MINERAL INVESTIGATIONS IN THE PORCUPINE RIVER DRAINAGE, ALASKA

By James C. Barker
Alaska Field Operation Center, Fairbanks, Alaska

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UNITED STATES DEPARTMENT OF THE INTERIOR

James G. Watt, Secretary

BUREAU OF MINES

FOREWORD

This is one of a series of reports that present the findings of reconnaissance-type mineral assessments 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 reports include data developed by both contract and Bureau studies; frequently a combination of both.

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 metalic 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 a 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.

TABLE OF CONTENTS

ILLUSTRATIONS

PLATES

TABLES

MINERAL INVESTIGATIONS IN THE PORCUPINE RIVER DRAINAGE, ALASKA

by

James C. Barker[1]

ABSTRACT

Between 1976 and 1978, Bureau of Mines personnel conducted a mineral resource investigation in the Porcupine River drainage of northeastern Alaska.

The study area is divided into three generalized geologic terranes based on a review of available literature, analysis of field data and metallogenic projections. Potential deposit types of each terrane are described as they are indicated by mineral occurrences and other data.

1. Granitic intrusives and meta-sedimentary host terrane. Evaluations were made of base metal vein deposits and skarn mineralization near the headwaters of White Mountain Creek. Uranium vein-type occurrences and tin greisen-like alteration were found within the Devonian Old Crow batholith which suggest similarities to mineral districts in the Carboniferous-Devonian plutons of the European Hercynian Orogeny. Intrusive contact areas are also enriched with tin. Several very extensive alluvial gravel deposits were found to be significantly enriched with tin, tungsten, radioactives and rare-earth resistate minerals. There is also a good potential for rhyolite and hypabyssal porphyry, breccia pipe or stockwork types of deposits for base metals, molybdenum, tungsten and uranium.
2. Mafic/ultramafic igneous rocks and associated sediments. These are a poorly known group of rocks which comprise a probable ophiolite sequence. Occurrences of chromite, placer gold and bedded barite are found within this sequence of rocks, along with associated placer gold. Within the

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[1] Mining Engineer, Alaska Field Operation Center, Fairbanks, Alaska

report area there are geochemical anomalies of barite, copper, manganese, and gold.

3. Sedimentary terrane. A geochemical survey was made of all tributaries to the Coleen and Porcupine Rivers. Lead, zinc and barium anomalies and minor occurrences near the U.S.-Canada border indicate potential for base metal mineralization in lower Paleozoic-Precambrian shales and carbonates. Little is known of the heavily vegetated area of sedimentary terrane in the southern portion of the report area. There is a major unconformity between the Late Devonian and younger sediments which may control mineralization. In Canada, rock units of similar age and lithology host lead-zinc and uranium deposits. Cenozoic sedimentary units also have potential for sedimentary uranium, oil and gas.

The Department of Energy is analysing all stream sediment and rock samples collected as part of this study. Analytical results for 44 elements will be available through a concurrent open file report by that department.

INTRODUCTION

During the 1976, 1977 and 1978 field seasons, approximately 175 man-days of field work were conducted. Work was done from boat and raft traverses of the Coleen and Porcupine Rivers which included those areas accessible on foot from the river, (figure 1) and with limited helicopter support elsewhere, figure 2.

The objective of the study was a regional reconnaissance of potentially favorable terranes for mineralization. All potential locatable or leasable minerals including petroleum were considered. This evaluation was based on 1) field investigations in areas of favorable geologic units as extrapolated from known deposits in Canada; 2) interpretations of air photographs and imagery, depicting those structural lineations and color variations that may be related

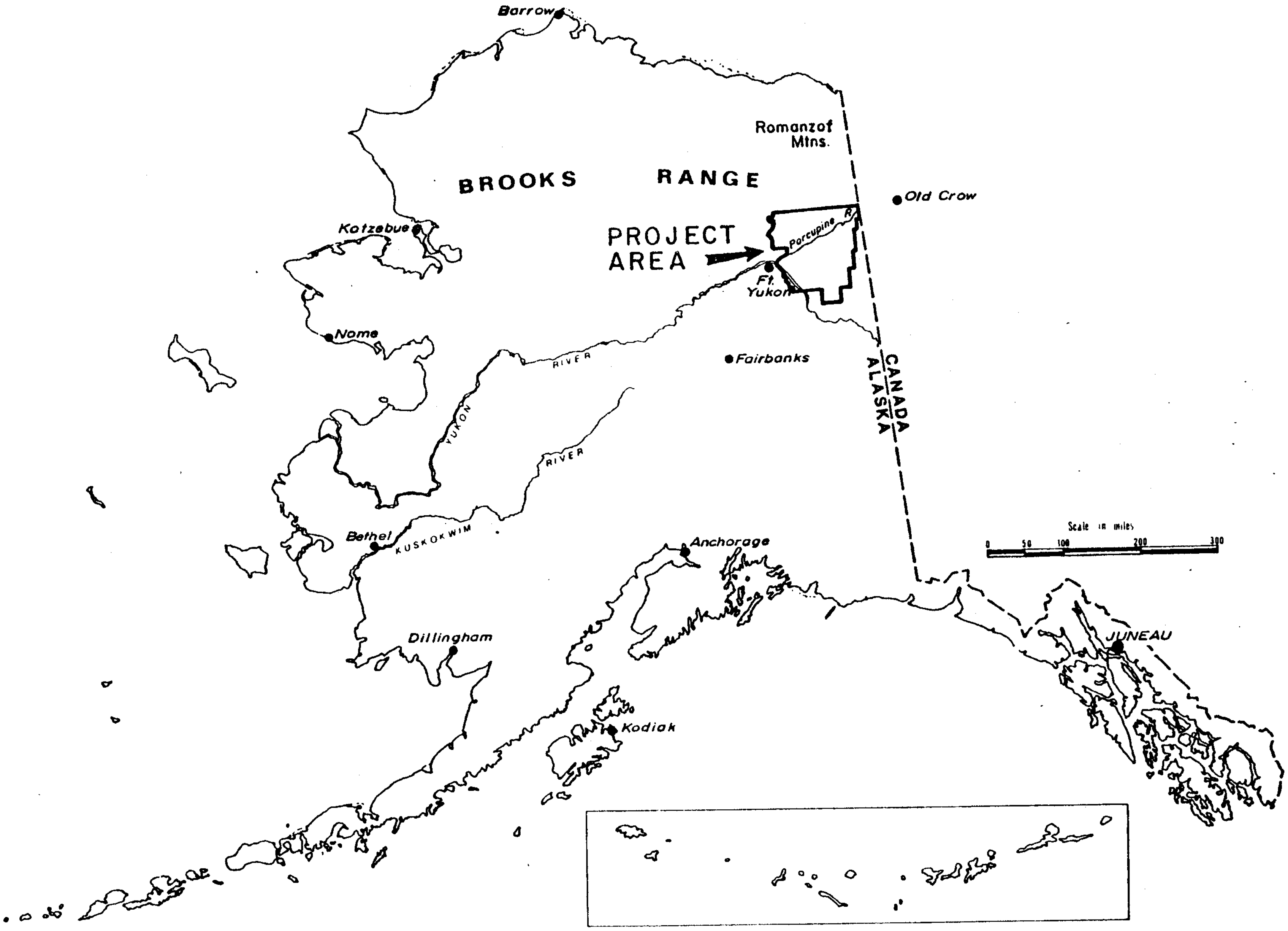
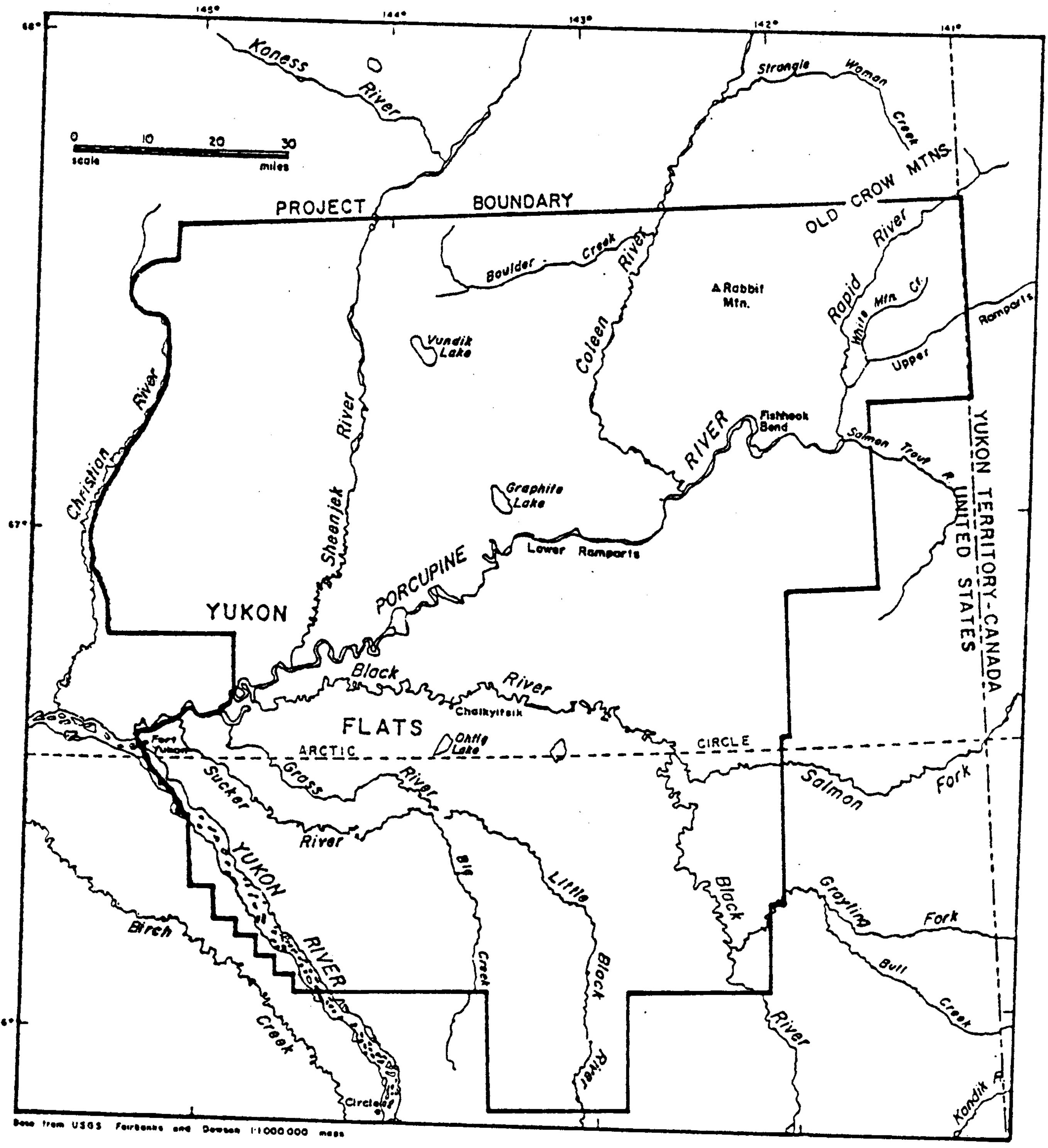


Figure I.– Location map



Base from USGS Fairbanks and Dawson 1:1000000 maps

FIGURE 2.- Project Area

to mineralization; 3) regional geochemistry based on analyses of stream sediments and systematic pan sampling; 4) rock and soil sampling in areas of suspected mineralization; 5) air-borne magnetic survey (8)2/; 6) air-borne radiometric survey (47) and follow-up ground investigations; 7) follow-up of previously known occurrences and anomalies; 8) available seismic and gravity data used to interpret potential oil and gas provinces; 9) location and characterization of additional mineral occurrences which relate to metallogenic provinces.

The results and conclusions presented in this report are preliminary and should not be considered in any way to be conclusive with respect to this region's mineral potential but, rather to merely serve as an indicator of the types of deposits and mineral commodities that may be present.

PREVIOUS STUDIES

The geology of the Porcupine River area has been investigated by Kindle (1908) (26), Maddren and Harrington (1955) (29), Cairnes (1914) (15), Mertie (1941) (30), Brosge and others (1966) (13), Laudon and others (1966) (27) and Churkin and Brabb (1967) (18). Maddren's (28) and Cairnes' (15) work was the result of geologic mapping of a four-mile wide zone along the International Boundary. Laudon and others (27) published a stratigraphic study of the Paleozoic rocks along the Alaska-Yukon border in 1966. Also, in 1966 a detailed geologic strip map of the Porcupine River Canyon was compiled by Brosge and others (13). The Devonian rocks of the Yukon-Porcupine Rivers area were reported on by Churkin and Brabb in 1967 (19). An aeromagnetic survey of northeastern Alaska was released in 1970 and published at a scale of 1:1,000,000 (8). Subsequent to this survey, a study was made by Brosge and Conradi in 1971 (9) of the bedrock magnetic characteristics associated with the various magnetic

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

anomalies. The first geologic reconnaissance mapping of the Coleen and Christian 1:250,000 quadrangles was published by Brosge and Reiser in 1969 (12) and 1962 (10) respectively. In 1970 a preliminary geologic map of the Black River quadrangle was published by Brabb (6). A study of the Jurassic mafic igneous complex in the Christian quadrangle was made by Reiser and others in 1965 (35).

A brief investigation for radiometric minerals along the Porcupine River was conducted by White in 1948 (43). Traces of radioactive accessory minerals were found in rhyolite, but it was concluded that the region did not warrant further investigation.

In 1977, results of an air-borne radioactive survey were released by the Energy Research and Development Administration (47). This 19 quadrangle survey included all of the study area in that report.

In 1968, Brosge and Reiser compiled geochemical analyses of 119 stream sediments and 89 rock and soil samples from the Table Mountain and Coleen quadrangles (11). Portions of this data, including stream sediment analyses from the Christian and Coleen quadrangles were tabulated and published in 1977 (14). Although sample stations were widely spaced, several regional anomalies and mineral occurrences were found which were further studied by the Bureau of Mines.

ACKNOWLEDGEMENTS

Considerable assistance with the field investigations and and preparation of this report was contributed by K. H. Clautice, Geologist, with the Bureau of Mines. The topographic and geologic maps used in this report were adapted from the U.S. Geological Survey published maps.

The Bureau of Mines was also assisted in the preparation of this report by W. P. Brosge, U.S. Geological Survey, who provided in-depth advice, field assistance and past data collected by the Survey; by M. W. Payne, University of Alaska, who provided geologic expertise and field assistance; by Dr. R. C. Swainbank, Vice President, Resource Exploration Consultants, who was contracted to provide air photo interpretation of Landsat, false color imagery and black and white photography. Samples were prepared by the University of Alaska, Mineral Industry Research Laboratory, under a Bureau of Mines grant. Analyses were also performed by the University unless otherwise noted. Uranium and thorium analyses were done by the Alaska Division of Geological and Geophysical Surveys. All sediment and rock samples referred to in this report are also being analyzed by the Department of Energy for 44 elements including uranium and thorium. Results will be concurrently open-filed by that department.

A section is included on oil and gas by D. P. Blasko of the Bureau of Mines. Petrographic work was contributed by W. L. Gnagy and T. C. Mowatt, also of the U.S. Bureau of Mines. Mowatt also provided a technical review of the findings.

LOCATION AND PHYSIOGRAPHIC FEATURES

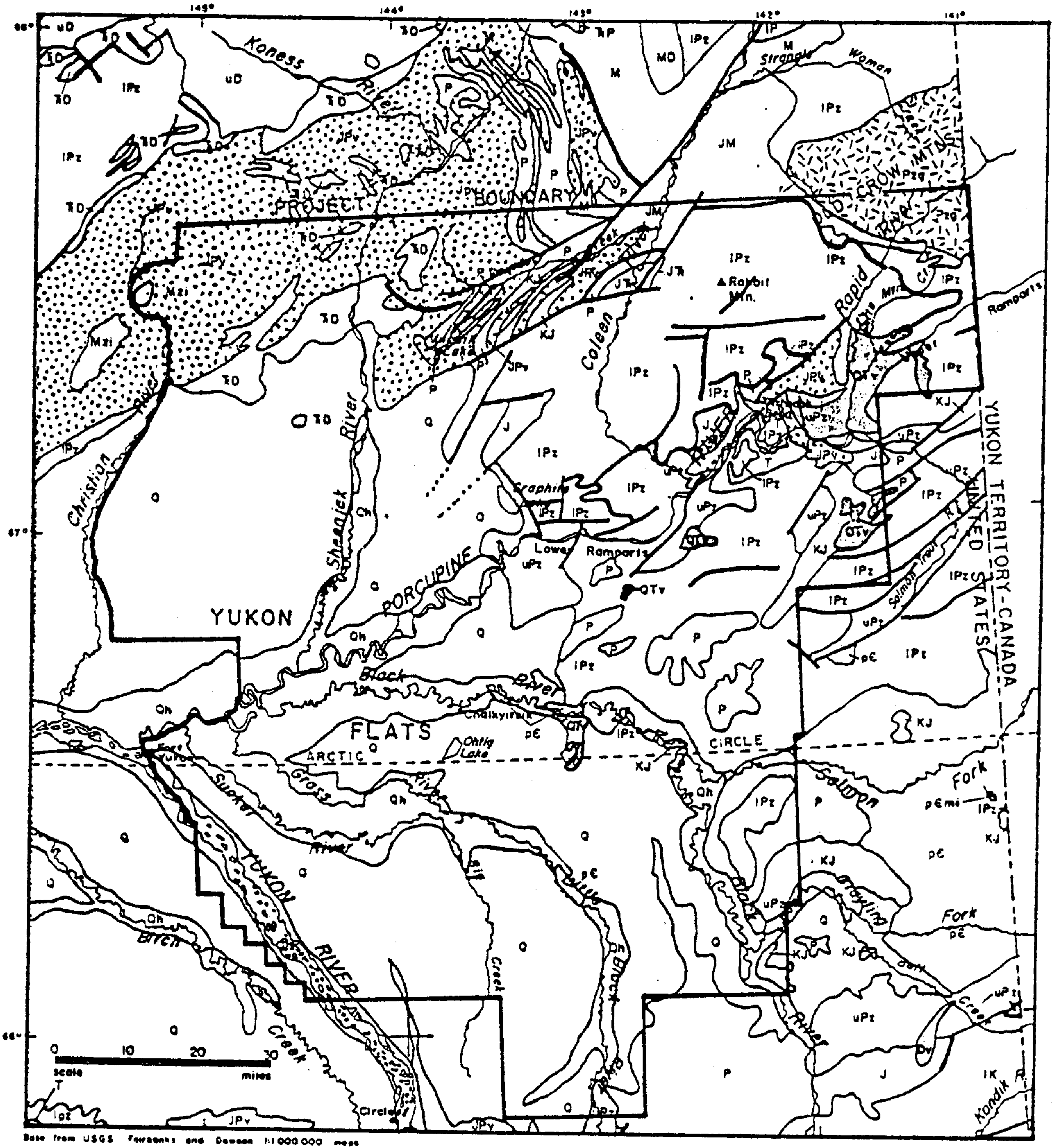
The study area is located in the physiographic region of the Porcupine Plateau. Principal topographic features are the Upper Ramparts (locally called the Porcupine River Canyon), the Yukon Flats and the Old Crow Hills, figure 2. This region is characterized by rather subdued and unglaciated low rolling hills, continuous dense vegetation and a dry continental climate with an annual average precipitation of eight inches (24). Bedrock is generally only seen as weathered rubble on a few of the higher ridges, and is best exposed along the canyon of the Porcupine River. The majority of the region lies north of the Arctic Circle and continuous permafrost should be expected.

Access to the area is very limited. Small fixed wing aircraft with floats can land on the Porcupine River, at several sites along the Coleen River and on a few lakes. The Porcupine River is navigable by medium-size barges along its 210 mile length from Fort Yukon to the Canadian border and for at least 70 miles beyond. The community of Old Crow in Yukon Territory is currently served intermittently by barge. The remainder of the region can be reached only on foot or by helicopter. The only known inhabitant of the area is a trapper on the Coleen River. The closest settlements are Old Crow, about 35 miles east of the area, in the Yukon Territory, and Fort Yukon to the southwest. Regular air service is available to Fort Yukon.

GENERAL GEOLOGY

The Porcupine study area is composed of Paleozoic and lower Mesozoic sediments and metasediments with a Tertiary sedimentary basin to the southwest, figure 3. The lower Paleozoic stratigraphy in the northeast region, figure 3, may in part be Precambrian based on extrapolation of the units into the Yukon Territory (33). Some metamorphic rocks uplifted by the Old Crow batholith may be Precambrian. Tertiary to Quaternary volcanism resulted in sheets of basalt lava and ash beds seen in the east-central area.

In the northwestern portion of the area, the sedimentary rocks form



adapted from Beikman and Lathram, 1976, (3).

FIGURE 3.-General geology of the Porcupine study area

Figure 3

EXPLANATION

STRATIFIED SEDIMENTARY AND VOLCANIC ROCKS.–

Mainly marine. In part metamorphosed.

