MINERAL INVESTIGATIONS OF CERTAIN LANDS IN THE EASTERN BROOKS RANGE: A SUMMARY REPORT

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Cecil D. Andrus, Secretary

BUREAU OF MINES

FOREWORD

This is one of a series of summary reports that present the findings of reconnaissance-type mineral assesments of certain lands in Alaska. It is important to remember that Alaska has not been seriously prospected for minerals other than gold--except in a few relatively limited areas. These summary reports include data developed by both contract and Bureau studies; frequently a combination of both. As digests of more detailed reports that are still in preparation, these summaries omit the detailed findings that will be presented in the main reports, but the basic data and conclusions remain the same.

Assessing an area for its potential for buried mineral deposits is by far the most difficult of all natural resource assessments. This becomes more apparent when considering that no two deposits even of the same genesis and host rock conditions are identical. Moreover, judgments prior to drilling, the ultimate test, frequently vary among evaluators and continue to change as more detailed studies add to the understanding.

Included in these reports are estimates of the relative favorability for discovering metallic and related nonmetallic mineral deposits similar to those mined elsewhere. Favorability is estimated by evaluation of visible outcrops, and analyses of sampling data, including mineralogic characteristics and associated elements, in combination with an evaluation of the processes that have formed the rocks in which they occur. Essentially, it is a comparison of a related series of prospects and the environment in which they occur with the mineral deposits and environments in well-known mining districts. Recognition of a characteristic environment allows not only the delineation of a trend but also a rough estimate of the favorability of conditions in the trend for the formation of minable concentrations of mineral materials. This is a technique long used in the mineral industry to select areas for mineral exploration. Qualifying a trend or area as "highly favorable" for the discovery of mineral deposits indicates that the combination of outcrop samples, mineralogic data and geologic conditions that have been observed essentially duplicate the conditions in a recognized mining district elsewhere.

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A SUMMARY REPORT

by

James C. Barker 1/

ABSTRACT

The Bureau of Mines made limited field reconnaissance during 1976 and 1977 in 4.3 million acres of land within the eastern Brooks Range. The work was funded by a special Congressional appropriation. Because of size, remoteness of the area, time constraints and restricted funding, the findings must be considered tentative.

The study region is divided into four rock type areas based on a review of the available literature. Mineral potential of each is described by mineral occurrences and other data. The four areas include:

1. Granitic and Metamorphic Rocks. These are located in the upper Coleen River area. Tungsten, molybdenum, and lead are found in volcanic breccia near Bear Mountain. Veins of copper, lead, silver and zinc also occur. Strata-bound or stratiform deposits similar to those in the western Brooks Range seem possible, but none are known.

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2. Devonian Sedimentary Sequence. These units include several prospects and occurrences of copper, lead, and zinc in the Wind River headwaters that are being investigated by industry. Copper minerals found near Index Mountain appear to have been derived from Devonian shales.

3. Mississippian - Permian Sedimentary Sequence. Recent discoveries of zinc, lead and barite deposits in similar rocks of the northwest Brooks Range suggest a mineral belt associated with these units extending across northern Alaska. Similar mineral occurrences may exist in similar rock units in the northwestern portion of the study region where occurrences of high-grade fluorite and copper were found north of Porcupine Lake.

4. Permian - Triassic Sedimentary Sequence. These rock units are known for their phosphate content and associated trace metals.

Due to the lack of time and scarcity of information, that portion of the Christian complex which extends into the study area was not investigated, although it is known that a barite prospect occurs west of the Sheenjek River on the south border of the study region.

INTRODUCTION

This study is part of the on-going mineral availability program of the Bureau of Mines, Alaska Field Operation Center. This is a regional reconnaissance of approximately 4.3 million acres of land in the vicinity

of Arctic National Wildlife Refuge, figure 1. All locatable, saleable, or leaseable minerals, except sand and gravel, are considered.

