, Russell, and Fikkan, 1976; Smith and others, 1977
43	Diane Creek	T.20N.,R.12E.	Cu,Zn	Massive and disseminated in layers [volcanogenic]	P	Weakly disseminated chalcopyrite, bornite, sphalerite, and pyrrhotite in calcareous schist and calc-silicate rocks mainly as float.	Private industry
44	Que Creek	T.20N.,R.12E.	Cu	Massive and disseminated in layers [volcanogenic]	P	Disseminated malachite in muscovite-quartz schist for at least 275 meters along strike.	Private industry
45		T.22 & 23N., R.10 & 11E.	?	?	P	83 lode claims staked in 3 blocks 1974.	Alaska Div. of Geol. and Geophys. Surveys Kardex File
46		T.23N.,R.11E.	Pb	Vein	0	Galena, pyrite and magnetite in float of quartz vien.	Alaska Div. of Geol. and Geophys. Surveys field station 72Z1
47		T.23 & 24N., R.11E.	Cu,Pb,(Au)	Vein	P	Numerous small quartz veins and veinlets with chalcopyrite and galena in quartzose rocks in contact aureole of granite; 46 lode claims staked 1974.	Private industry
48		T.23N.,R.10E.	Cu	Vein	0	Bornite, chalcopyrite, cuprite, and pyrite in 6 m thick quartz vein in limestone on ridge saddle near granite contact.	Alaska Div. of Geol. and Geophys. Surveys field station 72B48
49		T.23N.,R.10E.	Cu,Pb,(Au)	Vein	P	Numerous small quartz veins and veinlets with chalcopyrite and galena in quartzose rocks in contact aureole of granite; 20 lode claims staked 1974.	Private industry
50	Shishakshinovik Pass	T.24N.,R.11E.	Cu,Pb,(Ag),(Au)	Vein?	0	Selected specimens containing copper minerals assay 9.81 percent Cu, 27.73 percent Pb, and some Au and Ag.	Smith, 1913, p. 150
51		T.23N.,R.11E.	Cu,Pb,(Au)	Vein	P	Numerous small quartz veins and veinlets with chalcopyrite and galena in quartzose rocks in contact aureole of granite; 24 lode claims staked 1974.	Private industry
52		T.23N.,R.12E.	Pb,Zn,Ag,Mo	Vein?	0	Minor galena, sphalerite, and molydenite in granite near its contact zone; high geochemical anomalies in Pb, Zn, and Mo; float boulder has 2 percent Pb, 1.6 percent Zn, and more than 102.8 g/ton Ag (3 oz/ton).	U.S. Bur. Mines, unpublished data
53		T.24N.,R.12E.	(Zn),(Cu)	Disseminated	0	Pyritic black phyllite; some samples from area have >100 ppm Cu and >1000 ppm Zn; zone extends to both sides of creek.	Ellersieck, 1978a
54		T.25N.,R.13E.	(Cu),(Zn)	Disseminated	0	Thin pyritic layers parallel foliation in black phyllite; pyritic zone extends 4 km to the south; richest stream sediment sample contains 290 ppm Cu and 450 ppm Zn.	Ellersieck, 1978a
55		T.25N.,R.12E.	Cu	Vein?	0	Sparse massive sulfide samples containing chalcopyrite and malachite weathering from dolomite near contact with quartzite.	U.S. Geol. Survey 76Md266
56		T.26N.,R.11E.	Cu	Coating	0	Malachite staining at contact of conglomerate and marble.	U.S. Geol. Survey field station 76Tr143
57		T.25N.,R.11E.	Cu	Vein	0	Malachite, azurite, and pyrite in quartz vein.	Alaska Div. of Geol. and Geophys. Surveys field station 72B62
58		T.25N.,R.10E.	(Cu),(Pb),(Zn),(Zr)	Disseminated	0	Finely disseminated black minerals in 2 meter thick granitic dike cutting calc-schist; contains 200 ppm Cu, 200 ppm Pb, 2000 ppm Zn and 1000 ppm Zr.	U.S. Geol. Survey field station 76Md257
59		T.25N.,R.10E.	Cu	Vein	0	Malachite in quartz vein cutting marble at thrust contact.	U.S. Geol. Survey field station 76Md256
60		T.25N.,R.10E.	Cu	Vein	0	Malachite, azurite and chalcopyrite in quartz veins in marble near contact with phyllite. Quartz veins traceable for at least 50 m.	Alaska Div. of Geol. and Geophys. Surveys field station 73Pe153
61		T.25N.,R.10E.	Cu	Coating	0	Malachite in conglomerate.	U.S. Geol. Survey field station 76Md312
62		T.26N.,R.11E.	Cu	Coating	0	Malachite stain on small piece of quartzite float.	U.S. Geol. Survey field station 76Tr140A
63	Midas Creek	T.28N.,R.12E.	Au	Placer	0	Gold probably derived from glacial deposits upstream; little production.	Smith, 1913, p. 141-142; Cobb, 1973, p. 59