Qh	HOLOCENE DEPOSITS.—Alluvial, flood plain, beach, low terrace, swamp, and landslide deposits.
Q	QUATERNARY DEPOSITS.—Loess, eolian sand, terrace, flood plain and alluvial.
T	TERTIARY DEPOSITS.—Conglomerate, gravels, pebbly clay, lignite, minor tuff and ironstone.
lK	LOWER CRETACEOUS ROCKS.—Graywacke sandstone, shale, siltstone, and conglomerate.
KJ	CRETACEOUS AND JURASSIC ROCKS.—Graywacke, sandstone, quartzitic sandstone, quartzite, conglomerate, siltstone, shale, and argillite.
J	JURASSIC ROCKS.—Carbonaceous shale with minor siltstone and quartzite.
JŦ	JURASSIC AND TRIASSIC ROCKS.—Chert and argillite.
ŦP	TRIASSIC AND PERMIAN ROCKS.—Sandstone, siltstone, and shale.
P	PERMIAN ROCKS.—Chert, shale, and siltstone.
M	MISSISSIPPIAN ROCKS.—Conglomerate, shale, and limestone with subordinate shale, chert, and dolomite. Includes the Endicott Group and the Lisburne Group.
JM	JURASSIC TO MISSISSIPPIAN ROCKS.—Slate and fossiliferous quartzite of Jurassic and Mississippian(?) age.
ŦD	TRIASSIC TO DEVONIAN ROCKS.—Radiolarian chert, slate, and argillite of undetermined age and thickness.
uPz	UPPER PALEOZOIC ROCKS.—Sandstone, shale, siltstone, chert, limestone.
MD	MISSISSIPPIAN AND(OR) DEVONIAN ROCKS.—Sandstone, quartzite, graywacke, and quartz-chert conglomerate. Includes the undifferentiated Kekiktuk or Kanayut Conglomerate.
uD	UPPER DEVONIAN ROCKS.—Consists of a clastic sequence of shale, sandstone, chert, quartz-pebble conglomerate and quartzite.
lPz	LOWER PALEOZOIC ROCKS.—Dolomite, limestone, quartzite, shale. (May be Precambrian based on recent work by D. K. Norris.) (33)
p€	PRECAMBRIAN ROCKS.—Phyllite, slate, and siltstone near Salmon Trout River drainage.

FELSIC IGNEOUS ROCKS

r	RHYOLITE.—Sills peripheral to granite.
Pzg	PALEOZOIC GRANITIC ROCKS.—Biotite granite and quartz monzonite of the Old Crow Batholith.

MAFIC IGNEOUS ROCKS

QTv	QUATERNARY AND TERTIARY VOLCANIC ROCKS.—Olivine basalt flows.
Mzi	MESOZOIC INTRUSIVE ROCKS.—Leucogabbro, anorthosite and ultramafic rocks.
JPv	JURASSIC, TRIASSIC AND PERMIAN VOLCANIC ROCKS.—"Christian Complex."—basalt, diorite, gabbro, chert, peridotite, dunite.
Dv	DEVONIAN VOLCANIC ROCKS.—Includes spilitic basalt and lapilli tuff with interbedded dolomite, limestone, and shale of the Volcanics.
p€mi	PRECAMBRIAN MAFIC INTRUSIVE ROCKS.—Gabbro and diabase.

MAP SYMBOLS

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Contact

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Indefinite contact

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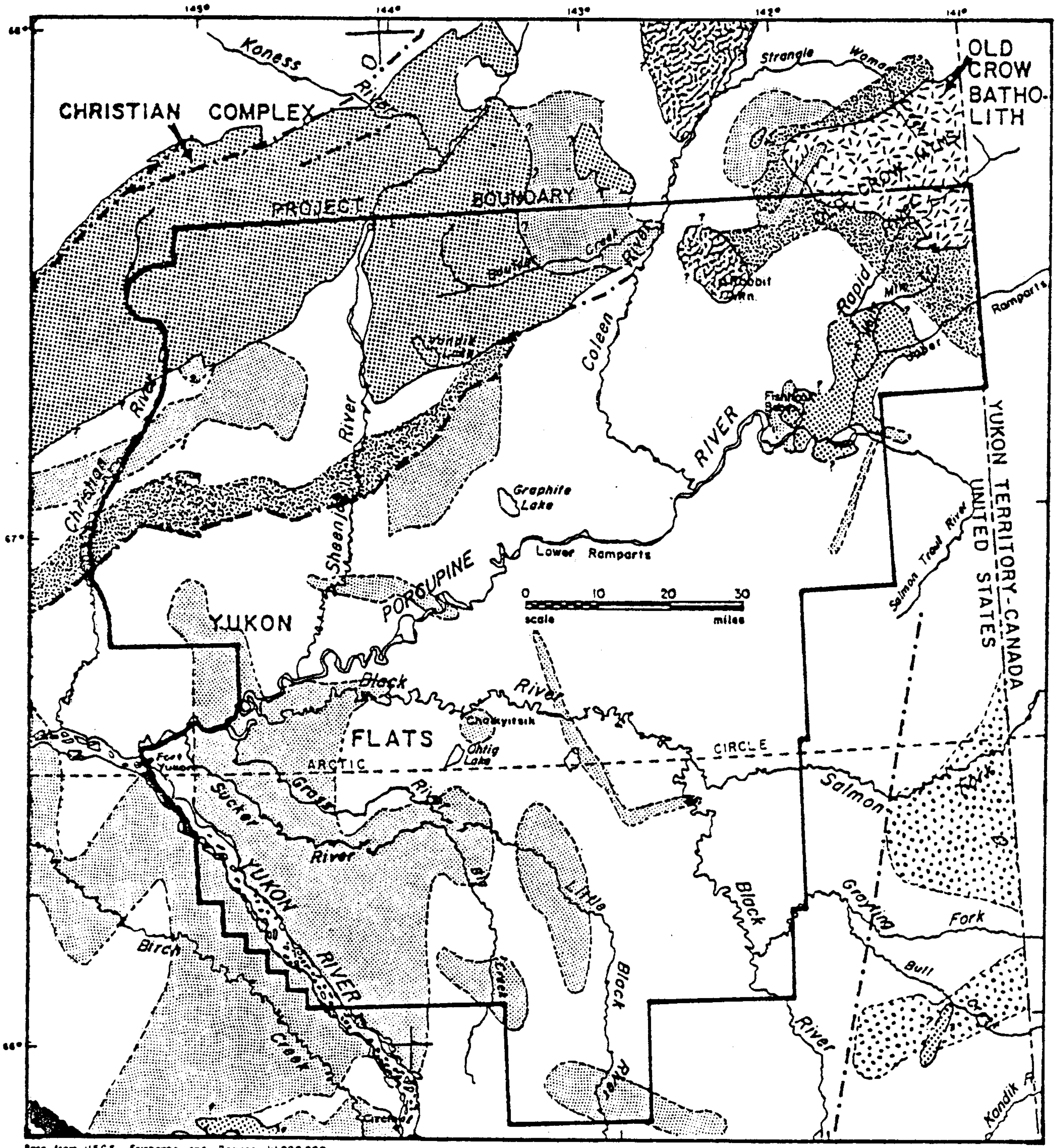
Fault
Dotted where concealed or inferred

a structural basin in which lies a Jurassic mafic/ultramafic, predominantly intrusive complex referred to as the Christian complex. Rocks in contact with the mafics are mostly chert, shale, argillite, and graywacke of late Paleozoic to Jurassic age (12). Mafic rocks also occur along the Porcupine River.

The Old Crow granitic batholith is crossed by the U.S.-Canada border in the northeastern corner of the region. This Carboniferous-Devonian(?) (2, 36) intrusion is flanked to the south by apparently younger rhyolite sills and by lower Paleozoic(?) or Precambrian sediments. These marine shales and carbonates form a portion of the Yukon shelf which extends eastward into Canada. Upper Paleozoic sediments, including sandstone, shale and chert occur southwest of this section. Quaternary basalt flows cap Tertiary clay, sandstone, mudstone and gravel and Paleozoic sediments forming the Upper Ramparts along the Porcupine River. There is a regional Late Devonian uncomformity in the eastern areas representing the Late Devonian orogenic events. The Porcupine River parallels an extension of the Kaltag Fault. (33).

A geologic map of the area compiled from aeromagnetic and geologic data (8) is shown in figure 4. Salient features noted on this map include the large amount of inferred granitic basement rock surrounding the exposed portion of the Old Crow batholith; the mafic igneous rocks concealed within the batholith; the major northeast trending faults bounding the Christian complex; the granitic intrusion indicated to occur along the southern margin of the Christian complex, and the extensive areas of mafic igneous rocks inferred to underlie the Yukon Flats.

All of these geologic terranes are discussed in more detail in later portions of this report, in the context of mineral resource potential.



Base from USGS Fairbanks and Dawson 1:1000000 maps

after Brosge and others, 1970,(7).

FIGURE 4.-Geologic map of the Porcupine report area interpreted from geologic and aeromagnetic data

FIGURE 4 - EXPLANATION

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Exposed sedimentary rocks and surficial deposits

EXPOSED CRYSTALLINE ROCKS

▨

Granitic intrusive rocks and migmatite

▒

Mafic intrusive and extrusive rocks

▩

Metamorphic rocks

CONCEALED CRYSTALLINE ROCKS INFERRED FROM MAGNETIC DATA

▧

Granitic intrusive rocks

░

Mafic intrusive and extrusive rocks

▓

Serpentine pods in schist and sedimentary rocks

⁘

Basement rocks of Precambrian(?) age or deep intrusive rocks

Flight lines 10-25 miles apart, flown 2,500-5,000 feet above sea level.

— · — · — · — · — · —

Fault
Inferred from magnetic data

——— ? ——— ? ———

Contact
Queried where doubtful

HISTORY OF MINERAL EXPLORATION AND PRODUCTION

There has been no mineral production reported, and only a minuscule amount of previous exploration on the Porcupine Plateau. In the early years of this century, the area was undoubtedly examined for gold by the prospectors active at the time. One gold placer prospect is reported just north of the study area on a small westerly tributary to the Coleen River. However, most of the Porcupine region appears to be either geologically unfavorable for rich gold lodes or placers, or else is unexplored due to the the dense vegetation cover and the permafrost. Consequently, no signigicant discoveries of any kind were reported, and the prospectors moved on to other regions. Little attention was paid at that time, however, to other lower value commodities, particularly in such a remote area as northeastern Alaska. Only one lone prospector is known to have worked briefly in the region since then.

Several very brief mineral reconnaissance efforts were undertaken by industry in recent years, mostly in the later part of the 1960's. However, further work was suspended after the land withdrawals that accompanied the passage of the Alaska Native Claims Settlement Act, and at the present time the lands of concern to this report remain virtually unexplored beyond the findings presented herein.

The rock units are parts of broader metallogenic provinces which can be traced into Canada. Mineral exploration and development in the Yukon Territory has resulted in a number of significant discoveries in the Canadian portion of these trends. Basinal margin carbonate formations similar to the Goz Creek and Godlin Lake lead-zinc deposits in the Yukon are examples.

MINERAL RECONNAISSANCE OF 1976-1978

Granitic Intrusive and Metasedimentary Host Terrane

Geology

The Old Crow batholith is a broadly domed, multiphase and partially contaminated granitic body. It has been described as a partly porphyritic biotite granite with large microcline phenocrysts and quartz monzonite with muscovite occurring locally (12). Host rocks of this intrusive have been referred to by Brosge as the Strangle Woman stratigraphic sequence. To the north, the granite intrudes and shows thermal contact effects on lower Paleozoic semischist, phyllite and quartzite. Areas of biotite and garnet schist are found adjacent to the batholith.

The southern intrusive margin is obscure, with possible thrust fault contact, and large sills of rhyolite. A thrust fault striking parallel to the southwestern margin of the batholith has overlain lower Paleozoic quartzite and Paleozoic(?) phyllite from the south onto undifferentiated Mississippian to Jurassic sedimentary rocks which in turn lie adjacent to the pluton. The undifferentiated units consist of limestone, quartzite, shale and sandstone (12).

Along the south-central border of the batholith, in the headwaters of White Mountain Creek (figure 3), lies a group of Paleozoic argillites, phyllites, calc-argillites, quartzites and limestones. These rocks are in contact with and intruded by dikes and sills of rhyolite which are exposed over as much as five to seven square miles, figure 5. The rhyolite contains phenocrysts of dark smoky quartz and, locally, minor traces of fluorite. Thermal contact effects on Paleozoic metasediments by the rhyolite were noted. During mid-Tertiary to Quaternary, general uplifting occurred in the vicinity, which may have first exposed the intrusive.

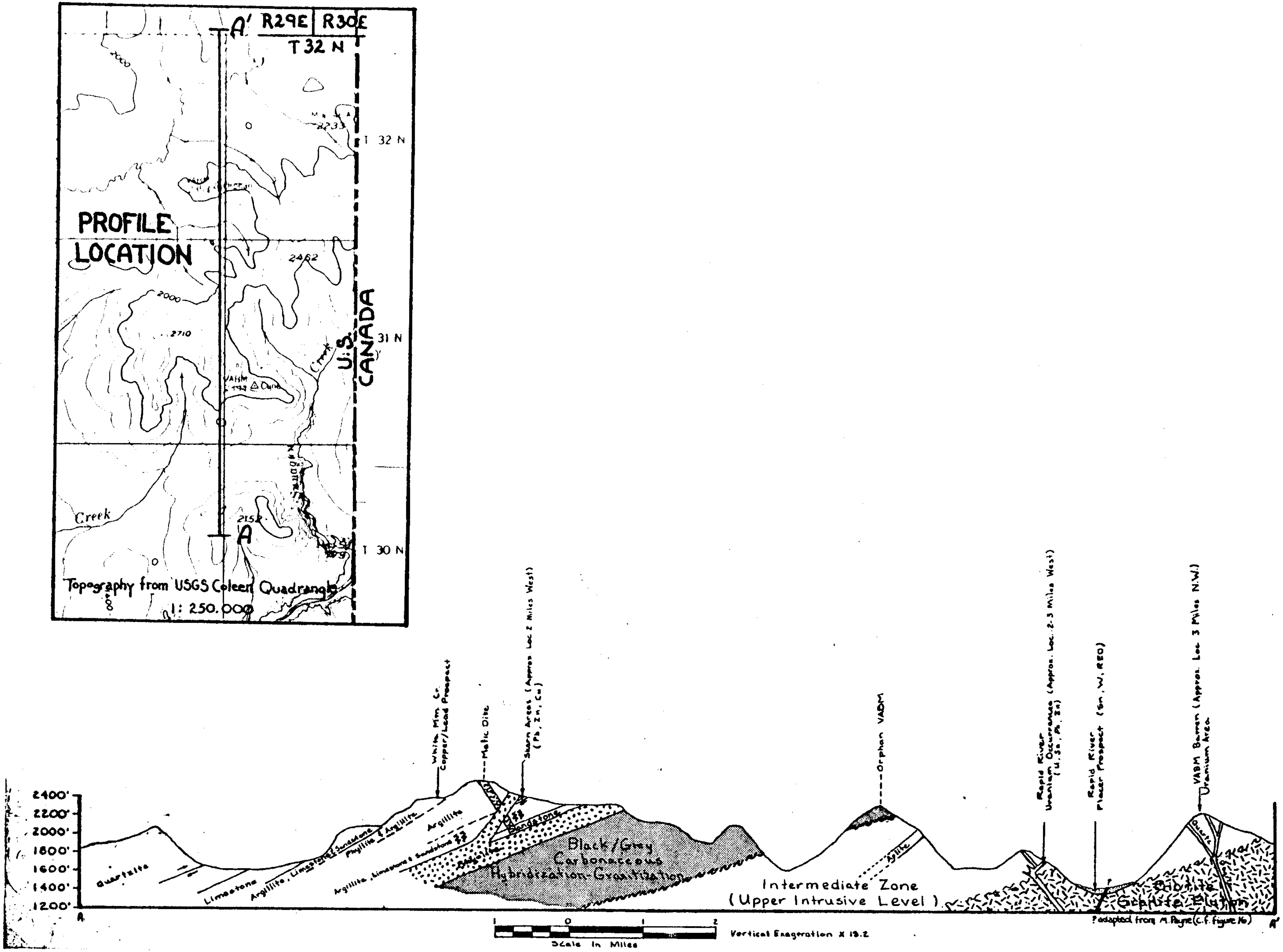


FIGURE 5.- Tentative composite profile, southern margin of Old Crow Granite

The batholith shows evidence of northeasterly displacements and northwesterly shearing associated locally with sericitic, muscovite, chloritic and silicic alteration. According to Payne (34) the batholith lies at the intersection of the Brooks Range and Ruby geanticline, which may in part account for the folding and shearing in the intrusive. There is evidence of recent uplift along the southern margin of the batholith. The characteristics of the Porcupine River Canyon suggests uplifting may still be continuing. Perched abandoned channels of the Porcupine can be found at elevations up to 500 feet above the present data level.

Potassium-argon dates on biotite at three locations in the American portion of the pluton indicate an age of 314 ± 9 m.y., 299 ± 10 m.y. and 295 ± 9 m.y. At this last site, a muscovite date has given 335 ± 10 m.y. (12). Three Canadian K-Ar biotite dates have given, 220 m.y., 265 ± 12 m.y. and 345 ± 10 m.y.(36). The age dates are varied and probably indicate successive reheatings with the Late Devonian date being most reliable. There have been no age dates reported on the rhyolite bordering this pluton, however, possible related(?) rhyolite associated with the Bear Mountain intrusive 55 miles to the north has been dated as Paleocene (54.6 ± 1.8 m.y.) on biotite (7). At both locations the rhyolite appears to be a control for local mineralization.

The Old Crow batholith appears to be one of a number of intrusions within a mid-Paleozoic (Devonian?) orogenic belt which extended eastward into Canada (2). The plutons involved include the Okpilak batholith and Jago stock in the Romanzof Mountains, Ammerman Mountain and the Bear Mountain pluton, all within the Arctic National Wildlife Refuge north of the Old Crow batholith. In the northern Yukon Territory, about 110 miles to the northeast, the Mt. Fitton and Mt. Sedgewick plutons have been assigned a similar genesis. All appear to have been also subjected to a late Cretaceous or Tertiary orogenic event as well (36).

Initial studies indicate similar mineral assemblages typical of mid-Paleozoic orogenies (e.g. the Hercynian Orogeny of Europe) associated with these plutons. Sable (36) has noted greisenization, as well as tin, fluorine, and beryllium mineralization at the Okpilak batholith. Uranium and tungsten skarns and residual tin have been reported at Mt. Fitton (21). At Bear Mountain, base metal veins and significant molybdenum and tungsten values in a rhyolite breccia occur. Within the Old Crow batholith tin, uranium, tungsten and base metal mineralization associated with both the rhyolite and granite were observed during the current study.

Interpretive Studies

Aeromagnetic Data

A preliminary aeromagnetic survey of this area (8) indicates that concealed granitic intrusive rock extends well beyond the present mapped borders of the pluton, notably into the upper Porcupine River area (figure 4). Granitic basement is also indicated to extend west to the Rabbit Mountain area. Several mineralized veins and rhyolite dikes in the phyllites of Rabbit Mountain are possibly related to this crystalline basement.

Field Investigations

Investigations along the southern and western margins of the batholith indicate a multiphased history for the intrusive, and a roughly defined zonation, figure 5. The inner or core zone consists essentially of an equigranular to partly porphyritic medium to coarse-grained biotite granite, surrounded by a middle zone of variable grain-sized leucocratic intrusive rock ranging from aplites to porphyritic, biotite granite and quartz monzonite with muscovite. Locally extreme sericitic and chloritic alteration, and greisen-like alteration generally associated with shearing, has occurred. Silicification (sometimes light green in color) and quartz veins with hematite are common in this zone. Several areas of volcanics (rhyolites), and tectonic shearing and brecciation have been noted. Tourmaline is common in the finer grain rocks.

The outer margin consists of black to gray carbonaceous(?) sericite granitic rocks, probably the result of contamination by, or at least in part, granitization of the host rock. This lithology has been found over an area of about eight square miles along the southern contact and intermittently on the west end of the intrusive. The granitized host may have been the carbonaceous black, limy shales of lower Paleozoic or Precambrian age that occur several miles to the south along the river. Higher than normal background concentrations of boron in the Paleozoic shales also tend to support this, as the black granite is typified by variable amounts of replacement tourmaline (granitic rock analyses range from 100 to 15,000 ppm boron). See table 1 for petrographic descriptions of this "border" phase and figure 6 for the sample locations described.

Portions of the batholith's intermediate zone appear to be indicative of the uppermost levels of a plutonic environment, which often are regions which are quite favorable for mineralization. Evidence suggests that the batholith is of the "plumasitic leucocratic" type as defined by Tauson and Kozlov (41). In summary, the batholith could be described as a hypabyssal (high level, shallow-seated) intrusive with implications especially for uranium, tin, and tungsten.