The evaluation is based upon (1) field investigations in areas of favorable conditions extrapolated from Canada where mineral deposits are known to occur; (2) field investigation of areas of present or past exploration by industry; (3) analyses of stream sediment and bedrock samples; (4) existing aeromagnetic survey data (4) 2/; (5) follow-up investigations of reported or previously known occurrences and anomalies; and (6) preliminary results of the on-going Geological Survey appraisal of mineral resources of the Philip Smith Mountains, figure 2 (5) (7).

The results and conclusions presented in the summary are preliminary. They serve as an indicator of the types of deposits and commodities that may be present. They should not be considered conclusive with respect to this region's ultimate mineral potential.

ACKNOWLEDGMENTS

The Bureau of Mines was assisted by W. P. Brosge, U.S. Geological Survey, who provided in-depth advice, field assistance and past data collected by the Survey, and by R. C. Swainbank, Vice-President, Resource Exploration Consultants, who conducted a mineral evaluation of the Bear Mountain area. Sample analyses were performed by Skyline Labs, Inc., of Denver, Colorado.

GENERAL ROCK TYPES

The project area is generally underlain by highly deformed sedimentary rocks dominated by the imbricate northward thrust-faulted Mississippian

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2/ Underlined numbers in parenthesis refer to items in the references listed at the end of this report.