64	Ningyoyak Creek	T.29N.,R.11E.	Cu	Vein	P	Copper mineralization over an area of about 25 x 30 m consisting of malachite and chalcopyrite in quartz veins and fractures cutting phyllite.	U.S. Bur. Mines, unpublished data
65		T.29N.,R.8E.	Cu,(Ag)	Vein	0	Small limonite rich gossan has 1800 ppm Cu and 5 ppm Ag at limestone - phyllite outcrop.	U.S. Geol. Survey field station 76Md43A,B
66		T.29N.,R.8E.	Cu	Vein	0	Malachite in small quartz vein cutting marble.	U.S. Geol. Survey field station 76Md43c
67		T.29N.,R.8E.	Cu	Vein	0	Chalcopyrite, malachite, and azurite along fractured surfaces in quartzite.	U.S. Geol. Survey field station 76Md28
68		T.28N.,R.8E.	Cu,Pb,Zn,(Cd)	Disseminated and coating	0	Malachite stains from fractured surface on conglomerate near contact with carbonate; 100 ppm Cd in sample.	U.S. Geol. Survey field station 76Tr30
69		T.28N.,R.9E.	(Zn),(Pb)	Vein	0	Anomalously high geochemistry from soil sample near two small quartz veins cutting Fe stained zone in carbonate; contains 420 ppm Zn and 110 ppm Pb.	U.S. Geol. Survey field station 76Tr19A
70		T.28N.,R.9E.	Cu,Pb,Zn,(Mo),(V)	Vein and disseminated	0	Sphalerite, galena, and malachite in small quartz veins; outcrop nearby black pyritic phyllite has 1000 ppm V and 70 ppm Mo.	U.S. Geol. Survey field station 76Tr145A, B
71	Kav	T.28N.,R.9E.	Cu,Ag	Vein	0	Prominent rusty colored hills of brecciated dolomite; pyrite, tetrahedrite-tennantite(?), chalcopyrite and malachite in small veins from 4 localities over an area of about 4 km².	U.S. Bur. Mines, unpublished data
72		T.27N.,R.9E.	Cu	Vein	0	Malachite in quartz float; Fe stained soil approximately 5 x 20 m in area.	U.S. Geol. Survey field station 76Md86
73		T.27N.,R.8E.	Cu	Coating	0	Malachite in conglomerate.	U.S. Geol. Survey field station 76Md42
74		T.28N.,R.8E.	Cu	Coating	0	Malachite in conglomerate.	U.S. Geol. Survey field station 76Md306
75		T.26N.,R.7E.	Cu,Pb,Zn, barite	Vein	0	Sphalerite and galena in small shear zone less than 1 m wide in limestone; barite, malachite, azurite vein less than 2 m wide cutting limestone.	U.S. Geol. Survey field station 76Md125
76		T.26N.,R.7E.	Cu	Vein and coating	0	Malachite, azurite, and chalcopyrite in small pods and fracture surfaces in quartz conglomerate below large flat thrust fault.	U.S. Geol. Survey field station 76Md126
77		T.25N.,R.8E.	?	?	?	Six lode(?) claims staked 1968.	Alaska Div. of Geol. and Geophys. Surveys Kardex File
78		T.21N.,R.12E.	(Cu),(Zn)	Geochemical anomaly	0	Anomalously high stream sediment sample, 365 ppm Cu and 625 ppm Zn.	Private industry
79		T.20 & 21N., R.6E. (approx. locations)	Coal	Bedded	0	Thin coal bed(s) in Cretaceous clastic rocks.	Smith, 1913, p. 152; Barnes, 1967, p. B19
80		T.23N.,R.11E.	Cu,U	Coating	0	Metatorbernite (Copper Uranyl Phosphate hydrate) in quartzite talus from south side of cirque basin.	U.S. Geol. Survey field station 72Tr25.1

FOOTNOTES FOR THE MINERAL OCCURRENCES TABLE

[1]Parentheses around a resource commodity signifies a minor element or geochemical anomaly.

[2]Symbols used for development category
- 0 - Mineral occurrence (no development)
- P - Prospect, inactive since 1970
- P (underlined) - Prospect, active since 1970
- M - Mine with recorded production. All inactive with the exception of the jade cutting operations on Dahl Creek and Jade Mountain (Map nos. 30 & 14).

[3]The metric system is used for description of all weights and measures with the exception of those in parentheses which are given in troy ounces and short tons.

[4]References - "Alaska Div. of Geol. and Geophys. Surveys Kardex File" refers to the claim file of active and inactive claims maintained by the state survey.

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MINERAL OCCURRENCES AND RESOURCES MAP OF THE AMBLER RIVER QUADRANGLE, ALASKA

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