Air Photo Interpretation

Interpretation of Landsat and high altitude false color infrared airphotos of the granitic terrane are shown in figure 7. Distinctive features possibly related to mineralization are:

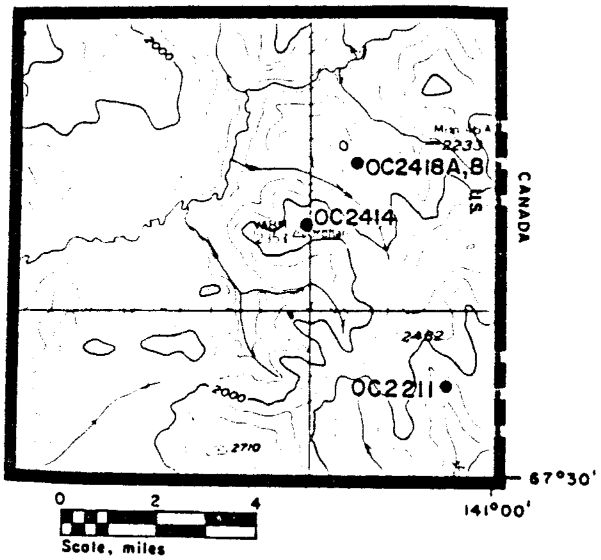
TABLE 1. - Petrography of "Black Granites"1/
by T.C. Mowatt (32)

Sample Number	Remarks
OC 2211	Graphic(?) granitoid(?); highly altered/contaminated/metamorphosed; feldspar strongly altered to sericite (± other indeterminate phases?); the latest-stage fractures contain hematitic-appearing infilling; these fractures transect an earlier-stage fracture set which is associated with clay (gouge?) material; much dark (carbonaceous, mostly?) material disseminated throughout the rock, and in optical/crystallographic configurations seemingly associated with the "graphic" texture of the rock (it is apparently graphically intergrown with quartz, and/or replacing feldspars); minor muscovitic mica; perhaps some tourmaline. Rock strongly stressed cataclastically.
OC 2414	Granitoid rock; one type (potassium?) of feldspar is completely altered to sericite; the other feldspar (plagioclase) grains are very strongly replaced by dark (tourmaline? or carbonaceous?) indeterminate phase(s)(some relict albite twins are recognizable in some of these)-, and sericite (to a lesser extent); there is ambiguity concerning this dark material - it is semi-opaque, its "acicularlath-like" habit may actually merely reflect its intimate intergrowth with micaceous materials; some of the micaceous material is pleochroic (colorless-grey), and probably is chlorite (after biotite?).
OC2418-A	Granitic rock; feldspars completely sericitized and also replaced by tourmaline(?); dark opaque (carbonaceous?) material disseminated through rock, some associated with red opaque (hematite-appearing) material, which latter also is seen lining fractures, as well as intergranular to the other phases.
OC2418-B	Breccia (fault zone?); angular quartz fragments, and larger fragments of granite (with feldspar altered to sericite ± other phases;

1/ Location of samples shown in figure 6.

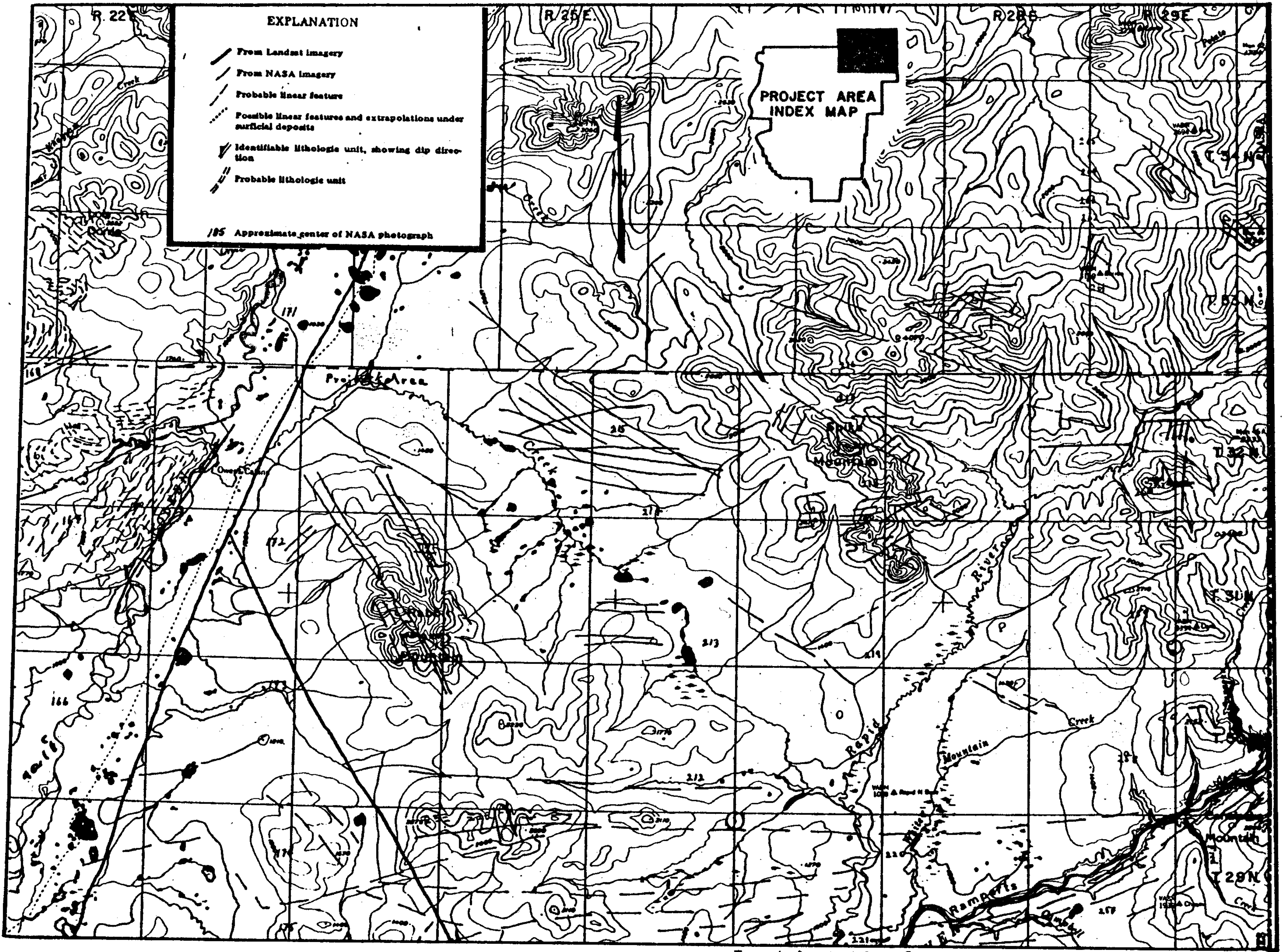
TABLE 1. - Petrography of "Black Granites", continued

Sample Number	Remarks
OC2418-B (cont.)	and replacement tourmaline [?] as well); some muscovitic mica; wall rock composed of granitic rock; matrix heavily impregnated/dusted with dark opaque material (as are many of the more highly altered feldspars in some of the fragments); the fragments are a heterogeneous assemblage, and are not all from the same source material; presumably the ubiquitous dark opaque material is carbonaceous.



Topography from USGS Coleen quadrangle 1:250000

FIGURE 6.-Rock sample locations, VABM Orphan area



Topography from USGS Coleen Quadrangle 1:250,000

FIGURE 7.- Air photo lineaments--granitic terrane

1) Linear features similar to "horsetail fractures" on Rabbit Mountain that may be mineralized and coincide with minor mineralization found to occur there.

2) A focus of lineaments around Spike Mountain that may localize any mineralization originating in the granite.

3) A circular feature in T. 31 N., R. 29 E. probably attributable to a lithologic unit but which coincides with an occurrence of copper, lead and zinc mineralization described in the White Mountain Creek prospect portion of this report.

4) An obvious lithologic linear south of the batholith, where a massive persistent quartzite bed outcrops over a strike length of about 20 miles. A circular feature with quartzite outcrops is noted along this linear in T. 29 N., R. 26 and 27 E., which may relate to basaltic lava found as float rock nearby. Chalcedony veining was also observed.

5) Although three miles north of the project boundary, an intensely fractured area of the intermediate zone of the Old Crow batholith in T. 33 N., R. 28 E. has potential for mineralization associated with the granite. These fractures or shears frequently show chloritic, clay and muscovite alteration. Some rhyolite volcanics found as rubble.

6) East-west linear associated with uranium mineralization in T.32 N., R.29 E. (see Rapid River Uranium Prospect).

Air photographs did not provide complete coverage in the batholith area, since flight lines diverged.

Possible Economic Deposit Types

Available information from previous investigations, the present field studies and occurrences of mineralization were combined in an attempt to define potential mineralization types associated with the Old Crow granitic terrane. Where possible, known prospects were then classified as representative of these various types. While other types of deposition are conceivable in this region, there was no direct evidence to support such possibilities. The results are preliminary at this time, but are a necessary step as an integral part of any land resource evaluation. Occurrence and prospect evaluations are described in more detail in a later section of this report.

Vein-Type Deposits

These are relatively small but high grade deposits of sulfide mineralization in metasedimentary rock. Occurrences of this type are found locally, especially in the black phyllites, confined to fractures, shear zones or faults. They were observed on Rabbit Mountain and at several localities in the "Cone area" (VABM Cone), figure 8. Economic minerals include copper, lead, zinc, and silver, occasionally with antimony and bismuth values. In Canada several vein-type occurrences adjacent to the Old Crow batholith are reported to contain lead and zinc, and in one case tungsten (45). Barite occurs as veins in schist contact rock on the north side of the batholith (7), figure 8. Minor copper minerals are found in quartz vein swarms also cutting schist on the northwest side of the batholith.

The potential for this type of mineral deposition appears high in Paleozoic or older metasediments in close proximity to the granitic intrusive, particularly the rhyolites associated with black phyllites, calcareous units and schist.

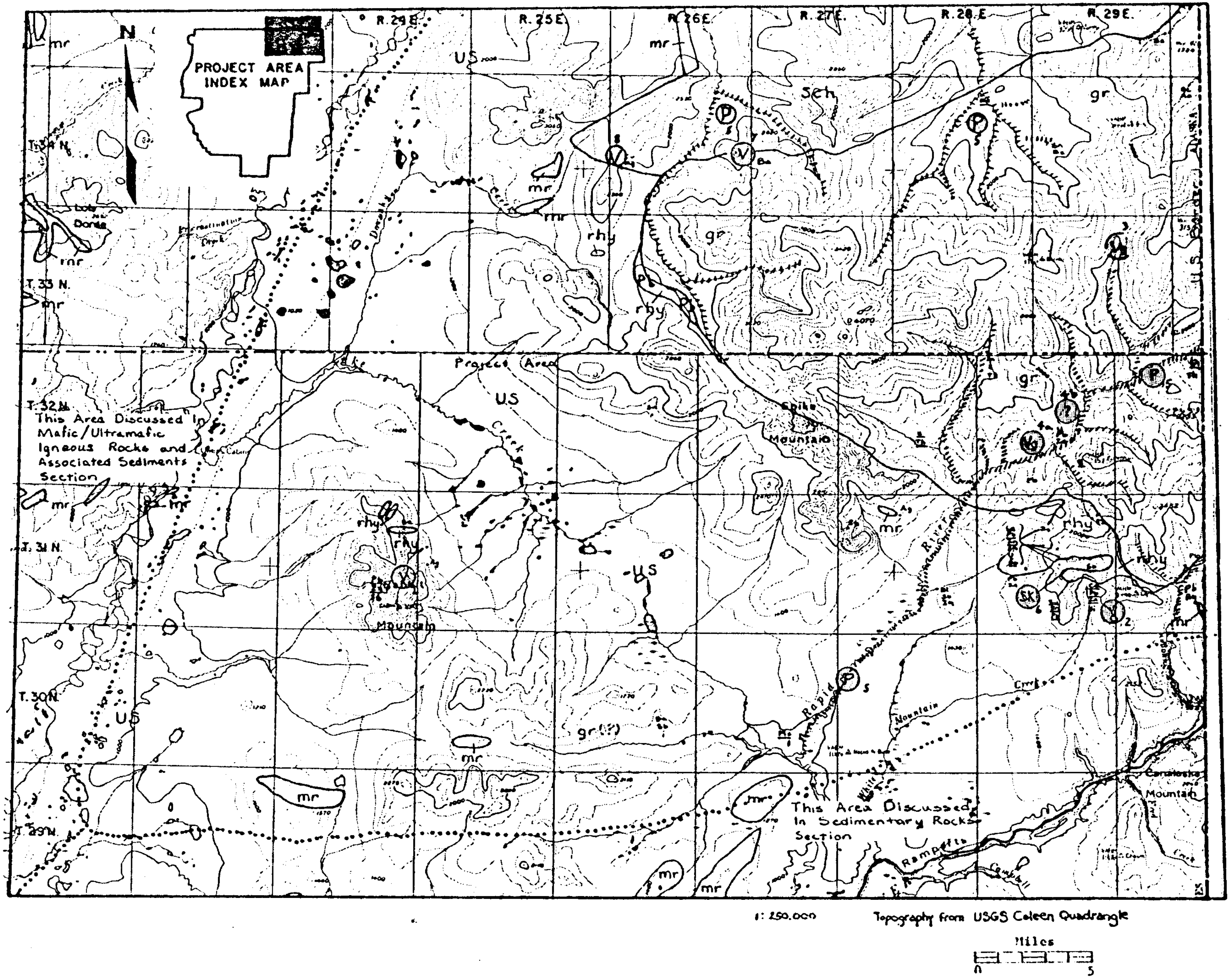


FIGURE 8.- Mineral occurrences and anomalies--granitic terrane

EXPLANATION

Geochemistry*

Cu - anomaly
Cu - group of anomalies

Ag - Silver
Au - Gold
Ba - Barium
Be - Beryllium
Bi - Bismuth
Cr - Chromium
Cu - Copper
Mo - Molybdenum
Ni - Nickel
Pb - Lead
Sb - Antimony
Sn - Tin
U - Uranium
W - Tungsten
Zn - Zinc

Possible deposit types

Ⓟ - Placer
(St) - Stratiform
(Sk) - "Skarn" type
Ⓥ - Vein or Breccia
(Vg) - Vein in granite
? - Mineralization of unknown deposit type
〰 - Potential placer stream

Rock Types (after Brosge and Reiser, 1968)

us	Undifferentiated sedimentary rocks and sediments.
gr	Granitic rocks.
rhy	Rhyolite; some granite.
sch	Quartz-mica schist; some greenschist quartzite.
mr	Mafic volcanic rocks.
-----	Terrane boundary.
—·—	Project area boundary

Prospects/Occurence

1. Rabbit Mtn - copper, lead
2. White Mtn Creek - copper, lead prospect
3. VABM Barren-uranium
4(a-b). Rapid River - uranium, tin occurrences
5. Old Crow Hills - tin, tungsten, rare earths placer prospects
6. Copper, lead, zinc prospect
7. Barite veins
8. Minor copper occurrence

*See appendices for analyses and locations of individual samples.

This should include those areas believed to be underlain by granite as indicated by magnetics, figure 4.

Since tin is known to be associated with the batholith, the possibility of cassiterite veins in the metamorphics should be considered. Such veins are usually apical and the vicinity of western end of the batholith may be particularly favorable.

Granitic-Associated Veins, Brecciations, and Silicic Zones

Secondary quartz veins and late stage silica, hematite concentrations and muscovite development occur in the Old Crow batholith, and in several cases contain uranium minerals, lead, zinc and minor tin values (see prospect reports). High residual concentrations of cassiterite and scheelite also appear to be derived from these sources. The presence of veins may indicate relatively small to medium-size but high grade deposits of these minerals, such as those mined in France and Czechoslovokia.

Some muscovite development in hybrid granitoid rock was noted in an altered breccia zone which also contained tin and uranium values in T. 32 N., R. 29 E. Brecciation and associated alteration is probably related to the extensive shearing in the cntrusive and this should be considered favorable for remobilized, volcanic or late intrusive related mineralization. Silica-rich breccia zones in the batholith appear confined to the previously described intermediate zone. A moderate to very deformed cataclastic texture is common in the quartz material.

The potential for this type of deposit is confirmed by the mineral occurrences found, however further work is necessary to determine if mineralization is economic. An intensely sheared area just north of the project boundary should also be investigated for this type of deposition.

Porphyry

For the purposes of this report, this group will include consideration of intrusive breccias, breccia pipes, and uranium porphyries [as described by Armstrong, 1970 (1)], as well as the more well-known copper/molybdenum intrusive deposits characteristic of the North American Cordillera. They are often closely related to mineralized vein systems. Supergene and relic hypogene enrichment of secondary minerals possibly could also occur in this highly weathered, deeply leached and unglaciated terrain.

A brecciated rhyolite body near the Bear Mountain pluton, 55 miles to the north was found to be mineralized with tungsten, molybdenum and lead. These rhyolites are similar in composition and emplacement to those on the perimeter of the Old Crow batholith.

"Porphyry type" uranium deposition of large tonnage and relatively low-grade mineralization is indicated to be possible in either differentiated phases of the granite or in rhyolite intrusives. However, due to deep leaching and weathering, subsurface evaluation would be necessary to further define the possibility. An occurrence of boulder rubble near VABM Barren of a highly altered zone of muscovite/minor biotite fine-grained granite rock, typical of that area (containing 31 ppm uranium) could be an example of a differentiated and altered phase with low grade "porphyry uranium" possibilities.

Some phases and tectonic structure of the finer-grained granites in the headwaters of the Rapid River have potential for lead, tin, and tungsten. The tin, tungsten and molybdenum geochemical anomalies (Appendix A) in upper Rapid River near the border may indicate sulfide phases of these elements associated with this type of deposit environment.

Particular emphasis for "porphyry-type" deposits should be given the region near the western extreme of the batholith.

Skarn

The possibilities for contact metamorphic/metasomatic deposits are probably limited to the intrusive granitic and/or rhyolite sill contacts with limestone, black shales to phyllites, and calcareous argillites along the southeastern perimeter of the pluton. The nature of the granitic rock suggests reasonably good potential exists for deposits of this type in the limited region. Several small showings of skarn development containing high-grade magnetite, sphalerite, bornite, and other sulfides were found at a calc-argillite contact with rhyolite near a geochemically anomalous area at the head of White Mountain Creek. Thermally altered calc-argillites containing up to 0.08% tin are found nearby. Eastward in Canada, a reported skarn contains tungsten, copper, and uranium at the contact with the genetically related Mount Fitton granite (21).

Placer

Alluvial gravels of the Rapid River and Strangle Woman drainages were found to be consistently enriched with cassiterite, scheelite, monazite, zircon, allanite, xenotime and minor amounts of lead and niobium minerals. Surface sampling indicates that extensive economic placers may exist. Other smaller drainages of the Old Crow pluton may also be mineralized at locations within and downstream of the granite or its contact metamorphic surroundings. Residual-type placers are likely in the deeply weathered (saprolite) zones, but would be of lower grade and extensively frozen. Preliminary work by the Bureau has identified possible tin placers in the the high bench ancient channels of the Porcupine River near the the International Border.

The probability for placer formations is enhanced by the lack of glaciation and the evidence of significant and recent uplift and subsequent erosion. Drilling and/or subsurface sampling will be necessary to confirm the presence and grade of possible economic placers.

Other Deposit Types

A number of soil samples from the "intermediate" zone of the intrusive have indicated a high background in lithium which is probably being derived from greisen-like alterations of the intrusive. No further investigation was made.

No pegmatities have been observed by the author in the Old Crow area, but they might be anticipated in this type of plutonic environment. High concentrations of certain trace elements often associated with pegmatites were detected in pan concentrate samples from streams within the granitic terrane.

Tantalum- and niobium-rich phases, either as pegmatites or in other deposit forms, may be of economic interest due to the high unit value of these elements. Minor niobium values were frequently found in granitic samples analyzed by the Los Alamos Laboratory, however, no significant tantalum was detected.

Mafic/Ultramafic Igneous Rocks and Associated Sediments

Geology

Mafic and ultramafic igneous rocks interlayered with maroon and green chert, shale, basalt flows and graywacke occur within the study area north and west of the Porcupine River. The predominantly intrusive igneous rocks, which form a portion of the Christian River sequence have been assigned a Jurassic age based on two K-Ar determinations on hornblende (35). Large sheared blocks of Triassic and possibly older sedimentary rocks occur as "rafted" inclusions in the igneous assemblage. The interlayered chert, shale, and graywacke, which tend to dip toward the center of the complex lie in a structural basin and have been dated late Paleozoic to Jurassic (35). A prominent northeasterly trending linear which parallels the Coleen River valley forms the eastern margin of the complex and suggests a down-thrown basement to the west.

Recent studies of radiolarian chert indicate that older ages, i.e. from Carboniferous to Permian, are probably more likely to be valid (7). The igneous rocks may represent sheeted dikes or a differentiated body, though the interbedded cherts and shales strongly suggest an ophiolitic affinity.