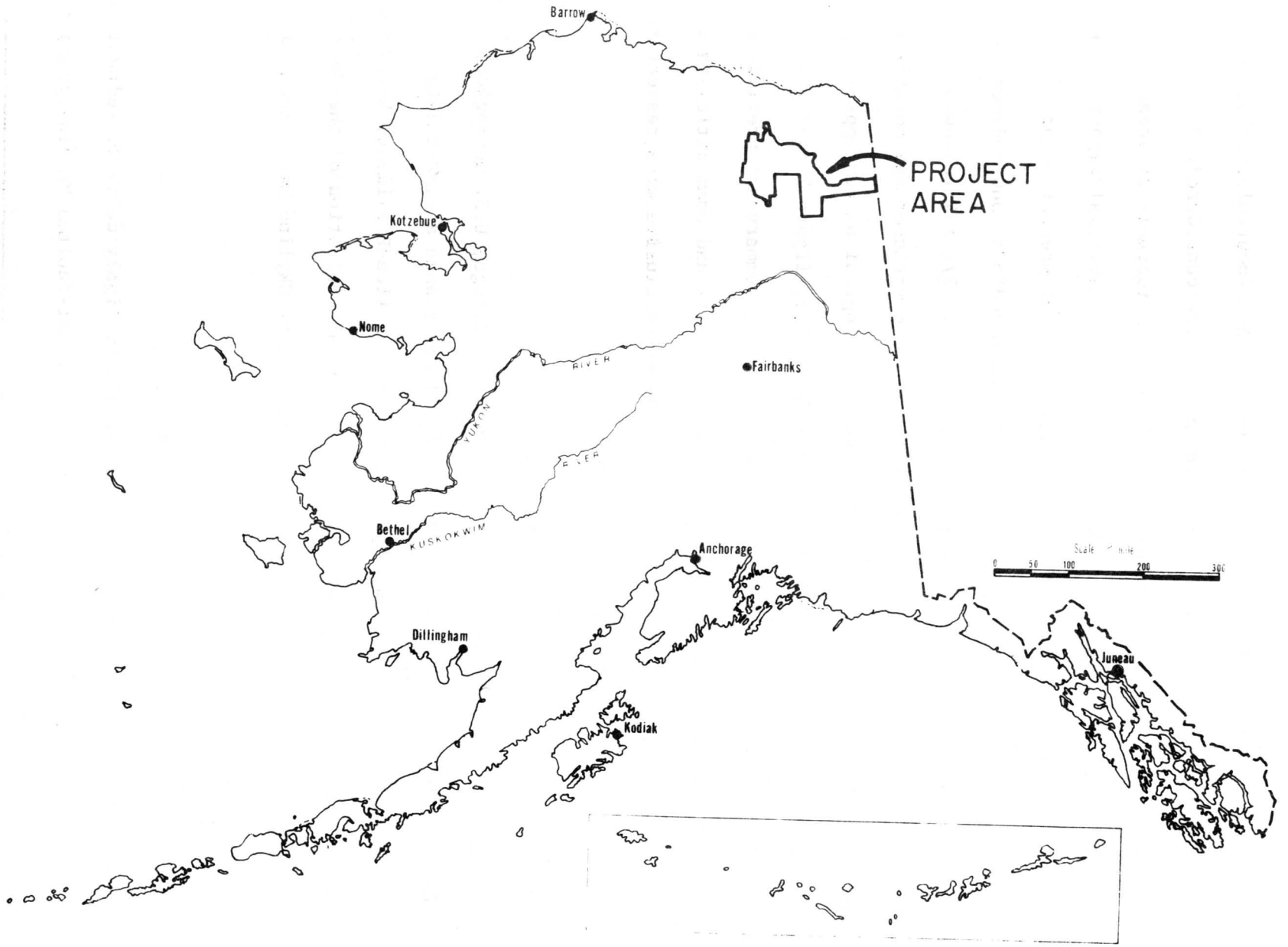

FIGURE 1.-Index map of Alaska showing location of project area

Lisburne Group. The Triassic sedimentary rocks (Shublik Formation) occur in two structurally low areas--one at Wahoo Lake near the Upper Echooka River and the other at Porcupine Lake, about twenty miles to the south, figure 2.

The Bear Mountain region of the upper Coleen River is transected by a major northeasterly trending fault. West of the fault, older metamorphic schistose rocks are believed to overlie a granitic basement (4) which is exposed at Bear Mountain. Further west, the metamorphics are overlain by younger sedimentary rocks. East of the fault, only the younger sedimentary rocks are exposed.

Other known igneous rocks which occur in the sedimentary sequences include small mafic intrusions located near the Ivishak River and mafic dikes and volcanics which occur near Porcupine Lake. Other volcanics are also indicated in this area. An extensive area of volcanic rocks is found along the East Fork of the Chandalar River. Several mafic bodies occur in the Koness River and Wind River areas.

The major known rock units of the eastern Brooks Range and adjoining areas have been grouped into four generalized sequences for purposes of the present study. These sequences correspond to those shown on figure 3. Grouping was based not only on age and lithologic similarities, but to some extent on mineral potential as well. The four sequences, from oldest to youngest are granitic and metamorphic rocks, Devonian sedimentary units, Mississippian/Pennsylvanian sedimentary units, and Permian/Triassic sedimentary units.

A possible fifth sequence of mafic volcanics and intrusives, cherts and shales collectively known as the Christian complex extends into the south central part of the area. Very little is known of this area and limitations of time and information prevented investigation.

MINERAL INFORMATION

Various metallogenic provinces are identified within each of the rock type areas. The following discussion is divided according to rock type and mineral occurrence data, both shown on figure 3. A summary of mineral data shown by map locations on figure 3 and 4 can be found in Appendix A. Referenced sample data are included in Appendix B.

Mineral Deposits in Granitic and Metamorphic Rocks

Mineralization of several types occur in the vicinity of the Bear Mountain intrusive. A highly weathered volcanic breccia, approximately 1000 feet in diameter, contains molybdenum, tungsten, and lead in amounts sufficient to warrant more investigation, figure 4 (map no. 25). This evaluation was limited to surface sampling. Due to the extensive weathering, the average grade of mineralization was not determined. Sampling of stream gravels indicated that tungsten minerals are present but grade was not determined.