Reiser and others (35) have noted that the igneous complex can be separated into two distinct groups. The predominant rocks are dark colored and consist largely of gabbro, diabase, and basalt. Generally these rocks have been hydrothermally altered. The light colored group consists primarily of interbanded hornblende leucogabbro, anorthosite, hornblende gabbro, pyroxenite and peridotite, and hosts at least one known chromite occurrence, figure 9. The relations of the two groups have not been established.

Interpretive Studies

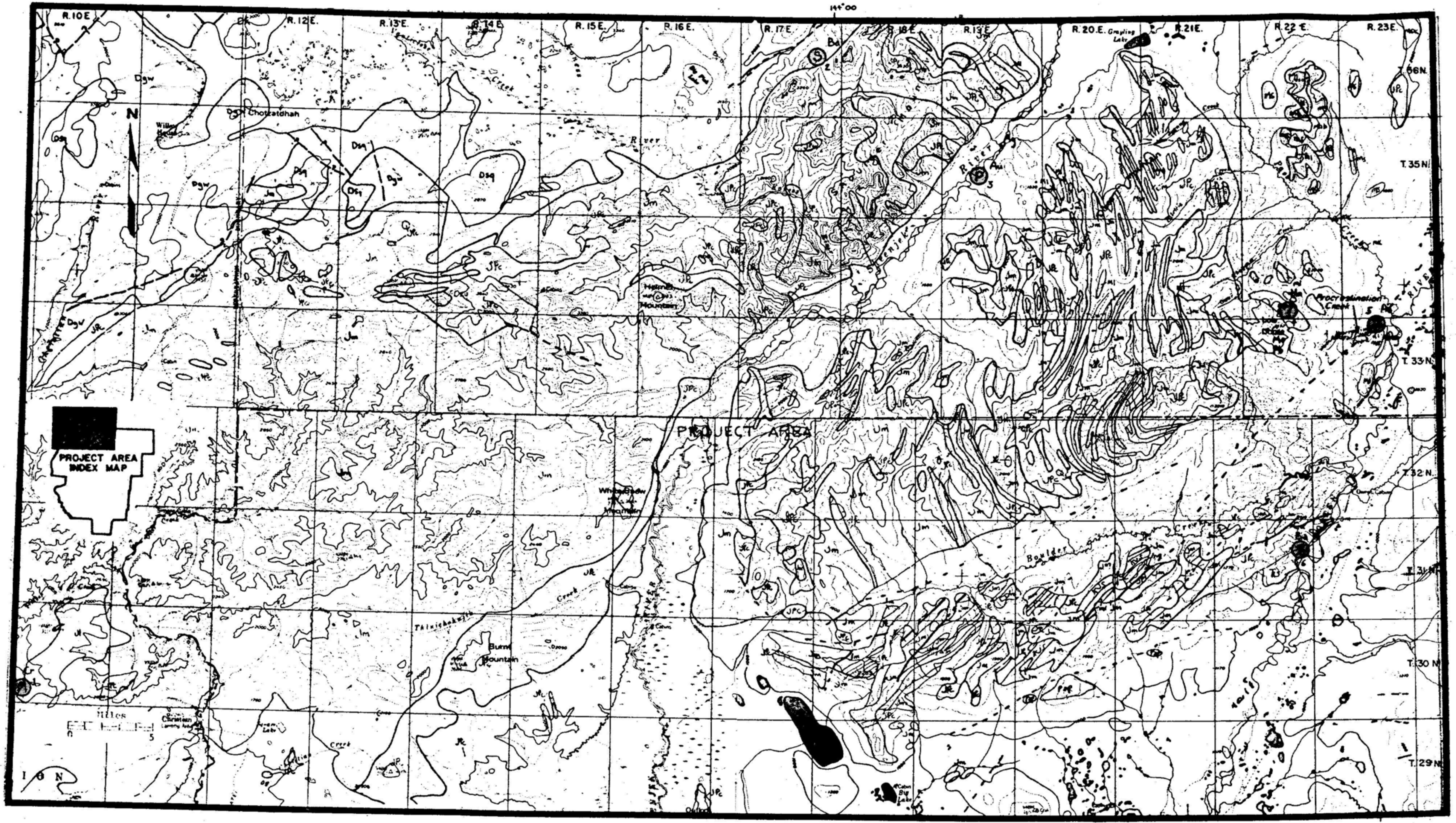
Aeromagnetic data (8) infers that the complex is bounded by faults to the northwest and by faults and a granite basement to the south. It has been suggested that portions of the complex may have been thrust northward into the area, similarly to the situation which has been interpreted for a mafic/ultramafic unit in the Beaver quadrangle to the southwest (7).

Very little is known about this complex of rocks, as outcrops are scarce, particularly on the eastern end which is the portion in the study area. The vegetation cover is so nearly continuous that float rock is often difficult to find, even on ridge tops and in creeks. The drainage systems generally consist of tundra seeps between thermokarst ponds, rather than down-cutting streams. Geochemical sampling in this terrain is therefore of dubious value. Very little field investigation was possible in the area.

Airphoto interpretation of the complex (figure 10) has indicated strong north-northeast lineations within and to the east of the complex, which trend subparallel to the previously mentioned major lineament following the Coleen River valley. Fairly conspicuous alternating resistant and non-resistant lithologic units are also noted in the complex. It is on the basis of sudden discordancies in trends of these lithologic traces that two probable fault traces are shown in the vicinity of Boulder Creek in T. 32 N., R. 22 E. on figure 10.

Linear features similar to "horsetail" fractures, which may be mineralized, are evident north of Vundik Lake (T. 30 N., R. 17 E.) and also in T. 30 N., R. 19 and 20 E.

Intersecting lineaments in T. 31 N., R. 22 E. coincide with barium and copper geochemical anomalies and an occurrence of barite float rock, figure 9, No. 6.



Topography from USGS Christian and Coleen Quadrangle 1:250,000

FIGURE 9.- Mineral occurrences and anomalies--mafic/ultramafic terrane

EXPLANATION

Geochemistry*

Cu - anomaly
Cu - group of anomalies

Ag - Silver
Au - Gold
Ba - Barium
Be - Beryllium
Bi - Bismuth
Cr - Chromium
Cu - Copper
Mo - Molybdenum
Ni - Nickel
Pb - Lead
Sb - Antimony
Sn - Tin
U - Uranium
W - Tungsten
Zn - Zinc

Possible deposit types

Ⓟ - Placer
Ⓜ - Magmatic-mafic/ultramafic
(?) - Mineralization of unknown deposit type
⫽ - Potential placer stream
(Sf) - Strataform

Prospects/Occurrences

1. Venetie chromite (22)
2. Bedded barite (7)
3. Sheenjek gold occurrence (11)
4. Manganese vein (23)
5. Procrastination Creek gold placer
6. Coleen River copper, barite

Geology (Modified after Brosge and Reiser, 1962 and 1969

Jurassic or Cretaceous. . . .	KJs	- sandstone
	Jm	- gabbro, basalt, quartz diorite
Jurassic.	Jl	- leucogabbro, anorthosite and ultramafic rocks
Triassic.	ŦRS	- Shublik Formation-black, partly calcareous shale
Jurassic or Permian	Jpc	- chert, sandstone, shale
	Mss	- sandstone
	Ms.	- siltstone
	Ml	- Lisburne Group - limestone
	Mlb	- Lisburne Group - brown weathering limestone
Mississippian	MK	- Kayak shale
Mississippian or Devonian	MDK	- Kekiktuk or Kanayut conglomerate
	Dsq	- quartzite, slate, graywacke
	DK	- Kanayut conglomerate
Upper Devonian.	DgW	- micaceous lithic graywacke and shale
Paleozoic	Pzp	- phyllite

——————— Contact
———— - - - Fault, dashed where inferred
—— — —— — —— Project area boundary

*See appendixes for analyses and locations of individual samples.

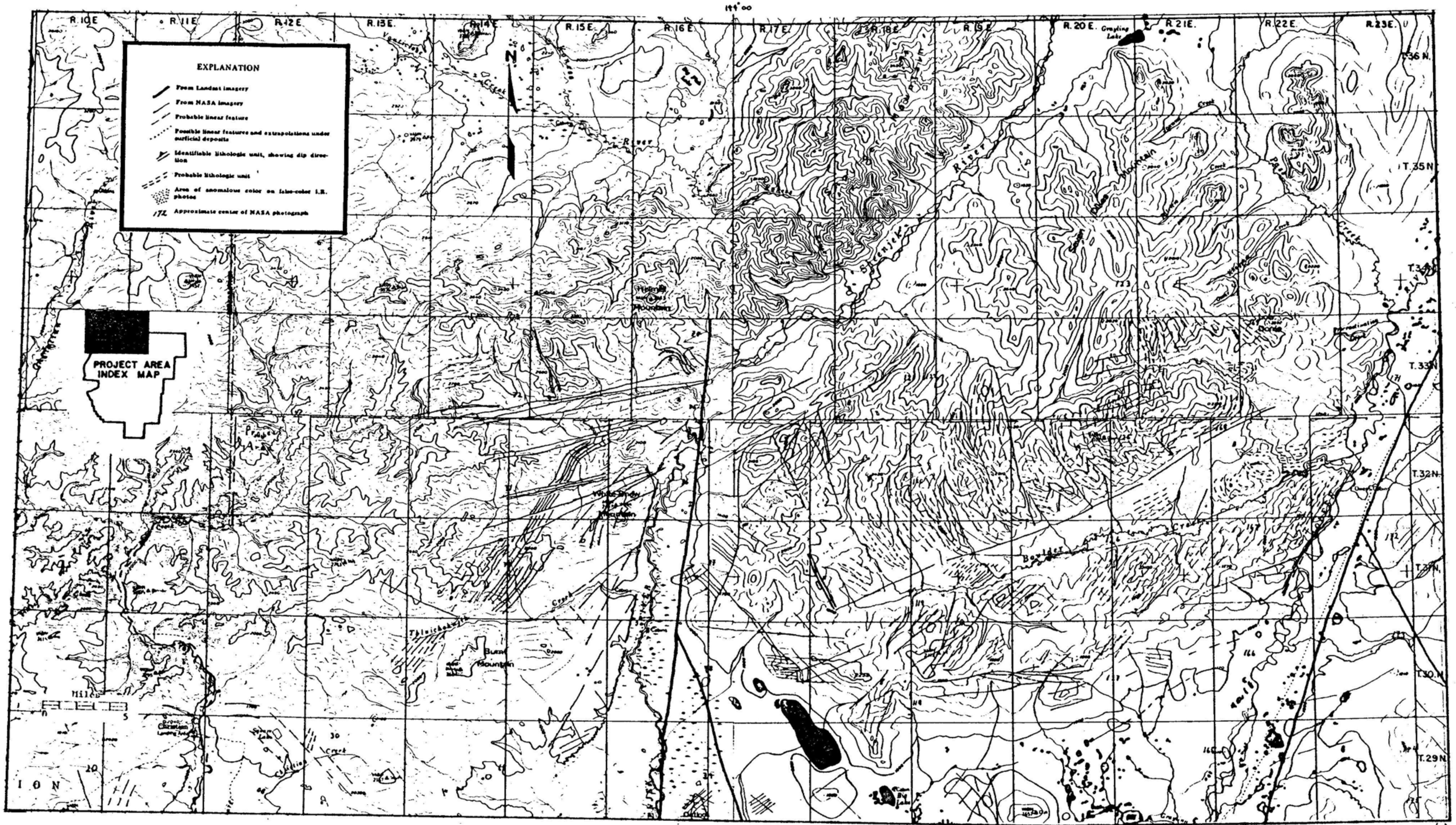


FIGURE 10.- Air photo lineaments--mafic/ultramafic terrane

Topography from USGS Christian and Coleen Quadrangles 1:250,000

Possible Economic Deposit Types

There is little known mineralization within this enigmatic complex of rocks. The following list of possible deposit types and mineral potential is based on a few known occurrences, as well as deposit types characteristic of mafic/ultramafic associations elsewhere.

Mafic/Ultramafic Associations

There have been no reported occurrences of chromite, or other economic minerals typical of mafic/ultramafic associations and magmatic segregations (including iron, nickel, cobalt, and platinoid minerals) within the project area. But, since very little is known about the nature of the complex, the potential existence of such deposits should be tentatively considered.

Chromite, as well as traces of platinoid metals, are known to occur within ultramafic rocks at one location immediately west of the report area in the Christian River sequence, figure 9. The occurrence is located in T. 30 N., R. 9 E. The following description of the occurrence was reported by Hawley and Garcia (22).

> [On Hill 2470] peridotitic rocks are exposed and the yellowish soil contains residual nodules one to two inches across of a weakly magnetic dark material. Analyses of about a 2 pound sample of nodules showed 4.5 percent chromium and a trace (0.10 ppm) of platinum and a lesser concentration of palladium. Anomalous chromium and detectable platinum metals were also found.

Until this sequence of rocks is better understood, the significance of this chromite occurrence cannot be determined. If the ultramafic rocks are part of a layered intrusion, possible significant chromium and platinum values might be expected. If instead they are of "alpine" affinity, which is more likely, the chromite would perhaps be more likely to occur only as probably uneconomic, small, podiform deposits, although this is not always the case.

Massive Sulfide Deposits

The possible ophiolite sequence of interbedded mafic volcanic rocks, radiolarian cherts and shales could be a potential host for copper, with gold and possibly zinc, in massive sulfide deposits. This type of deposit would be similar to marine basaltic lavas and pyroclastic associates which host the well known Cyprus copper sulfide mineralization. A few gold and copper anomalies occur in the northeastern part of this rock sequence (i.e. Procrastination Creek) and are shown in figure 9.

Placer-Platinum and Gold

The potential for economic concentrations of minerals within the alluvial gravels of the Christian complex is generally unassessed and surficial expression of their existence would be poor in this covered terrain. Platinum placers are found associated with mafic/ultramafic complexes elsewhere. Gold is known to occur with greenstone-volcanic sequences. On Procrastination Creek, a tributary to the Coleen River, several gold placer claims were staked in the 1950's. A rock sample containing traces of gold has also been reported from this last location (11). Brosge also reported a single occurrence of gold placer on the Sheenjek River (figure 9, map No. 3).

Sedimentary-Barite

Bedded barite occurs within the Christian complex [north of the report area (T. 36 N., R. 17 E.)] in interlayered chert, argillite, and mafic rocks, figure 9. The largest barite bed is about 20 feet thick, and is exposed for about 100 feet. Several other thinly bedded occurrences and barite nodules in shale have been noted in this vicinity (7).

Fragments of white massive barite in stream gravel, and pan concentrated samples also containing barite were found in the same units at location 6 (T. 31 N., R. 22 E.), figure 9, (see prospect description).

Based on these two occurrences, upper Paleozoic to lower Mesozoic shales and cherts associated with the mafic complex appear to have potential as host rocks for bedded barite deposits. A sedimentary origin (with or without volcanogenic affinities) for the barite is possible, as is, alternatively, a hydrothermal source related to the mafic complex which intrudes the sediments.

The quality of barite that occurs within the area is unknown, but it appears to be free of sulfides.

Other Deposit Types

Manganese has been reported to occur in the Lois Dome area (T. 34 N., R. 22 E.) as a one inch vein of psilomelane within red ferruginous argillite (23), figure 9. Brosge and Reiser (11) report minor gold values in a manganiferous pebble from this same vicinity. Manganese oxide was common in heavy mineral concentrates.

The origin and extent of manganese mineralization within the project area is unknown. The possibilities for several different deposit types exist, including a sedimentary origin within the Paleozoic(?) shales, or more likely, a source associated with the mafic volcanics. Similar Paleozoic and Mesozoic chert-greenstone ophiolite complexes in the western United States are host to massive stratiform manganese deposits. It is believed that these deposits were formed by submarine hot springs at localities such as a midocean rise or the base of an island arc (40).

Asbestos associated with serpentinized ultramafic rocks is a possibility; however, the ultramafic portion of the Christian complex has been reported to be fairly small and no serpentinization has been noted. Since very little is known about the geology of the complex, the potential for asbestos mineralization is unknown. Attention should be focused on the mafic complex intrusive units near the region believed to be underlain by a granitic basement of unknown age, figure 4. If the latter is younger, the potential for serpentine alteration would be enhanced.

Sedimentary Rocks

Geology

Sedimentary rock units of the Porcupine study area are shown in figure 11. The rocks are best described where they are exposed along the Porcupine River canyon; very little is known of the sediment units in the study area to the south of the river. Early to middle Paleozoic rocks consist predominantly of limestone and dolomites that formed on the Yukon carbonate shelf which extended eastward into Canada. In the Yukon Territory these rocks probably correlate to the clastics (i.e. Road River Formation) (17) which host some Canadian lead-zinc deposits.

A mid-Devonian disconformity is mapped through these rock units within the Porcupine River sequence, and generally a regional angular unconformity has also been recognized between Late Devonian and younger rocks relating to tectonic activity which began in that period within this part of Alaska.

The Carboniferous section consists of partly carbonaceous and hematitic sandstones overlain by thinly interbedded limestone, shale and chert. The Permian is predominantly a detrital facies of chert-pebble conglomerate, sandstone, siltstone, and argillaceous rocks which are possibly equivalent to the Siksikpuk Formation of northern Alaska. Highly carbonaceous shales of this age outcrop along the Porcupine River. Locally, limy interbeds occur indicating a shelf margin facies change, and these limestones may reach thicknesses of several hundred feet.

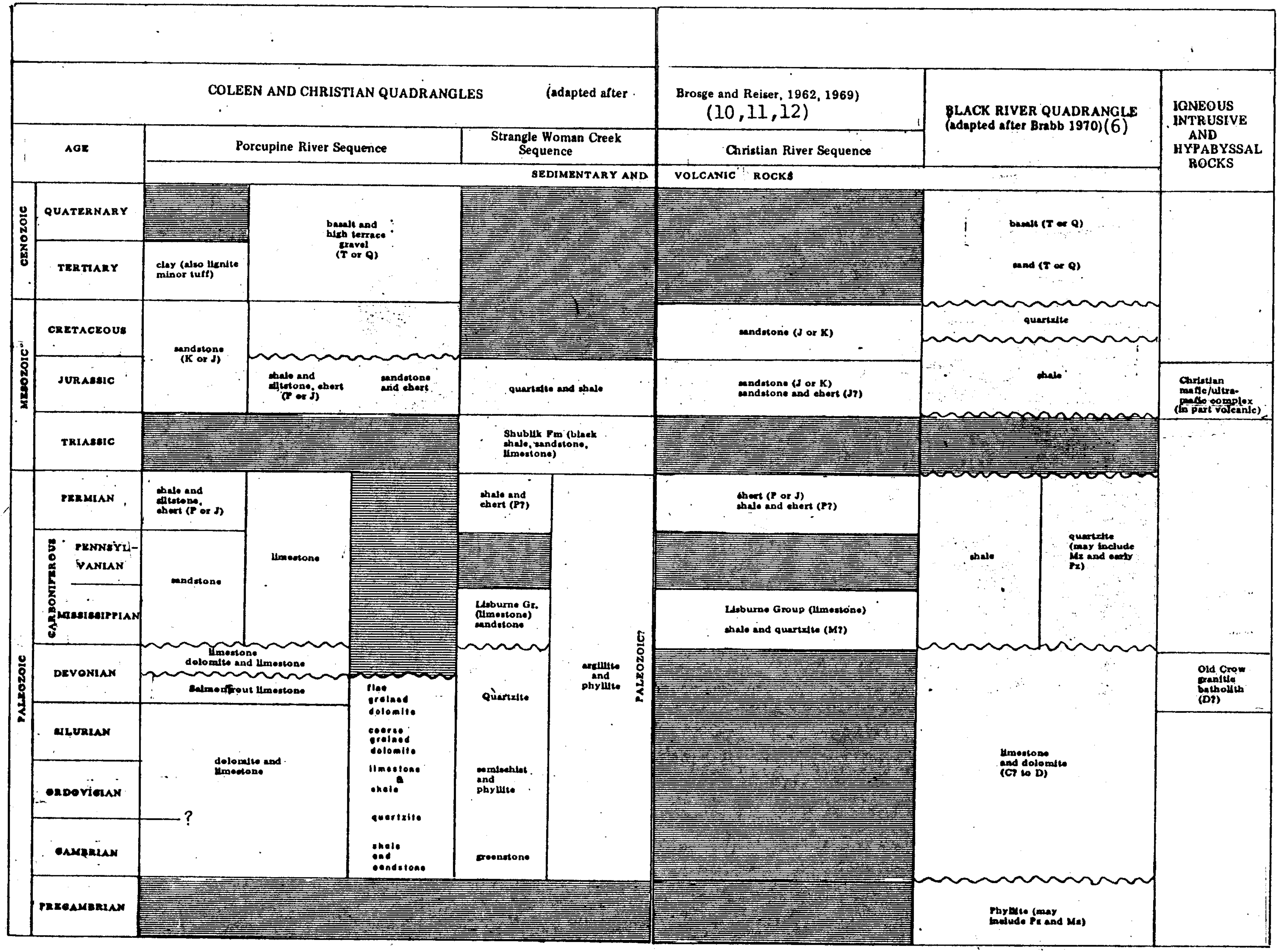


FIGURE 11.- Correlation chart for rock units of the Porcupine area

Carboniferous to Permian rocks of the Black River region consist predominently of quartzite and shale. Immediately east of the study area within the Black River Quadrangle is a large poorly known area of Precambrian bedrock. This unit consists of semi-phyllite, sandstone, graywacke, slate and meta-carbonates.

Along the Porcupine River, close to the Canadian border, a thick sequence of white and orange weathering dolomite, pyritic quartzite and black carbonaceous and limy shales occur, and these are intruded by younger greenstone dikes. Although mapped most recently as Paleozoic, earlier workers have considered these sediments to be Precambrian in age (13). Canadian geologists consider these to be part of the Precambrian Tindir group (20). Dolomites of this area frequently contain extensive and numerous randomly oriented veinlets and breccia fillings of chalcedony.

Triassic units, not recognized throughout most of the report area, are mapped only in the Strangle Woman sequence (figure 11) which occurs in the northcentral portion of the study area. Here highly sheared, deformed and partially silicified Triassic black shales, sandstone, and limestone of the Shublik Formation occur within relatively small areas along the Coleen River (12). The tectonic activity is probably related to movement along the "Coleen lineament".

Jurassic and Cretaceous rocks, predominantly products of detrital sedimentation, occur in the Porcupine River area and consist of sandstones, siltstones, shales, with some cherts. Units of these rocks five to ten miles south of the Porcupine are either in fault contact or unconformably overlie the older sediments. Thick beds of gray chert breccia are also recognized, within the Porcupine River sequence, to be of Permian or Jurassic age. In the Black River area these units appear to be predominantly quartzite to slate and shale in composition.

Tertiary sediments consist predominantly of weakly to moderately lithified gravels, mudstone and sandstone with clay, lignite, ash and minor tuff. They outcrop in the "Coleen Basin" near Fishhook Bend of the Porcupine River (34). Residual hematite, partially petrified wood and plant fragments are common in the gravels. Fossils indicating both non-marine and some marine facies are also present (12).

Tertiary or Quaternary basalt flows cap the Porcupine sequence in the vicinity of the Porcupine River, and to the south into the Black River quadrangle. Some areas of the Tertiary sediments east of the Coleen River appear to be covered by these flows.

It is likely that a thick stratigraphic section of Tertiary sediments underlie the expansive Yukon Flats. Vegetative cover is continuous in this area but the occurrence of remobilized soda-ash precipitate lake beds suggest an original origin within a climate typical of the Tertiary period, as reflected by Tertiary sedimentary rocks elsewhere in this region.

Interpretive Studies

Aeromagnetic Data

Aeromagnetic data shows inferred crystalline basement extending from the Old Crow batholith to beneath sedimentary rocks of the upper Porcupine River, figure 4. This crystalline basement, which would have intruded the Lower Paleozoic sedimentary units, could have unresolved implications for mineralization as proposed by Baadsgaard and others (2) below a major Devonian - Mississippian unconformity.

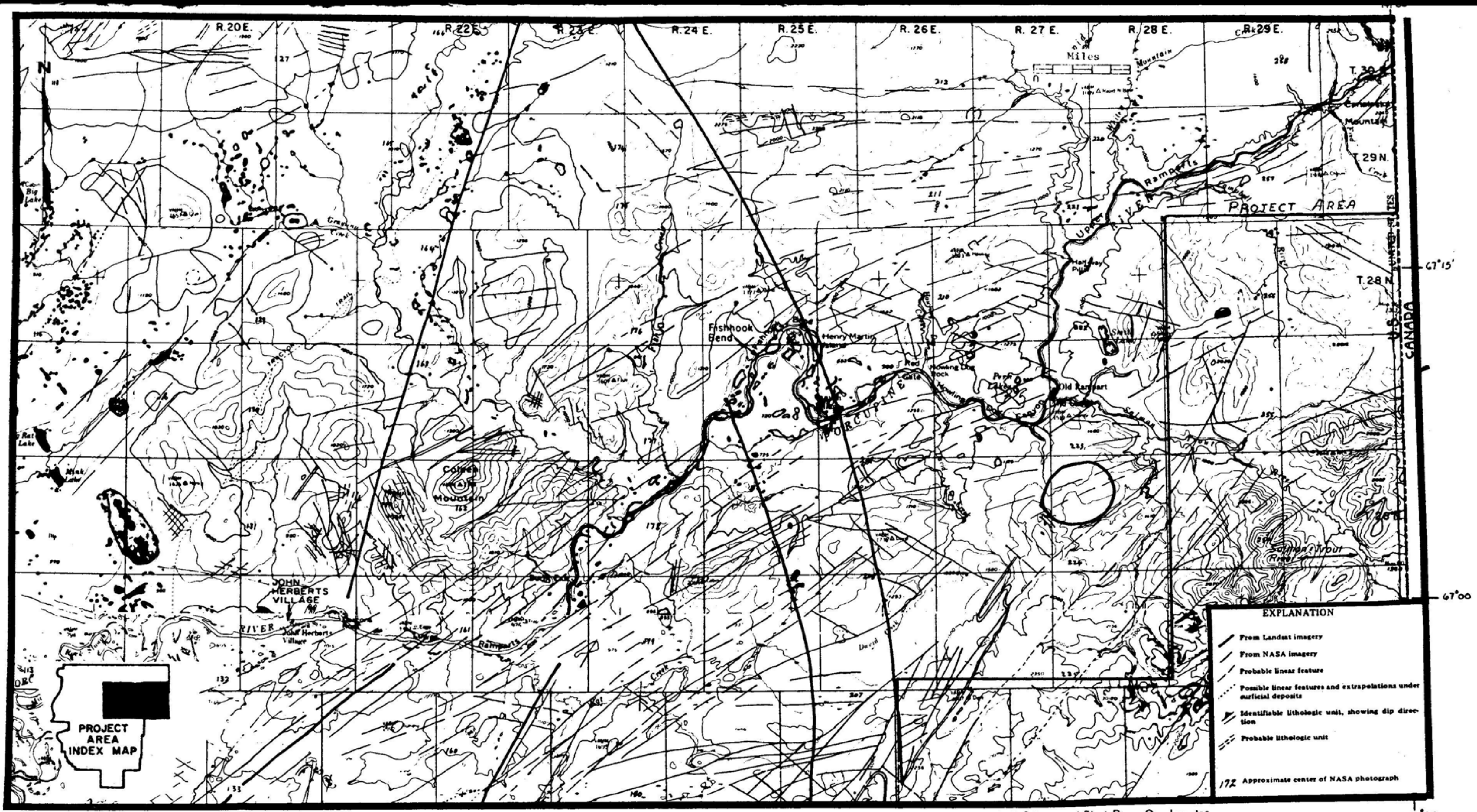
Also indicated are extensive areas of mafic intrusive and extrusive rock that are inferred to lie within the Yukon Flats Tertiary basin. Small areas of concealed mafic rocks are also indicated in the vicinity of the basalt flows on the Upper Porcupine River.

Air Photo Interpretations

Air photo interpretations for the sedimentary terrane of this report are shown in figures 12 and 13. Time and funds available for on the ground follow-up generally limited field work to only the northern portion covered in figure 12, which was accessible to the Porcupine River. Very little is known of the geology or mineral potential of the area to the south, which can only be described as "most extensively" vegetated. Further geologic, geochemical and geophysical surveys are necessary to adequately interpret the airphoto data.

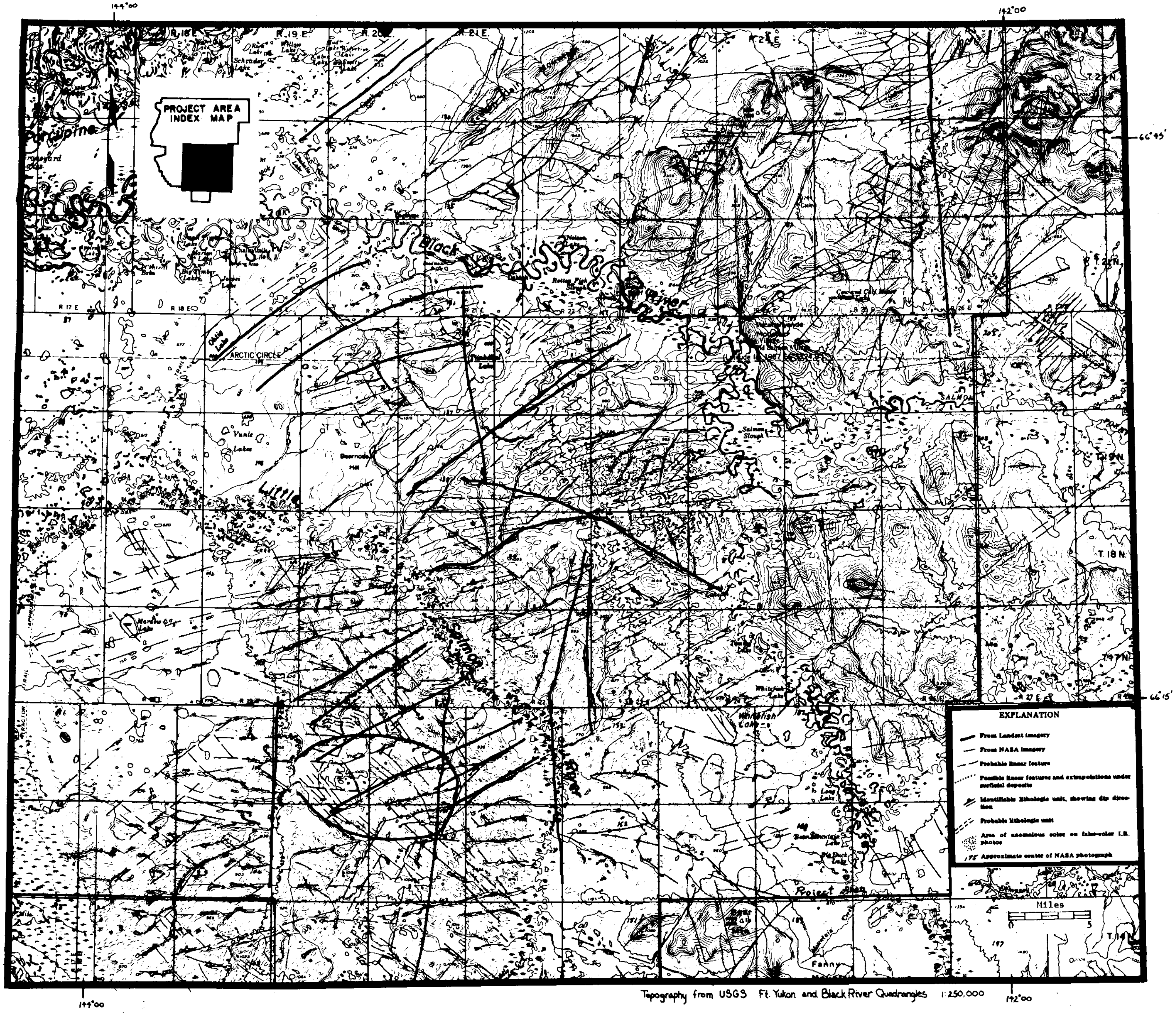
In the northern portion (figure 12), the most favorable foci of fracturing which might serve as localizing agents for mineralization are as follows:

1. A zone around the northwest and west-northwest lineaments in the area north of Fishhook Bend, where they are intercepted by numerous northeasterly lineaments (T. 28 N., R. 26 E.). A pan concentrate sample was anomalously high in molybdenum in this area (sample No. 89).
2. An intensely fractured area north of John Herberts Village is located near the intercept of a north-northeasterly megalineament and several northeasterly and northwesterly lineaments (T. 26 N., R. 21 E.).
3. An area north of the Salmon Trout River, about 12 miles upstream from the confluence with the Porcupine River, where several northeasterly lineaments converge and intersect northerly and northwesterly lineaments. Zinc and silver geochemical anomalies have been noted in this vicinity by a previous study (11). Brief follow-up did not indicate readily apparent mineralization, however.
4. A sub-circular feature about 6 miles south of Old Rampart may represent a center of uplift with possible associated mineralization, or may be related to the nearby Quaternary basaltic flows. A sample of pyritic limestone and calcite veins to the east contained minor values



Topography from USGS Coleen and Black River Quadrangles

FIGURE 12.-Air photo lineaments-northern portion, sedimentary terrane



Topography from USGS Ft. Yukon and Black River Quadrangles 1:250,000

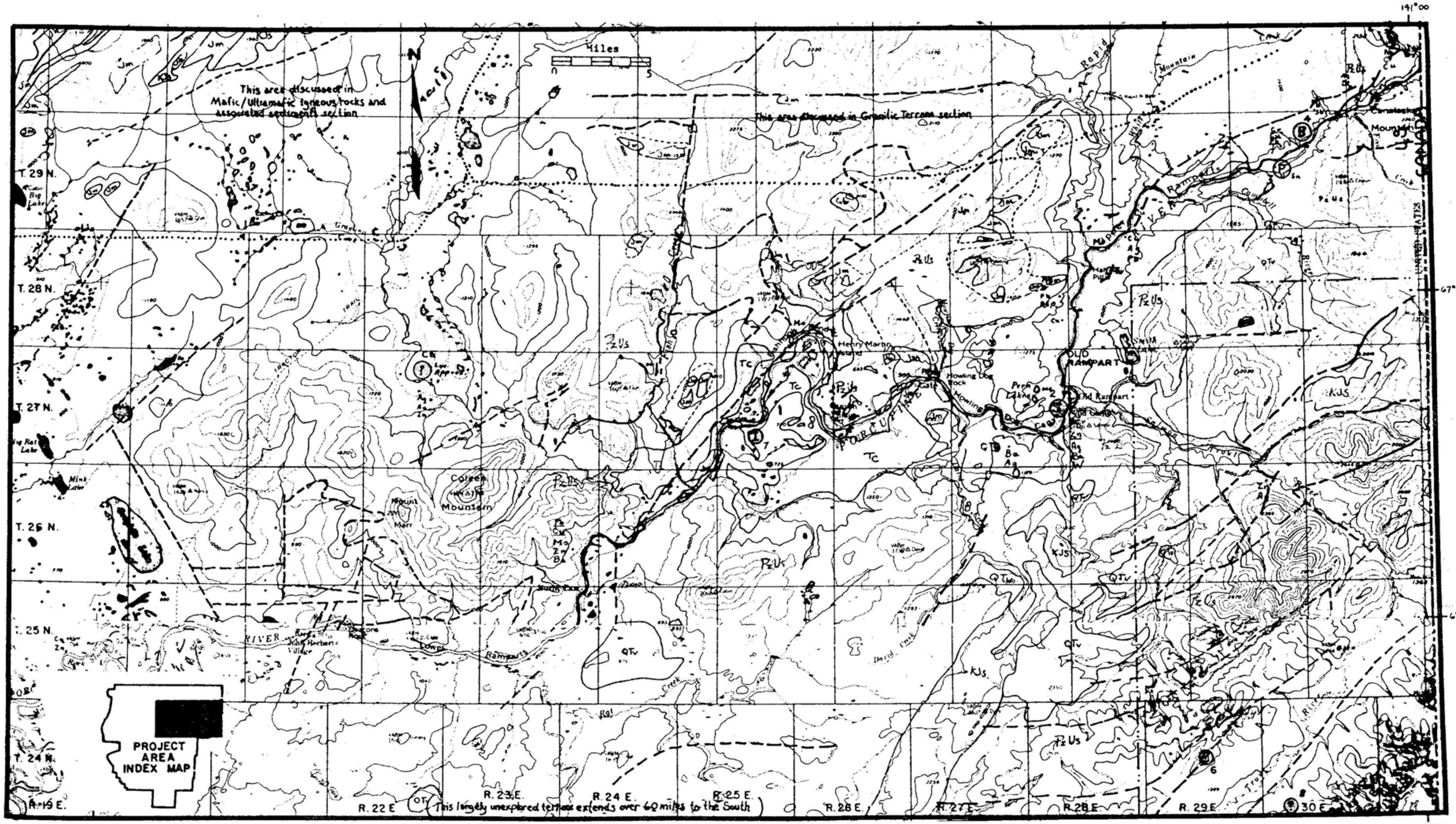
FIGURE 13.- Air photo lineaments--southern portion, sedimentary terrane

of silver and molybdenum. Iron-stained carbonates interbedded with black shales just south of Old Rampart are highly anomalous in copper, lead, zinc, barium and silver (figure 14).

5. Along the Upper Porcupine (T. 29 N., R. 29 E.), air photographs show abandoned river channels several hundred feet above the present elevation of the river over a distance of approximately ten miles. Pan concentrate samples contained detectable tin, tungsten and rare earth minerals (Refer to discussion of the Porcupine River ancient placer occurrences).

The southern portion of the study area is shown in figure 13. Numerous linear features were discernible on the Landsat images in this area. Only those features were added to the map which did not coincide with linear features already identified from study of the NASA photographs. This area, which is mapped (6) as predominantly covered by Quaternary loess, has many linear features evident on both NASA photographs and satellite imagery. These linears may be due to regular drainage and erosion of a formerly horizontal planar sheet of homogeneous loess, but it is more probable that the predominantly regular northeasterly and northwesterly pattern is caused by structures underlying the loess, probably at no great depth. Basalt flows known to be extensive to the southwest may also underlie this area and account for the structural pattern.

South of Black River, a single obvious sub-circular feature, as well as several obvious northeasterly and a few northerly trending features are observed on Landsat images. Many less obvious, but quite persistent northeasterly and northwesterly linears are visible on the NASA photographs, and some of them coincide with those interpreted from the Landsat images. These linears probably relate to subsurface fractures, and possibly to a slight domal uplift south of



Topography from USGS Coleen and Black River Quadrangles 1:250,000

FIGURE 14.- Mineral occurrences and anomalies--sedimentary terrane

EXPLANATION

Geochemistry*

Cu - anomaly
Cu - group of anomalies

Ag - silver
Au - Gold
Ba - Barium
Be - Beryllium
Bi - Bismuth
Cr - Chromium
Cu - Copper
Mo - Molybdenum
Ni - Nickel
Pb - Lead
Sb - Antimony
Sn - Tin
U - Uranium
W - Tungsten
Zn - Zinc

Possible deposit types

Ⓟ - Placer
(Sf) - Stratiform (Marine)
(?) - Mineralization of unknown deposit type
Ⓑ - Breccia filling
Ⓘ - Industrial minerals and coal

Geology (after Brosge and Reiser, 1969; Brabb, 1970)

Quaternary or Tertiary	QTv	Basalt flows.
Tertiary	Tc	Conglomerate, sandstone, clay, lignite and tuff
Cretaceous or Jurassic	KJs	Gray, ferruginous sandstone
Jurassic	Jm	Mafic rocks, gabbro, basalt, quartz diorite
Paleozoic.	PzUs	Undifferentiated Sedimentary rocks

———— - - - -	Contact, dashed where inferred
———— - - - -	Fault, dashed where inferred
. . . .	Terrane boundary
—— - - —— - -	Project area boundary

Prospects/Occurrences

1. Coleen Mountain or River prospect - copper (23)
2. Shale/carbonate - copper, zinc, lead
3. Porcupine River - ancient channel placer
4. Zinc values in carbonate breccia
5. Soda ash deposits, north and south of Chalkyitsik, (not shown on figure 14, located in T 20 N, R 18 W)
6. Lead, silver prospect by Doyon Ltd. (44)
7. Coal (lignite)
8. Lead, silver prospect by Doyon Ltd. (44)

the Little Black River in the vicinity of T. 15 and 16 N., R. 20 and 21 E.

Although topographic linear features are numerous in the southern portion of this terrane, except in a few instances they do not seem to form definite foci. The following represent only the most obvious locations where mineralization might be expected to be localized (figure 13):

1. In the vicinity of T. 16 N., R. 21 E., in a salient of the Little Black River, a sub-circular megalineament is intersected by northeasterly and northerly linear features. Several smaller-scale features also intersect nearby. A similar situation exists in the center of the township to the north.
2. A focus of intersections of quite persistent but narrow linears occur northeast of Whitefish Lake, and this radial pattern may be caused by local uplift.
3. A northwesterly megalineament "horsetail" between R. 22 and 23 E., T. 18 N., and the bifurcation coincides with the projections of two subparallel northerly megalineaments. A color anomaly readily visible as greenish-blue coloration of the falsecolor infra-red photographs is present in the same area which is probably due to unusually heavy growths of white spruce.
4. Two other small areas of color anomalies, both yellowish-blue, occur at the contact of the Permian quartzite and Devonian limestones in T. 21 N., R. 24 E., and T. 22 N., R. 22 E. These were not investigated.