Lead, silver, copper and zinc minerals in a vein system up to several feet thick are exposed for about 2000 feet near Galena Creek, figure 4 (no. 26). In addition, small widely scattered veinlets of galena (lead) and sphalerite (zinc) were found disseminated in metamorphic siltstone over an area of about 160 acres. The over-all grade

of disseminated mineralization appears quite low. Evidences of similar mineralization were traced for nearly one-half mile parallel to a ridge crest above Galena Creek.

The potential for other such mineralized structures (including porphyry deposits) in this region is apparent although as yet, no other deposits have been found. An area extending approximately thirty miles to the south is indicated to have a concealed granitic basement and is considered favorable for these types of deposits.

This area includes an extensive zone of metamorphic rocks. Large, high-grade deposits of massive stratiform sulfides are associated with certain stratigraphic horizons of metamorphic units in the western and central Brooks Range ("Ambler District," esp. Arctic Camp). At present, there is no evidence to either suggest or negate the possibility of similar deposition in the metamorphic rocks of the upper Coleen River. Further investigation of this possibility is needed.

Mineral Deposits in Devonian Sedimentary Rocks

Lead, zinc and copper mineralization has recently been discovered in Devonian Carbonate formations, figure 4 (no. 1-7, 12, 13). Black shales and phyllites were found to contain copper and zinc mineralization (nos. 10 and 11). These last are of particular interest because major deposits of zinc and lead in apparently similar black shales have been discovered recently in the Yukon Territory at MacMillan and Howards Pass (2). Minor malachite and copper, barium, manganese and lead in sediment samples from the upper Koness River (no. 30) suggest possible mineralization in the Devonian shales near Index Mountain. Over

200 claims have been staked and exploration by industry, including drilling, is continuing in the areas open to mineral entry. Little data from this work is yet available.

Occurrences of mafic rocks, with associated cherts and shales, extend into the southern portion of the Devonian sequence. Several beds of barite, the largest of which is about 20 feet thick, and at least 100 feet long, are interbedded with cherts and mafic rocks just south of the project area (3). No metallic minerals of consequence were reported with this deposit (no. 29); however, lead and zinc are often associated with barite occurrences elsewhere.

Mineral Deposits in Mississippian/Permian Sedimentary Rocks

The mineral resources of these rocks are poorly known in this area. However, recent discoveries of deposits of zinc, lead, and barite in the Wulik, Red Dog and Drenchwater prospects in the western Brooks Range have delineated a regional metallogenic trend that may possibly extend across northern Alaska. This trend appears to extend through the study area west and north of the Porcupine Lake where fluorite is associated with cherts, shales, dolomites and volcanic rocks (nos. 14 and 15). The mineralization appears to involve volcanic activity associated with a marine environment of the time of deposition. Fluorite occurs at Drenchwater 250 miles to the west; it is typically associated with this type of deposit worldwide.

In the study region, there are indications that sulfide and fluorite mineralization may have taken place north of Porcupine Lake, possibly in conjunction with fumarole gases or volcanic sublimates. Mineralization

may be stratiform in cherts and shales. Amounts of fluorite occur 3 miles north of Porcupine Lake (no. 14). Minor fluorite occurrences are wide spread in this region. Stream sediments in this region contain anomalous amounts of tin, copper, silver, zinc and strontium (refer to Appendix B).

Copper minerals were also identified in shales and gray cherts about fifteen miles north of Porcupine Lake (no. 16). The extent and nature of this occurrence has not been investigated.

Strata-bound sulfide minerals may be present in certain stratigraphic horizons in the Upper Lisburne Group. Such horizons are known in the Romanzof Mountains a few miles northeast of the study area (17).

Fossil tin placers in conglomerates, formed from ancient alluvial gravels with heavy mineral constituents, are suggested in the northeast part of the study area in the vicinity of the Romanzof Mountains. Fragments of cassiterite and tourmaline occur in the conglomerate near Lake Peters (6).