Geochemistry

Geochemical studies were limited by the time and resources available for this study and did not permit a full regional reconnaissance of the sedimentary terrane. A survey was made, however, of all accessible streams that drain into the Porcupine and Coleen Rivers. This made possible a limited interpretation of geochemical background in many of the sedimentary units that comprise the terrane. For specific sample locations and analyses, refer to the Appendixes and to the analyses being open-filed by the D.O.E.

The following discussions should be considered strictly preliminary until more reliable analytical data is thus available.

1. T. 25 N., R. 19 E. Carboniferous or Permian sandstone: Exposures of brecciated ferruginous and manganiferous sandstone and argillites contain anomalous copper and zinc.
2. T. 26 N., R. 23 E. Lower Paleozoic (Precambrian?) limy black shales: These rocks contain lenses of high carbon content with anomalous molybdenum and barium. Stream sediments in this area which also drain Devonian argillaceous dolomite are additionally anomalous in copper, lead and silver.
3. Howling Dog Canyon, (T. 27 N., R. 27 E.): Greenstones and conglomerates overlain by Quaternary/Tertiary basalt lavas: In the Howling Dog Canyon area, stream sediments were anomalous in barium, copper, chromium and silver, which might be expected. In the upper portion of the canyon, the lavas overlie Paleozoic siltstone and limestone.
4. Old Rampart, (T. 27 N., R. 28 E.): An outcrop of iron-stained Devonian limestone is anomalous in copper, zinc and lead. Vanadium and nickel were also found to be above background levels. A nearby spring is reported to contain nickel alum, possibly originating in Middle Devonian rocks (39).
5. Half-way Pillar, (T. 28 N., R. 28 E.): An area mapped as pre-Tertiary siltstone overlain by younger basalt flows contained values of copper, molybdenum, barium, silver and boron. Pan concentrate samples of a small eastflowing creek 1.5 miles south of Half-way Pillar contained

tourmaline and monazite. Siltstone in this drainage was slightly radioactive, apparently due to thorium.

6. T. 29 N., R. 28 E. Quaternary/Tertiary basalt lavas overlie Precambrian(?) dolomite and limy black shales. Stream sediments contain anomalous copper, molybdenum and chromium. It is not certain whether the copper and chromium values were from the basalts or the sedimentary rocks, however, a sample of the black shale contained anomalous copper and lead.

7. T. 29 N., R. 29 E. Northwest flowing streams west of "VABM Chasm" are anomalous in chromium, copper and molybdenum.

8. Upper Porcupine: The upper ten miles of the Porcupine River traverses a geologically complex region of lower Paleozoic or Precambrian dolomite, quartzite (commonly pyritic) and black shale to slate. Thin mafic sills intrude the sequence. Several samples of brecciated dolomites and limestones were found to contain minor occurences of lead and zinc minerals. Sediment samples indicate the area to be anomalous in lead, barium, chromium, copper and molybdenum, and thus suggest the rock units to be favorable for base metal and barite mineralization. Sample map no. 97 (CC-58) contained very anomalous values of selenium, lanthanum, tin and molybdenum. No followup was possible of this site. Brecciation is widespread with silica, chalcedony, calcite, goethite and hematite fillings and veins. Bleaching and argillitic alteration was prominent in several outcrops. This geochemical regime may be an expression of basement intrusive rock and consequent partial assimilation at depth.

·Possible Economic Deposit Types

The following list of possible deposit types within the sedimentary terrane is based on the limited data available for this area, in conjunction with projections from Canada where there is known mineralization in similar rock units. Refer to figure 14.

Carbonate-Hosted, Including "Mississippi Valley Type"

Potential host rocks for epithermal(?) lead-zinc mineralization are found in the lower Paleozoic and Precambrian(?) units which occur within approximately 5,000 square miles of the project area. Shale/carbonate facies intergradations, paleokarst evaporite strata, unconformities, and extensive tectonic activity could provide favorable loci for mineralization. While this region remains largely unexplored, to the southeast in the Yukon significant base metal mineralization is found in equivalent rock units.

Mineralization in the Yukon's Dawson district is reported to occur above and below unconformities between Precambrian and Ordovician carbonates, within Precambrian buff-orange weathering dolomites, and in breccia zones within structures in lower Paleozoic limestone, dolomite and shale (37). Another example of this type of deposit is the Pine Point Mine, Northwest Territories, where lead-zinc mineralization occurs in Devonian dolomitized paleokarst structures related to shallow marine reefs and intertidal evaporites (38).

Exploration targets within the project area would include rock units bounding the Mid- or Late-Devonian unconformity mapped within the Porcupine River sequence and/or the regional unconformity of Devonian-Mississippian time. The possibility of mineralization in the lower Paleozoic-Precambrian, chalky weathering and orange dolomites appears favorable, as suggested by minor sulfide occurrences and goethite. Mapped and interpreted lineations and structures, as described previously, should be explored.

Several recently discovered lead-silver prospects of unknown geologic setting occur within several miles of the study area in the headwaters of the Salmon Trout River (44). A major exploration effort is also underway at a Canadian silver, lead and zinc prospect several miles east of the project area.

Shale-Hosted Lead-Zinc

Deposits of this type occur to the southeast of the study area in Canada. They are found in black shale, chert and limestone of deep water, basinal margin origin. Mineralization is sometimes recognized to be related most likely to volcanogenic or exhalative activity, such as the Grum deposit, while other localities are thought to be simply sedimentary (i.e. associated with connate brines). This mode of deposition, or one possibly due to a biogenesis association with highly pyritic and carbonaceous shale, is exemplified by the Tom deposit (16). Mineralization is commonly lead, zinc and copper, sometimes accompanied by silver. Distal barite horizons are often found in this association. The shales hosting these deposits often have high background values in zinc, molybdenum, vanadium and other trace elements.

Possible facies equivalents to the known Canadian shale-hosted deposits are found within the Porcupine project area. These units mapped as Silurian and Devonian or Mississippian, as well as Upper Mississippian chert, shale, black silty shales and limestones, appear to have potential for this type of deposit.

An example of possible shale-hosted mineralization occurs in T. 30 N., R. 30 E., where an extensive area of highly fractured, weathered and iron-stained shales with interbedded black clay are found about one-half mile up a small southerly tributary of the Porcupine River. The area is completely devoid of vegetation and the creek water smells of hydrogen sulfide. Several stream sediments draining this area were not anomalous, but two soil samples contained 135 and 370 ppm lead.

Sedimentary Uranium

A recent airborne radiometric survey (47) has indicated anomalies in areas along the margins of the Yukon Flats. The Flats contain non-marine sediments of probable Tertiary age which could act as host for sedimentary-type deposits. In the Coleen Basin (34), bedrock consists of uncorrelated conglomerates, sandstone, mudstones, lignite and weakly cemented gravels with hematite; clay and petrified wood. Tuff, locally welded, and ash are also found in the section. Some strata of mudstone contain abundant nodules of an earthy blue phosphate mineral known as vivianite, which was also found to be replacing partially carbonized wood fragments.

Sandstones range from well indurated to poorly cemented silty sandstone. Frequently they contain plant fragments, hematite and goethite. Fossils indicate some marine facies are also present (12). No pyritic enrichment was found, but iron-stained outcrops were observed. The Tertiary sediments are locally overlain by Tertiary and Quaternary lava flows, such as the area of Fishhook Bend on the Porcupine, which could aid in preserving or trapping uranium mineralization. This type of geologic environment is presently one of active exploration for uranium deposits in southern and central British Columbia and Washington.

Gray, ferruginous sandstone of Jurassic or Cretaceous age could also represent a potential host for sedimentary uranium. Carbonaceous beds within these rocks are of possible non-marine origin (e.g. Graphite Point on the Porcupine River). Particular study should be made where these units overlie the pre-late Devonian angular unconformity.

Potential uranium source rocks are found in the Old Crow granite of Devonian(?) age, a multiphase intrusive having associated uranium and thorium minerals (see granitic terrane discussion). Another possible source is the volcanic tuff interbedded with the Tertiary sediments. Water-lain ash and mudstone in the western Yukon Flats contains anomalous values of uranium (up to 50 ppm uranium). Black shales of Precambrian(?) and Paleozoic age were found to be slightly radioactive and might also have potential as a uranium source rock.

Numerous stream sediment samples from areas along the Porcupine River were found to have moderately high thorium values (to 50 ppm) but uranium values did not exceed normal background. A slightly radioactive pre-Tertiary [Permian(?)] siltstone appeared to be the source of monazite in heavy mineral concentrate from creeks draining the area.

It is not known what effects past and present climatic conditions have played in northeast Alaska in the formation and preservation of stratiform uranium deposits. However, occurrences of soda ash and potassium minerals in the Flats do suggest a past climate of the type normally associated with these evaporite-type mineral environments.

Soda Ash

Some dry lake beds large enough to be readily visible on satellite imagery of the Yukon Flats are mantled with soda ash minerals. A sample from one mile west of Ohtig Lake (T. 20 N., R. 18 E.) contained thermonatrite, feldspar and trona. Smith, in 1926, also reported potassium salts in lake waters north of Ft. Yukon (39). Similar occurrences of calcium carbonate, feldspar and quartz southwest of Ft. Yukon appeared to have been formed in conjunction with degassing of the substrata, and ground water-fed lakes that intermittently dry up. Sources and geologic significance of these minerals are uncertain, but one interpretation might be to suggest remobilization of various marine and non-marine evaporite sequences that may be found at depth; e.g. gypsum, soda ash and potash. Origin of the sodium and potassium minerals perhaps is more likely associated with the extensive Tertiary felsic and intermediate volcanism to the north of the Yukon Flats.

Sand and Gravel

Although sand and gravel accumulations cannot be identified uniquely with any particular geologic terrane, for convenience they are discussed here with sedimentary rock deposits.

Any construction activity in the upper Porcupine region would require large supplies of gravel fill to protect the continuous and unstable permafrost, and to provide a stable work base.

Extensive near surface deposits occur in the Yukon Flats, as either active alluvium or terraces. The Coleen and Sheenjek Rivers flow through broad alluvial valleys for nearly their entire length, and these areas could be easily utilized for any forseeable demand. The upper half of the Porcupine River, except for a small alluvial-filled basin near Fishhook Bend, lies in a deeply incised canyon with limited alluvial but extensive high bench gravels which would contain a variable ice content. Difficulties of access into the canyon, in addition to environmental considerations, would probably preclude use of the active alluvial material. Small amounts could be derived from portions of tributary streams such as the Salmon Trout, Rapid, and the Campbell Rivers. Elsewhere, crushed rock, particularly limestone and quartzite, will have to be produced from local sources. This has been the case with the Kandik oil exploration wells immediately to the south of the study area, where crushed limestone was used.

Other Deposit Types

Low grade, high ash coal occurs in the Fishhook Bend area. A channel sample of a typical two foot thick seam exposed in a river cut bank was analyzed as follows:

Table 2 - Coal Analysis

	Basis	Moisture	Volatile Matter	Fixed Carbon	ASH	Heating Value BTU/lb
PR11407R	1	34.02	28.09	19.42	18.47	5,155
	2		42.57	29.44	27.99	7,812
	3		59.12	40.88		10,849

Basis 1. As received
2. Moisture free
3. Moisture-ash free basis

As described in the "Prospects and Occurrences" section, potential tin and rare-earth placers may be found in perched ancient channels of the upper ten miles of the Porcupine River.

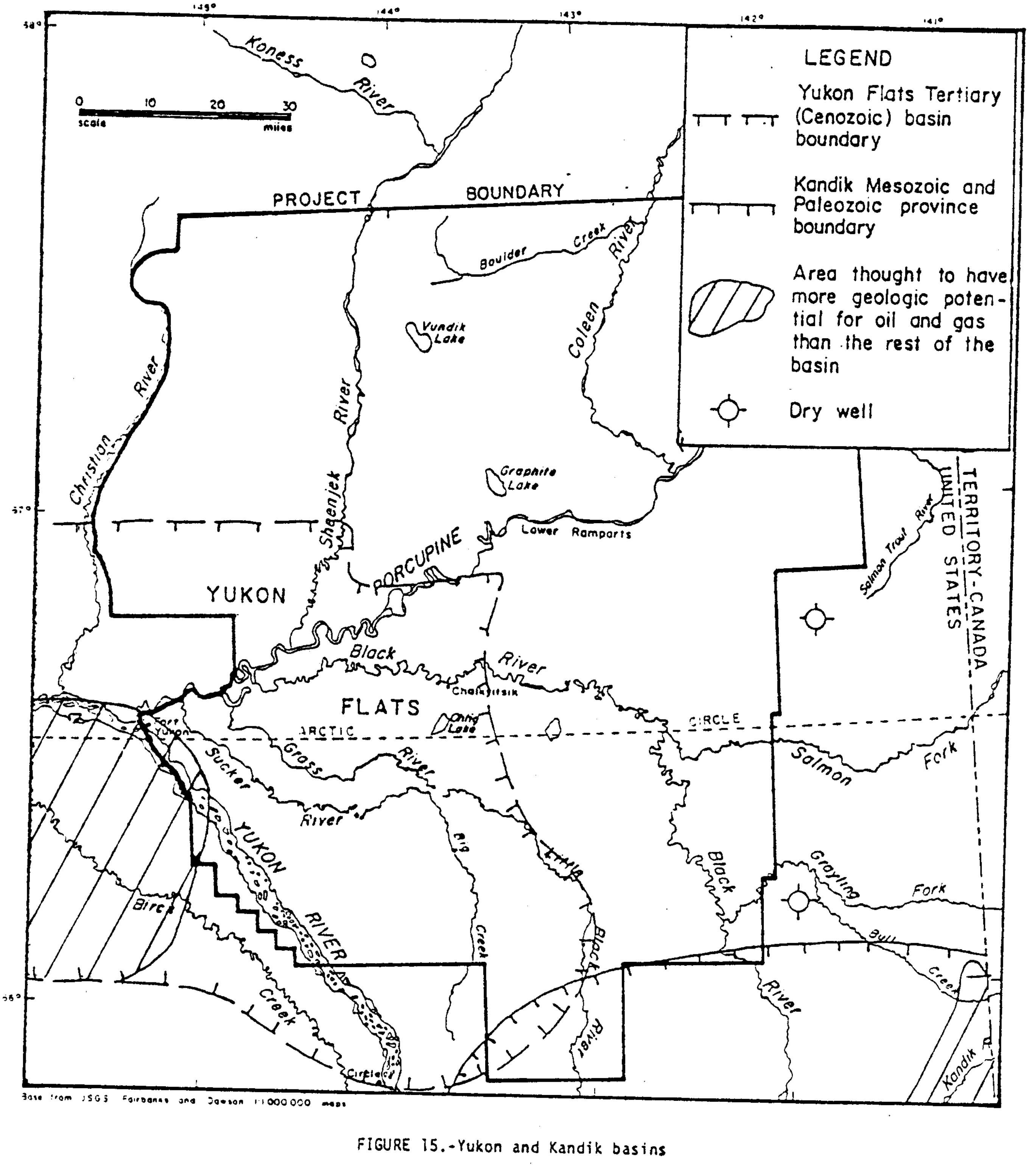
The nickel alum occurrence at Old Rampart (39) may indicate nickel mineralization in nearby gabbro/diorite units.

No analyses of the limestones were made for cement qualities, but such is probably present as a resource.

Kandik Province and Yukon Flats Basin

Mesozoic-Paleozoic Province-Kandik Basin:

A 3,000 square mile province (figure 15) has been outlined and defined as a possible petroleum province due to the presence of Mesozoic and Paleozoic rocks along the Yukon and Porcupine Rivers according to Miller and others (31). A stratigraphic sequence reveals the presence of the following formations: Middle Cretaceous, Early Cretaceous, Late Triassic, Permian, Pennsylvanian, Late Mississippian, and Mid-Devonian.



Base from USGS Fairbanks and Dawson 1:1000000 maps

FIGURE 15.-Yukon and Kandik basins

The Kandik Province may be the best place to test the Paleozoic sequence in central Alaska because intrusive volcanics are absent or pre-date the sediments. This province includes the southern part of the study area, figure 15.

In the Committee Report (49), a short dissertation suggests that although Cretaceous sediments in the Kandik basin do not possess favorable reservoir characteristics, the possibility of finding structures in which the Paleozoic sediments may be within drillable depths makes exploration of the basin attractive.

Another Geological Survey report (18) indicates that an area which might have the most petroleum promise to test Paleozoic sediments is that between the Kandik River to the north and the Nation River to the south. Of note is the fact that Paleozoic rocks in the Eagle Plains area of Canada have been tested and have yielded natural gas. This area lies about 100 miles east of the Kandik province.

Summarized, the information contained in the Geological Survey reports would indicate that the Kandik basin area is a very likely and prospective spot to be categorized as a possible petroleum province. The geologic targets would be primarily the Paleozoic sequence and, secondarily, the rocks of Mesozoic age.

The southwestern quarter of the study area includes a portion of the prospective province, figure 15. The interpretation of the nature of the deposits and their relationships in the Yukon Flats basin has changed over the years as additional data has been obtained (31, 49). Present thinking by the Geological Survey, based largely on interpretation of aeromagnetic data, indicates that only a small portion of the basin is part of a Cenozoic province. Although the gravity and density work done to date is far from adequate, the work defines the "lows" in the basin which may represent troughs filled with Tertiary

(Cenozoic) sediments (3). Thus, the information available suggests that part of the Yukon Flats Basin within the southwestern quarter of the study area appears to hold promise as a possible petroleum province.

There is no information indicating oil or gas seeps in the Kandik province. However, oil shale, bituminous limestone, organic-rich rocks and reef-like carbonates outcrop in Mississippian formations. Oil has been test-retorted out of limestone. A Bureau of Mines field party reported (25) that when the limestone outcrops near the Tatonduk River were broken, they emitted a fetid odor.

T. G. Payne reported approximate locations of oil seeps on the Porcupine and Coleen Rivers (31). These sites were not revisited during this investigation.

There is also no information indicating the presence of oil or gas seeps in the Yukon Flats basin. There are some occurrences of coal outcrops within the basin however.

The first well to be drilled in the Kandik Basin was completed as a dry hole in 1976. The well was drilled to a depth of 11,044 feet. Two more wells were drilled in 1977, one to 9,123 feet and the other to 13,533 feet. All of the wells were dry holes. The wells were drilled by Louisiana Land and Exploration as part of an exploration agreement with Doyon Ltd., the Native Regional Corporation which owns exploration rights on the land the wells were drilled in.

In the Yukon Flats basin, surface geological exploration has taken place by both Geological Survey and private industry in the past years. The upland areas surrounding the basins have had thorough, although generally unpublished, geologic work. Seismograph operations have taken place on the Yukon River across the entire basin. Overland seismic operations have been conducted by industry in the the last few years, and interest in further seismic work continues. Aeromagnetic studies have been undertaken and provide the justification for further detailed seismic work and surface geologic studies. There have been no exploratory wells drilled in the Yukon Flats basin. Although not officially acknowledged, industry has hinted that past seismic work has located several structures within the basin.

SAMPLING AND ANALYTICAL PROCEDURES

Stream Sediment Samples

Stream sediment samples were collected with a steel shovel from the finer sandy portion of the active channel or deepest, most active part of a dry creek bed. Organic rich material was avoided. Samples were put in water-resistant paper sample bags, then air-dried before screening and analysis. Float rock and stream characteristics were noted and recorded at each sample station.

A pulverized fraction (-200 mesh) of the -80 mesh portion of each sample was analyzed by 6-step, D-C arc semiquantative emission spectrographic methods for 42 elements. These analyses were made by the Mineral Industry Research Laboratory, University of Alaska, under the direction of Dr. P. D. Rao. In some cases, samples were also analyzed using atomic absorption methods. Results are presented in the analyses tables of Appendix A, Table A-1 and in tables associated with specific site or prospect discussions.

Uranium and thorium analyses were made by the State of Alaska, Division of Geological and Geophysical Surveys laboratory, under the direction of H. S. Potworowski. Samples were analyzed fluorometrically for uranium, after a hydrofluoric acid-nitric acid digestion and preparation of a pellet by fusion with a carbonate, fluoride flux. Thorium values were determined by colorimetry.

Splits of sediment and rock samples, where available, have been analyzed by the Los Alamos Scientific Laboratory for beryllium and lithium by emission spectrography, and for silver, bismuth, cadmium, copper, niobium, nickel, lead, tin and tungsten by x-ray fluorescence. Sediment samples will also be analyzed for aluminum, barium, calcium, chlorine, dysprosium, potassium, magnesium, manganese, sodium, strontium, titanium, and vanadium using neutron activation with a short time delay before analysis; and for gold, cerium, cobalt, chromium, cesium, europium, iron, hafnium, lanthanum, lutetium, rubidium, antimony, scandium, samarium, tantalum, terbium, thorium, ytterbium, and zinc by using neutron activation with a long time delay before analysis. Results will be available in an open-file report from the D.O.E.

Pan Concentrate Samples

Pan concentrate samples were collected to enhance values of resistate minerals with high specific gravity, such as those containing tin, tungsten, radioactives, chromium, gold, zirconium, barium, some of the rare-earths and various trace elements. Generally, these minerals are difficult, at best, to detect with routine stream sediment sampling and analysis procedures.

As with the stream sediment samples, the pan samples were collected with a steel shovel from well sorted, silty gravel from the center of the active channel. A 14 inch pan was filled to slightly rounded with approximately minus one inch of material and panned to a minimum of a 40 gram sample, then carefully washed into a plastic bag. In the laboratory, the material was concentrated with bromoform (2.85 sp. g.). The heavy fraction was then screened at 14 mesh and the minus material was magnetically separated. A split of the -14 mesh, non-magnetic concentrate was then pulverized and analyzed for 24 elements by semi-quantitative emission spectrography. The 1976 sample analyses were made by the Bureau of Mines, Reno Metallurgical Laboratory, and the 1977-78 analyses by the Mineral Industry Research Laboratory, University of Alaska.

During 1977, 635 pan concentrate samples were taken using this procedure in metamorphic and igneous terranes of central and northeastern Alaska (including those of the study area.) The limits of anomalous values calculated from histograms compiled from these 635 sample analyses can be seen on figure B-1, Appendix B.

Sluice Box Samples

An 8 inch by 30 inch portable sluice box with expanded wire riffles was used to further evaluate the heavy mineral content of the Rapid River and Strangle Woman Creek. In order to obtain sufficient samples for petrographic examination and further analytical work, larger samples consisting of approximately one-tenth of a cubic yard of finer (approx. -1/2 inch) gravel and sands were taken from the active channel and put through the sluice box. All concentrates, as well as the box bedding carpet were placed in a plastic bag. In the laboratory, the sample was air dried and the collected material was shaken from the carpets. These samples were then analyzed as pan concentrate samples. The samples were also assayed for several elements by analytical methods. Recovery efficiency of heavy minerals with the small sluice box is not known, but considered poor.

Soil Samples

Soil samples, taken from the "B" (usually missing) or the "C" horizon (frequently from frost boils), were dried and sieved at minus 80 mesh. Copper, lead, zinc, silver and generally molybdenum were analyzed by atomic absorption. Uranium, when it was analyzed, was done fluorometrically as with the sediment samples.

Rock Samples

Rock samples for analysis were usually taken as random chip samples across a geologic unit of interest, for example, a mineralized area or a zone of alteration. The area traversed by the chip sample was recorded. If a sample consisted of an individual high-graded rock, or was representative of a formation, this was noted as well as outcrop characteristics. Samples collected in either case totaled approximately 1-2 pounds.

Samples were crushed, pulverized, and analyzed by atomic absorption for specific elements. Rock sample splits were retained for specimen purposes, as well as petrographic and mineralogic analysis. Splits of these samples are also being analyzed by LASL for the same elements sought in the sediment samples.

PROSPECTS AND ANOMALIES

White Mountain Creek -- Copper, Lead, Silver Prospect

(T. 31 N., R. 29 E., figure 8)

Geology

A vein occurrence of sulfide mineralization is associated with a northeasterly striking shear zone in carbonaceous black phyllites and interbedded green and maroon slaty argillites. These Paleozoic metasediments are part of a raised and breached topographic feature near the southern perimeter of the Old Crow batholith. Limestone, calcareous argillites and shales, and quartzites also make up this sequence. The rocks overlie and are intruded by rhyolite sills and dikes. One such dike, with phenocysts of smoky quartz, intrudes argillites approximately three-quarters of a mile north of the prospect. Numerous mafic greenstone dikes, some of which are mapped as Jurassic (12), also intrude the metasediments, but do not appear to be related to the mineralization.

Minor occurrences of iron-stained gossan are frequently found throughout the metasediment sequence, but appear preferentially associated with the black phyllites.

Outcrop mapping done as part of this investigation indicates that specific units could be projected across White Mountain Creek Valley, figure 16. Several tentative dip and strike measurements indicated a moderate southerly bedding dip,

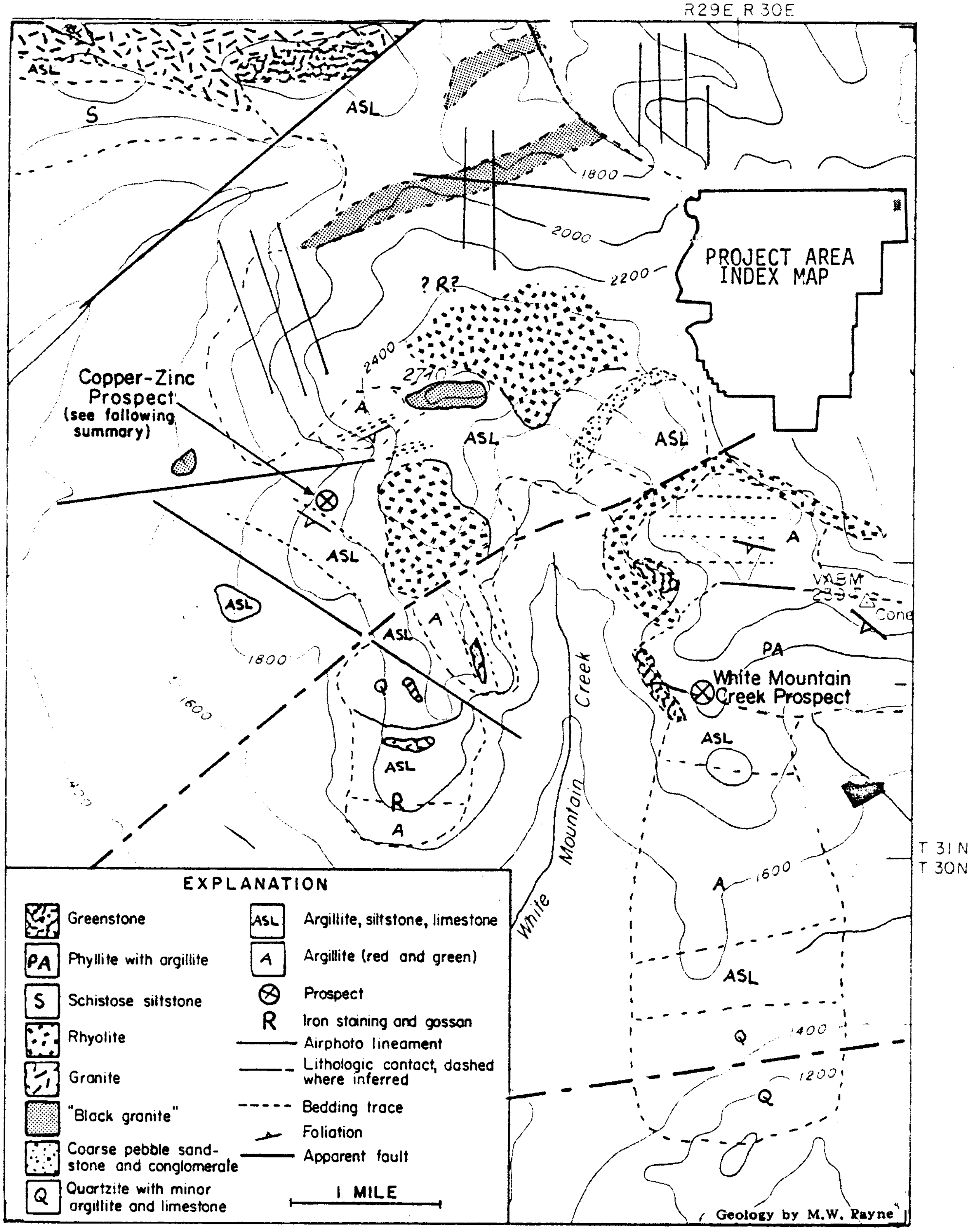


FIGURE 16.- Outcrop geology--White Mountain Creek area

to which the strike of the mineralization appears to conform.

Air photo interpretation suggests a circular feature near the east end of the mineralized zone.

The prospect lies on the east limb of a horseshoe-shaped topographic feature about seven miles north of the Porcupine River, four miles west of the International Border. Mineralization occurs across a low tundra-covered saddle at an elevation of 1,950 feet.

In this vicinity, the tree line is about 1,800 feet elevation, with continuous tundra above that, except for the tops of ridges. Residual bedrock is exposed only in occasional frost boils through the tundra and as weathered scree on the ridges. Permafrost is continuous in the vegetated and colluvium-covered areas.

Mineralization

In 1977, sulfides were found by the Bureau of Mines during a ground reconnaissance of the area.

Geochemical data collected and reported by Brosge and Reiser in 1968 (11) noted several undescribed mineral occurrences on the other side of the valley, about three miles to the west.

A zone of disseminated copper and lead sulfides, with values of silver, occurring in frost boils, trends east-northeast apparently conforming to the bedrock strike. Host rock appeared to be a silicified and propylitized shear zone in phyllites. The mineralized float was found along the strike for approximately 1,200 feet, and over a width of 50 to 150 feet (figure 17). True width of the vein is likely to be significantly less. No in-situ bedrock could be seen in the vicinity. Mineralization is open to the southwest, where the zone goes under heavy vegetation cover. A few discontinuous occurrences were found further along strike another quarter mile to the northeast

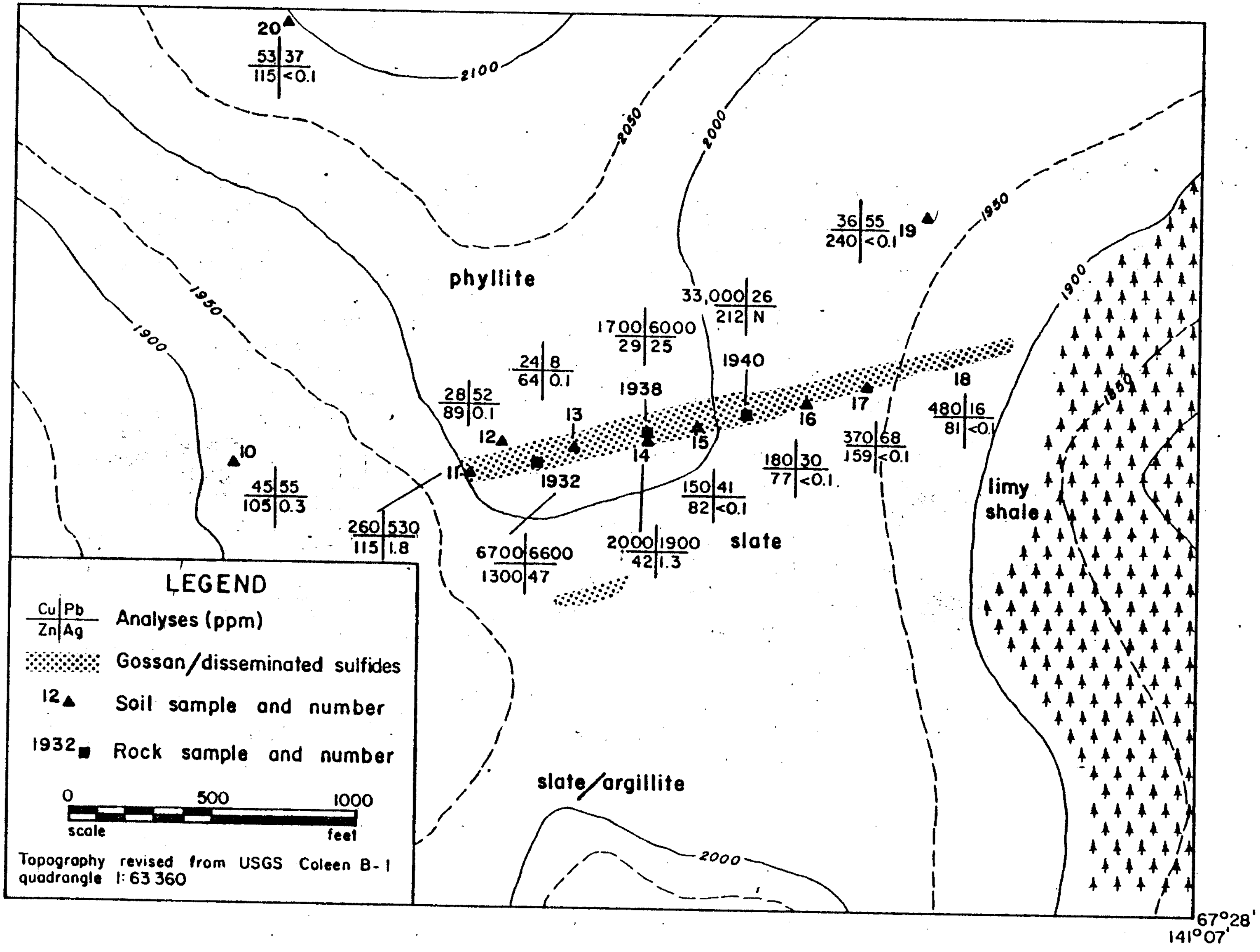


FIGURE 17.-White Mountain Creek prospect

in a zone of iron stained, leached, silicified rock and phyllite rubble. No anomalous radioactivity was found associated with the mineralized zone.

Two random chip samples of partially leached mineralized rock yielded copper values from 1,700 to 33,000 ppm, and lead from 26 to 6,600 ppm. Soil samples also indicate anomalous amounts of base metals. Results of analyses by atomic absorption are indicated on figure 17.

Geochemistry

Analyses of mineralized samples were noticeably lacking in zinc values, which is in contrast to the contact metamorphic mineralization seen four miles to the northwest.

Soil samples on the White Mountain prospect were taken from frost boils with inorganic silts and clays at depths of about 10 inches. As part of the Bureau's work, 61 sediment and 27 rock samples were taken near and along White Mountain Creek and various small side tributaries, figure 18. Some samples are slightly anomalous in base metals, table 2. Limited follow-up indicates more vein-type prospects may be found, although surface evidence will be generally obscured by vegetation.

Results and Recommendations

Vein-type mineralization exists in the metasedimentary sequence at the head of White Mountain Creek. Minor mineral occurrences of oxides and carbonates(?) are frequently found in the vicinity. Due to the vegetative cover and deep weathering, any potentially significant mineralization will probably not be seen in place at the surface. Further area-wide soil sampling and ground geophysics appears warranted. The circular feature seen on air photos of the area should also be investigated, figure 7. The absence of zinc values indicates possible zonation away from the intrusive contact region.

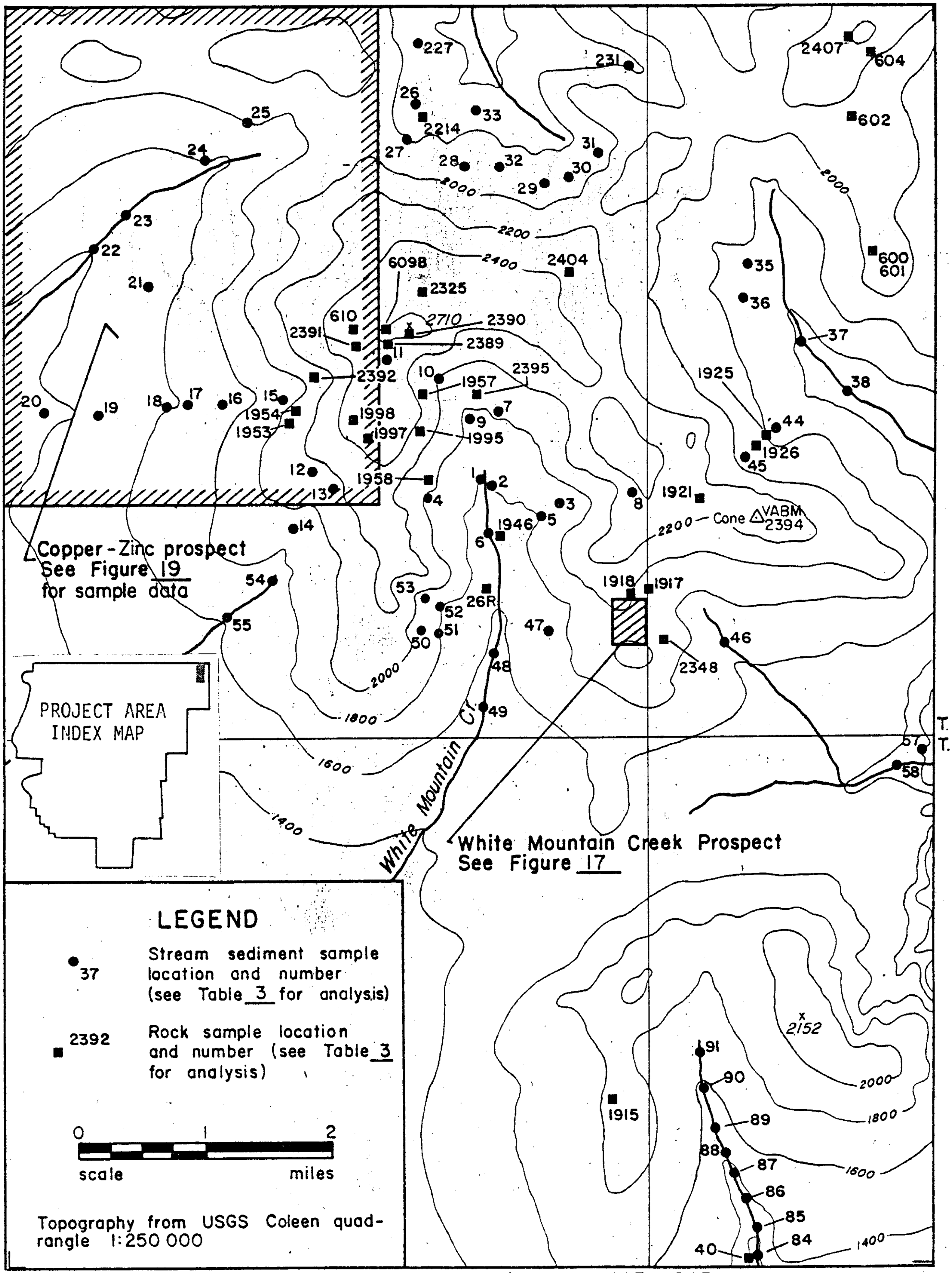


FIGURE 18.- White Mountain Creek area sediment and rock sample location map

TABLE 3 - White Mountain Creek Stream Sediment and Rock Analyses (in ppm)1/

Stream sediments

Map No.	Sample No.	Cu	Pb	Zn	Ag	U	Th
1*	0C1959					6.6	13.3
2*	0C1960					7.8	15.3
3*	0C1961					3.5	12.8
4	CC 27	48	390	540	N	3.8	14.5
5	CC 19	41	110	150	N	3.1	--
6*	0C1945					5.3	11
7	CC 16	24	230	250	<5	2.1	11.8
8*	0C1930						
9	CC 15	25	30	125	<5	2.3	11
10*	0C2339					3.7	12.5
11*	0C2323					3.2	10.8
14	CC 28	30	90	190	N	4.2	14
26	CC 71	26	60	75	N	--	--
27	CC 70	14	200	130	N	--	--
28	CC 67	8	100	70	N	12.7	26.3
29	CC 65	8	100	80	N	12.3	53.5
30	CC 64	10	50	60	N	6.1	21.3
31	CC 63	13	50	80	N	13.1	26.8
32	CC 66	7	60	50	N	12.7	28.3
33	CC 69	10	90	90	N	10.2	43
35*	0C2331					8.6	37.5
36*	0C2208					7.8	57.5
37	CC 6	13	50	52	N	3.4	--
38*	0C1924					4.8	12.5
44*	0C1922					3.8	12.8
45*	0C2343					4.1	11.3
46*	0C2346					2.9	9.75
47	CC 21	28	30	110	N	1.3	--
48	CC 22	25	60	160	N	5.4	--
49*	0C2313					3.3	11.5
50*	0C1948					2.7	9.5
51	CC 24	43	30	90	N	2.9	8.3
52	CC 25	33	50	130	N	2.7	10.5
53*	0C1947					3.3	7.3
54	CC 29	26	40	130	N	3.2	11.3
55*	0C2316					3.0	10.3
57	CC 11	26	40	100	N	2.9	23.0

1/ Cu, Pb, Zn, Ag, Mo, Sb analyzed by atomic absorption unless indicated (*). U analyzed by fluorometry, Th by colorimetry.

* Analyzed by emission spectrograph. Refer to appendix A, Table A-1.

TABLE 3 - White Mountain Creek Stream Sediment and Rock Analyses (in ppm) 1/ (continued)

Stream sediments

Map No.	Sample No.	Cu	Pb	Zn	Ag	U	Th
58	CC 13	39	<30	87	N	1.4	12.5
84	CC 37	5	N	9	N	--	--
85	CC 36	11	30	30	N	2.4	6.5
86	CC 35	8	N	40	N	--	--
87	CC 34	7	N	30	N	1.7	5.8
88	CC 33	12	N	35	N	--	--
89	CC 32	11	N	35	N	1.6	6.8
90	CC 31	14	40	35	N	--	--
91	CC 30	20	N	60	N	2.7	9.8
227	CC 72	23	N	100	N	2.3	--
231	CC 62	10	30	60	N	--	--

1/ Cu, Pb, Zn, Ag, Mo, Sb analyzed by atomic absorption unless indicated (*). U analyzed by fluorometry, Th by colorimetry.