Mineral Deposits in Permian - Triassic Sedimentary Rocks

An area some twenty miles long and five miles wide near Porcupine Lake is the largest exposure of Permian-Triassic shales and sandstones in the study area. The Shublik Formation, a part of this series, in the eastern Brooks Range generally consists of phosphatic black limestones and carbonaceous limy shales. Stratigraphic horizons of phosphate rock (those containing more than 13.8 percent P_2O_5 by weight) reported in the Shublik Formation several miles northeast of the study region contain as much as 35.8 percent phosphate over a thickness of approximately twenty feet (6). The phosphate stratas typically also contain minor

amounts of uranium (up to 0.1 percent), as well as traces of copper, molybdenum, nickel, vanadium, and the rare earth elements. In some instances the concentrations of these metals may be sufficient to consider them as potential by-products in the phosphate. Two relatively large groups of exposures of the Shublik Formation occur near Wahoo Lake and in the vicinity of Porcupine Lake (no. 24). No sampling of possible phosphate-bearing horizons in either of these areas is known.

The Sadlerochit Formation is typically pyritic and contains barite concretions and siderite in some horizons. In the study area the unit has a moderately high background in zinc and barium. The formation may possibly contain recoverable deposits of these commodities.

Triassic to Middle Cretaceous rocks in northern Alaska are reported to include oil shales (12). Little is known of the size and extent of these occurrences, nor is it known if the portions of these units in the study region contain oil shale.

MINERAL POTENTIAL

Rock type trends, known deposits and occurrences described in the foregoing discussion of Mineral Information were combined in an attempt to delineate areas favorable for mineral exploration, figure 5. Areas containing known mineralization that may represent deposits of the size and grade commonly mined were considered highly favorable. Areas indicated as less favorable may indeed be less mineralized or they may merely be areas of less data and exploration.

ON-GOING STUDIES

The Bureau of Mines will continue to more accurately define the conclusions of this report through additional field examinations as funding and personnel are available and through monitoring of exploration by industry in adjacent lands. During the 1978 field season, it is planned to further study the region northward from Porcupine Lake which appears highly favorable for fluorite, barite, copper, lead and zinc deposits. The Mississippian rocks which occur in this region trend to the southwest and reconnaissance examinations will be conducted along this trend. Phosphate and oil shale deposits will also be investigated.

CONCLUSION

Areas favorable for the discovery of various mineral deposits were identified in portions of all four of the basic rock types. Based on the data currently available, the following areas appear to merit additional investigation.

1. The granitic intrusive and associated rocks at Bear Mountain appear to contain tungsten, lead, and molybdenum mineralization that may have concentrated in minable deposits.
2. Devonian sedimentary rocks - The grouping of lead, zinc and copper prospects in the upper Wind River region and their apparent similarity to deposits found in similar rocks in the western Brooks Range and in Canada, suggests that this is highly favorable for discovery of minable deposits. In the upper Koness River area these rocks may be favorable for copper.

3. Mississippian/Permian rocks - These rocks appear to be favorable for the discovery of stratiform sulfides, barite and fluorite, particularly in the region north and west of Porcupine Lake. In the western Brooks Range very large mineral deposits occur in similar rocks of this age.
4. The Permian-Triassic units of the study area may contain phosphate and possibly oil shale. Barite and perhaps base metals also may be present.

A fifth area includes the Christian complex west of the Coleen River and south of the Devonian sequence. The present study did not include evaluation of this unit. A prospect for barite is known to occur west of the Sheenjek River on the south border of the study region.

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APPENDIX A: SUMMARY OF MINERAL DATA

(refer to figure 4 for map locations)

Map Location No.	Commodity	Remarks
1.	Copper	Chalcopyrite and malachite in leached quartz vein in limestone. Eight claims located (Beaucoup Group) in 1971. Exploration of the claims is continuing (13).
2.	Copper, lead zinc	Galena, sphalerite and chalcopyrite in veinlets and boxwork in limestone. Twenty-two claims located (Occasional Group) in 1971. Exploration of the claims is continuing (13).
3.	Copper	Quartz vein in limestone with chalcopyrite, pyrite and malachite. Two claims located (Hungry Group) in 1971. Claims have since been abandoned (13).
4.	Lead, zinc, copper	Disseminated crystals and veinlets of sulfides in limestone and dolomite in creek rubble.
5.	Lead, copper	Minor sulfides in quartz veining.
6.	Zinc, lead	Outcrop of chert breccia with sphalerite matrix in creek bed. Limestone and chert mapped in area. Nineteen claims located in 1977 and exploration is continuing (13, 8).
7.	Zinc	Boulders of dolomite breccia with massive sphalerite in creek bed. Fifty-seven claims located in 1977 as two claim blocks. Both prospects, Nos. 6 and 7, are described to occur... "in a chert cap on a limestone bed that is overlain by yellow-weathering phyllite silt shales and sandstones..." (13, 8).

Map Location No.	Commodity	Remarks
8.	Copper	Copper occurs as minor chalcopyrite and malachite in green diorite, andesite porphyry and sheared fine-grained dolomite.
9.	Copper	Fine-to medium-grained andesitic tuff with siderite, limonite, chalcocite, trace bornite and malachite. Area mapped as limestone.
10.	Copper(?)	Four claims located in 1972. No available information on mineralization. Area is mapped as black meta clastic Upper Devonian rock (13).
11.	Copper	Copper values appear to be derived from Upper Devonian black meta clastic rocks, adjacent to, or under a thrust unit of Skajit Limestone. Two hundred and two claims were located (ACH and CHA Groups) in 1975. Exploration, including drilling is continuing (13. 16).
12.	Copper	Upper Devonian green shale associated with red (hematitic) shales, contains malachite along cleavages. A sample of the green shale analyzed 4,200 ppm copper.
13.	Copper	Analysis of a sample of Skajit Limestone and calcite veining indicate 9.2% copper.
14.	Fluorite	Cobbles and small boulders of a (bedded ?) sedimentary disseminated fluorite in a carbonaceous argillaceous chert. Fluorite is predominantly purple in color and sample contain trace lead. Two separate samples contained 21 and 34% CaF_2.

Map Location	Commodity	Remarks
15.	Fluorite	Fluorite and pyrite occur as veinlets, and fracture fillings in siliceous sedimentary rocks.
16.	Copper	Malachite, disseminated pyrite and chalcopyrite occur in gray cherts and silicic siltstone.
17.	Tin, fluorite, uranium, copper, molybdenum, lead, tungsten	These minerals occur at scattered locations in the vicinity of the Romanzof Mountains intrusive rocks (6).
18.	Copper	Chalcopyrite in brecciated quartzite of the Kekiktuk Conglomerate (6).
19.	Copper	Chalcopyrite in phyllite interbedded with chert and volcanic rocks (6).
20.	Copper	Chalcopyrite in sheared volcanic rocks (6).
21.	Copper	Malachite and azurite in sandstone (6).
22.	Copper, lead	Sample of quartz vein in green slate and volcanics contains 0.5% copper, 0.15% Pb (6).
23.	Manganese	Sample of manganiferous siltstone from interval 175 feet thick in Lower Cretaceous rocks contains 5% manganese. Strata includes thin beds of manganese nodules (6).
24.	Phosphate	Shublik Formation outcrops, known to contain unmeasured reserves of phosphate. In the Lake Peters areas, an eighteen-foot section contains 35.8% P_2O_5, trace uranium and other metals (10).

Map Location No.	Commodity	Remarks
25.	Tungsten, molybdenum, lead	Outcrop samples of a highly weathered brecciated rhyolite in an area roughly 1,000 feet in diameter contain up to 770 ppm W, 740 ppm Mo, and 420 ppm Pb. A nearby soil sample contained 4,900 ppm molybdenum and 860 ppm tungsten. Alluvial gravels of the creek draining this region contain 3% tungsten in a sluice box concentrate.
26.	Copper, lead zinc, silver	Mineralized vein system east of Galena Creek up to several feet thick and 2,000 ft. long is filled with base metal. West of Galena Creek sphalerite and galena occur as scattered veinlets for approximately one-half mile along the ridge crest.
27.	Copper	A sample of schist contains 1,500 ppm Cu and 2.5 ppm Ag (10).
28.	Barite	Vein barite occurs near the granite contact (10).
29.	Barite	Beds of barite up to 20 feet thick and exposed for 100 feet occur in chert, shales and mafic rocks (3).
30.	Copper, manganese	Malachite and pyrite occur in green shales associated with red (hematitic) shales. Sediment samples in the area contain greater than 1% manganese.
31.	Coal	Eastern end of the North Slope, Cretaceous subbituminous field (1).
32.	Copper, gold	Chandalar District, includes known deposits of gold, both lode and placer, and prospects of copper tactites and porphyry (10).
33.	Fluorite	Fluorite mineralization with grades up to 78% (16).

APPENDIX B - RECONNAISSANCE SAMPLING

A survey of the project area and immediate vicinity included 964 stream sediment samples not including samples taken during the prospect examination of the Bear Mountain area, figure 4.

Histograms were compiled from semiquantitative emission spectrographic data of the sediment samples taken by the Bureau. For the elements Ba, B, Be, Cu, Mo, Mn, Ni, Nb, Pb, Sr and V, the threshold values were calculated at the 95th and 98th percentile levels. For Ag, Sn and Zn, any detected value was considered anomalous.

Sample density of the project area averaged approximately one sample to seven square miles. Due to the limitations of this study, no samples were taken in the project area south of 68 degrees north latitude. Also, very little sampling was undertaken in the Philip Smith Mountains. The Geological Survey is currently compiling a mineral appraisal of that area and data are now available from that study (7).

Where geographical groups of samples are anomalously high in certain elements, they were so outlined in figure B-1. Erratic, individually high sample analyses or areas that were high in only one trace element were generally not considered.

The interpretation of the data as represented in figure B-1 is strictly preliminary at this time.

EXPLANATION

Area Map No. 1/, 2/	Anomalous Elements
1.	Cu, Zn, Ag, B, Co, Mn
2.	Sn, Zn, Mn, Co
3.	Ag, Co
4.	Sr
5.	Sn, Ag, Sr
6.	Sn, Ag, Sr
7.	Ba
8.	Cu, Zn, Ba, Pb, B, Ni, Nb, V
9.	Cu, Pb, Cr, La
10.	Ag, Ba, V
11.	Cu, Ag, Cr, Ni, Co, Ba, Bi, V, Mo, Mn, Pt
12.	Cu, Co, Ba, Ag, B, V, Mn
13.	Ba, Cw, V, B, (La, Pb, Mn, Zn) - weakly anomalous
14.	Cu, Ba, Pb, Zn, V, Ni, La
15.	Ba, V, La, B
16.	Zn, Cu, Ba, Pb, Ag, V, B
17.	W, Mo, Cu, Pb, Ag, V, B
18.	Pb, Zn, Mo
19.	Cu 3/
20.	Cu 3/
21.	Cu, Zn, Mo 3/
22.	Cu 3/
23.	Cu 3/
24.	Cu 3/
25.	Cu 3/
26.	Cu 3/
27.	Cu 3/
28.	Sn, W, U, Mo 3/ (based only on low density sampling)

1/ Sampling density of the project area north of 68° North latitude was approximately 1 sample per 7 square miles.

2/ Anomalous geochemical regions are based on groups of samples with generally consistent higher level values of the elements known, (c.f. histograms, Table 1).

3/ Adapted from Grybeck, D. Known Mineral Deposits of the Brooks Range, Alaska. U. S. Geol. Survey Open File Rept. 77-166C (4).