* Analyzed by emission spectrograph. Refer to appendix A, Table A-1.

TABLE 3 - White Mountain Creek Stream Sediment and Rock Analyses (in ppm) 1/ (continued)

Rocks

Rock No.	Cu	Pb	Zn	Ag	U	Th	Field Description
26	13	80	80	N	--	--	float gossan, rock in area of green slate and greenstone
40	12	540	500	N	3.4	2.0	iron oxide cemented breccia float rock
600	10	<30	130	N	0.8	7.5	black, fine grained, silicic intrusive
601	19	<30	33	N	--	--	medium grained, biotite granite
602	<5	30	30	N	0.4	3.8	fine grained, granitic rock, slight iron stain
604	<5	100	60	N	2.3	47.5	fine grained, black "granite"
609B	<5	70	55	N	18.9	26.8	rhyolite with slight manganese stain
1915	15	13	20	N	--	--	limonite stained, shale with unidentified black fracture filling material
1917*	1	N	N	L	--	--	dark green phyllite
1918	120	N	78	N	--	--	mafic dike (gabbro?)
1921*	L	N	N	N	--	--	rhyolite
1925*	2	N	N	N	--	--	rhyolite with occassional specks of fluorite
1926*	15	L	N	N	--	--	sheared and resilicified quartzite and phyllite in contact with rhyolite
1932	6700	6600	1300	47	--	--	Mo-6, Au-<0.1, disseminated galena and chalcopyrite in sheared and resilicified black phyllite. Random chips of mineralized float rock in frost boils

1/ Cu, Pb, Zn, Ag, Mo, Sb analyzed by atomic absorption unless indicated (*). U analyzed by fluorometry, Th by colorimetry.

* Analyzed by emission spectograph.

TABLE 3 -- White Mountain Creek Stream Sediment and Rock Analyses (in ppm) 1/ (continued)

Rocks

Rock No.	Cu	Pb	Zn	Ag	U	Th	Comments
1938	1700	6000	29	25	--	--	Mo-4, Sb-85, galena and chalcopyrite in leached quartzose, iron stained rock. This sample was a random grab of mineralized chips of float rubble.
1940	33000	26	212	N	--	--	Mo-7, Au-<0.1, same description as #1932
1946	10	L	N	N	--	--	rhyolite float
1957	90	400	200	N	--	--	random chips of rhyolite scree with manganese stain
1958	10	5	N	L	--	--	chips of rhyolite with specks of fluorite
1995	10	N	N	1	--	--	metasedimentary skarn(?) with magnetite, manganese stain.
2209	26	37	120	--	--	--	granite
2214*	10	N	N	N	--	--	chips of black siliceous granite, from scree along 1/4 mile

Rock No.	Cu	Pb	Zn	Ag	Mo	Comments
2325	8	10	92	--	10	Sn-698 2/ near rhyolite/argillite contact. Argillite tactite.
2345	57	2300	110	2	10	green stained argillaceous limestone
2389	6500	12000	11000	2	10	Sn-142, U-26.72 2/ strong manganese stain in argillite, some epidote, vuggy. High graded from rubble.
2390	6000	90	360	--	6	quartz veins in argillite, small amount of limonite, chlorite (grab).

1/ Cu, Pb, Zn, Ag, Mo, Sb analyzed by atomic absorption unless indicated (*). U analyzed by fluorometry, Th by colorimetry.

2/ Reported by the Los Alamos Scientific Laboratory.

* Analyzed by emission spectrograph.

TABLE 3 -- White Mountain Creek Stream Sediment and Rock Analyses (in ppm) 1/ (continued)

Rocks						
Rock No.	Cu	Pb	Zn	Ag	Mo	Comments
2395	13	250	1000	3	<5	quartz veins in phyllite, weak limonite, yellow-green mineral common as sugary coating, high graded from rubble
2404*	5	20	N	N	--	rhyolite, smoky quartz phenocrysts, dark gray, aphanitic 1/2" diameter inclusions with biotite
2407*	5	N	N	N	--	rhyolite

1/ Cu, Pb, Zn, Ag, Mo, Sb analyzed by atomic absorption unless indicated (*). U analyzed by fluorometry, Th by colorimetry.

* Analyzed by emission spectrograph.

The prospect itself, due to its possible size, should be further evaluated by geophysics, hand pitting and, if further warranted, by shallow drilling to intersect the vein at depth, perhaps below the level of extensive oxidation.

Copper, Zinc Prospect

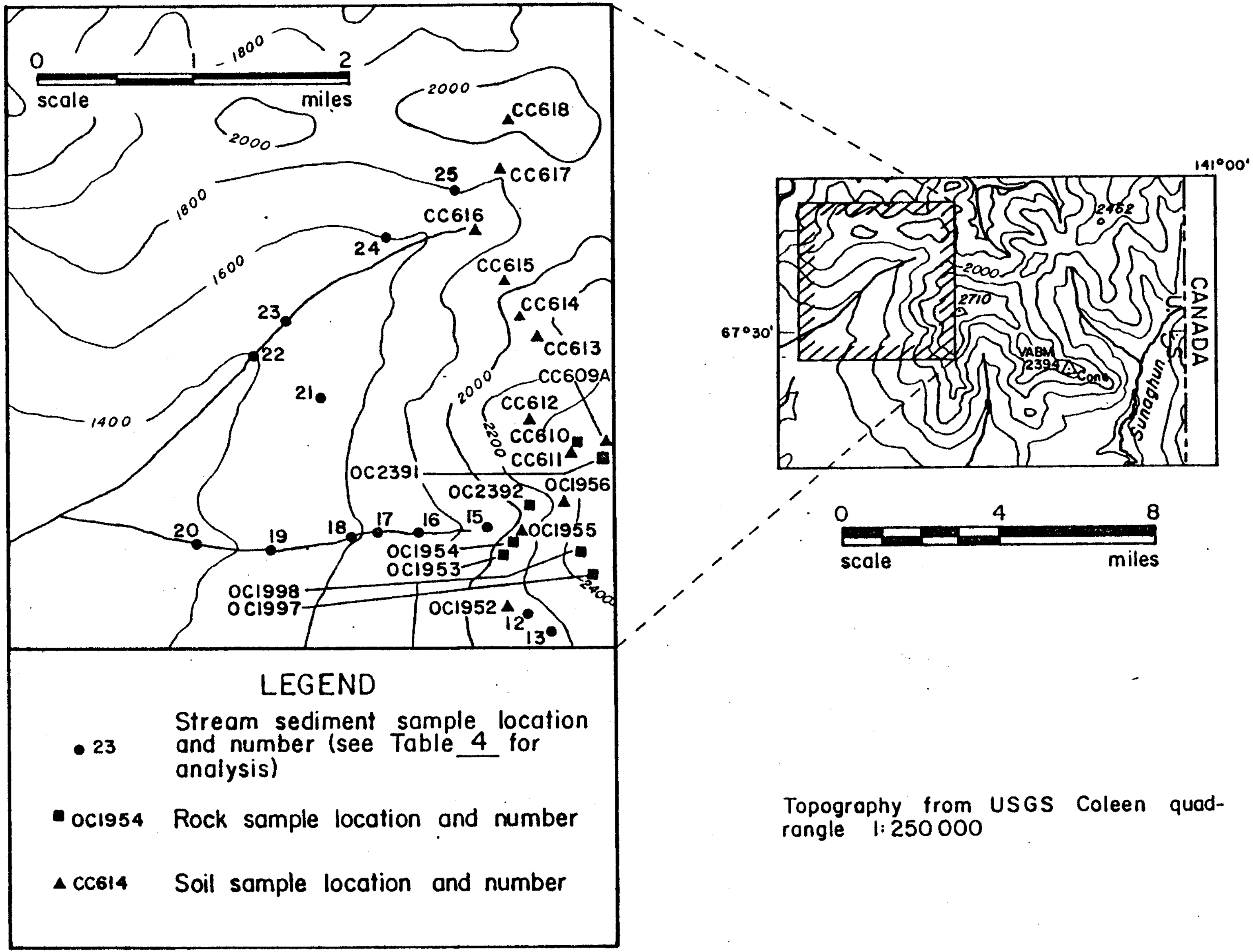
(T. 31 N., R. 29 E., figure 8)

Geology

Copper, lead, zinc and minor tin mineralization was found associated with intrusive rhyolite near the southern margin of the Old Crow batholith. A sequence of Paleozoic metasedimentary rocks, including black phyllites, slaty maroon and green argillites, calc-argillites, quartzites and limestone, is intruded by rhyolite dikes and sills, figure 16. This sequence appears to correlate to the upper intervals of the Neruokpuk Formation further north.

The rhyolite is undated but perhaps is younger than the Paleozoic granite. Thermal effects of the rhyolite have formed extensive hornfels in the country rock. The rhyolite here, as elsewhere on the perimeter of the batholith, contains biotite, abundant phenocrysts of smoky quartz and rare disseminated fluorite.

The prospect area lies at the head of a small westerly-flowing creek draining the area of contact between an overlying rhyolite sill and metasediments just west of the head of White Mountain Creek, figure 19. The location is approximately 10 miles north of the Porcupine River. Elevation ranges from 1,600 feet to 2,400 feet and the area is completely above tree line. Weathered bedrock is occasionally exposed, but most of the terrain is scree on the slopes and ridge tops with tundra in the flatter areas. Permafrost is continuous in the vegetated and colluvium-covered areas.



Topography from USGS Coleen quadrangle 1:250 000

FIGURE 19.- Copper-zinc prospect and sample location map

TABLE 4 -- Copper, zinc Prospect Analyses (in ppm) 1/

Stream sediments

Map No.	Sample No.	Cu	Pb	Zn	Ag	U	Th
12*	0C2319					7.4	16.5
13*	0C1915					7.8	14.3
15	CC 96	32	370	370	<5	3.1	12.5
16	CC 95	32	780	930	<5	2.7	11.3
17*	0C2201					4.1	12.0
18	CC 94	31	50	890	<5	5.6	--
19	CC 93	34	530	1000	<5	10.2	14.0
20	CC 92	29	170	370	<5	4.1	11.0
21	CC 91	17	60	120	<5	-	--
22	CC 90	15	40	90	<5	2.9	--
23	CC 88	19	40	100	<5	2.2	14.5
24	CC 87	16	40	90	<5	2.4	17.3
25	CC 86	17	30	75	<5	1.8	11.3

Soil

Map No.	Cu	Pb	Zn	Ag
CC 618	17	<30	63	<5
CC 617	22	<30	57	<5
CC 616	15	40	79	<5
CC 615	19	130	160	<5
CC 614	19	80	110	<5
CC 613	15	180	150	<5
CC 612	20	510	450	<5
CC 611	22	2500	1000	<5
CC 609	33	420	800	<5
0C1956	290	4100	6400	0.9
0C1955	44	540	440	0.5
0C1952	47	25	80	0.1

1/ Cu, Pb, Zn, Ag, Mo, Sb analyzed by atomic absorption unless indicated (*). U analyzed by fluorometry, Th by colorimetry.

* Analyzed by emission spectrograph.

TABLE 4 -- Copper, zinc Prospect Analyses (in ppm) 1/, (continued)

Rock Samples

Map No.	Cu	Pb	Zn	Ag	U	Th	Comments
CC 610	1100	37000	9700	7	14.8	9.5	Manganese stained quartzite and shale, minor gossan, near rhyolite contact
0C1953*	20	N	N	1	1.7	3.2	Shale/calc-argillite tactite, fractured heavy manganese and limonite staining
0C1954	86000	8700	3800	43	3.3	2.5	Calc-argillite, skarn (?), secondary quartz with magnetite and copper sulfides, Mn and Cu stain, random chips of mineralized float rock, taken over 75 feet.Sn-38
0C1997*	5	20	N	N	27.7 2/	29.4 2/	Nb-122, Be-21 2/ Rhyolite porphyry (grab sample)
0C1998	16	170	1040	N	14.4 2/	55.6 2/	Nb-78 Thermally altered argillite from contact with rhyolite, (chip sample)
0C2392	690	11400	9100	7	10.17	6.4	Brecciated argillite, strong limonite and clay, some boxwork. Sample high-graded from rubble outcrop.
0C2391	5500	11000	12000	84	160.2	N	Mo-8, Sn-767 Be-102 2/ amount of malachite in light orange gossan. High-graded from rubble.

1/ Cu, Pb, Zn, Ag, Mo, Sb analyzed by atomic absorption unless indicated (*). U analyzed by fluorometry, Th by colorimetry.

2/ Reported by the Los Alamos Scientific Laboratory.

N - Detected

* Analyzed by emission spectrograph.

History

Samples collected by the Geological Survey (11) in this vicinity indicated possible mineralization along the rhyolite contact. A soil sample contained 2,000 ppm lead and 2,300 ppm zinc, from a site 0.5 miles east of the prospect, which was also near the contact. Another rock sample on the White Mountain Creek side of the ridge contained 300 ppm copper, 20,000 ppm zinc, 1,500 ppm lead and 6 ppm silver. The latter sample was described as from a local area of manganiferous granite near the rhyolite/metasediment contact.

There has been no known exploration by private industry in the area.

Mineralization

The principal occurrence consists of locally high grade lenses of chalcopyrite, bornite, sphalerite, galena, and magnetite in a thermally altered calcareous argillite intruded by rhyolite. Mineralization could only be viewed on a rubble slope for about 75 feet. Abundant iron and manganese stain was prevalent along the contact in the area.

Malachite staining was noted in argillites 0.25 miles to the north of the main occurrence. Rock samples collected in this area (OC 2325, 2389, 2390, 2391, 2392 - see tables 3 and 4) generally contained several percent of base metals and up to .08% tin. Tin minerals could not be visually identified however, so it is uncertain how extensive this element may be in the prospect area.

A heavily iron-and manganese-stained area, approximately 1.0 miles north of the prospect, was grab sampled. Analysis gave 3.7% Pb, 0.97% Zn, 0.11% Cu (No. CC 610), figure 19. Analysis of a panned concentrate of a small creek draining north of this site yielded 2% zinc. The strong presence of zinc associated with the tactites suggests a zonation between the intrusive rhyolite and the hydrothermal vein-type occurrence to the east.

Geochemistry

Figure 19 shows the locations of samples taken in this vicinity. Analysis of sediment samples (map numbers 15 through 20) taken from the west flowing drainage (table 4) gave values for zinc between 370 and 1,000 ppm, lead 50 to 780 ppm, and minor copper of 29 to 34 ppm. A panned concentrate sample contained 2% lead. Emission spectrograph data (Appendix A, Table A-1) also indicated anomalous amounts of manganese and antimony in sediment samples.

Geophysics

The airborne radiometric survey (46) indicated a "preferred" uranium anomaly (high ratio U/Th) over the rhyolites in this area. Ground follow-up did not discover uranium mineralization near the surface, although the rhyolite as a whole has a higher radioactive background than the granite, as well as being considerably higher than the metasediments. Trace amounts of uranium (up to 160.2 ppm) were noted in samples of the argillite tactites.

Airphoto interpretation shows a northeast trending lineament following the trace of the drainage.

Results and Recommendations

Mineralization due to thermal effects of the intruding rhyolite has taken place, suggesting a potential for contact metamorphic and metasomatic deposition. Occurrences examined appeared to be derived from small lenses and pods of high grade mineralization in tactites. However, the moderately strong geochemical anomalies, the numerous occurrences and the presences of zinc and lead in the pan concentrate suggest that further prospecting and sampling of the calc-argillite-rhyolite contact is warranted. This should include detailed soil sampling, petrography and geophysics. Particular attention should be directed toward the distribution of tin and its mode of occurrence as well as the possibility of contact veins of uranium.

Rabbit Mountain

(T. 31 N., R. 24 E., figure 8)

Geology

Rabbit Mountain is an abrupt topographic rise consisting of black to gray phyllites, siltites, quartzites and slaty argillites which appear to overlie a massive quartzite unit. These rock units apparently dip moderately to the northeast. The sequence tenuously correlates to the upper intervals of the Neruokpuk Quartzite of the Brooks Range. Numerous small faults and shear zones cut the phyllites, particularly the southern and higher portion of the mountain. Several rhyolite dikes, each less than 100 feet thick, intrude the argillites on the northern limb. Strong northeasterly trending lineaments and horsetail fracture patterns, visible on air photographs, intersect this locality, figure 8.

The bedrock exposures are located about 12 miles west of the Old Crow batholith, with elevations ranging from about 1,500 feet to 3,050 feet at the summit. The surrounding relatively flat terrain drains on a gentle gradient to the Coleen River, 8 miles to the west. The vegetation of the lower elevations is a continuous mat of tundra, with black spruce, which overlie continuous permafrost. Access is by helicopter or on foot from a float plane landing site on the Coleen River.

History

Mineralization is reported to have been first found by E. Owens, a prospector who formerly lived in the Coleen River Valley. Since then, it has been examined briefly by at least one mining company. Reports by government geologists, and subsequently published geochemical data (11) confirmed occurrences of copper, lead, zinc, including values up to 20,000 ppm Cu, 15,000 Pb, 2,200 ppm Zn, and 26 ppm Ag. However, neither detailed prospect evaluation nor any subsurface work to evaluate the mineralization has been done. As a result of these reports,

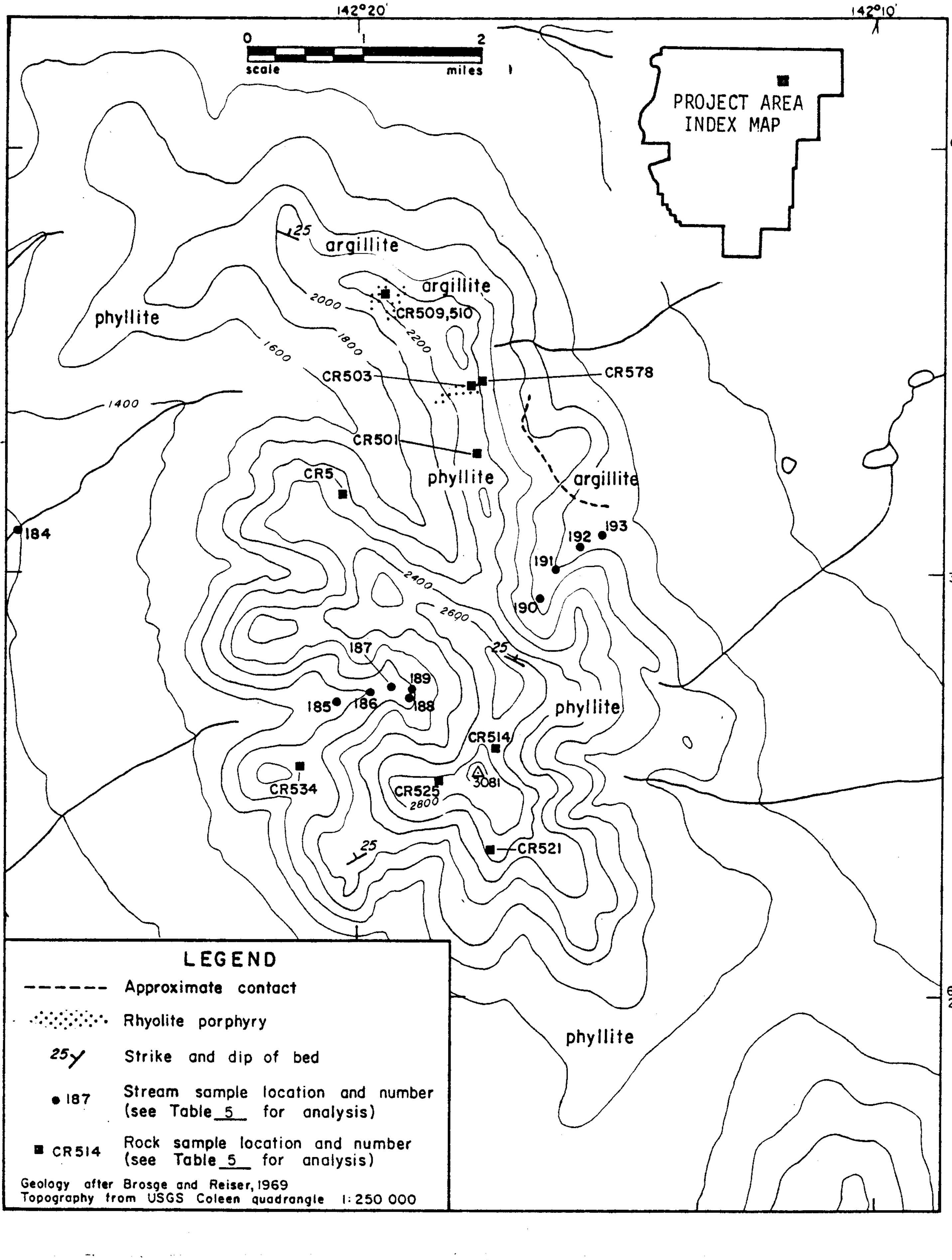


FIGURE 20.- Rabbit Mountain stream sediment and rock sample location map

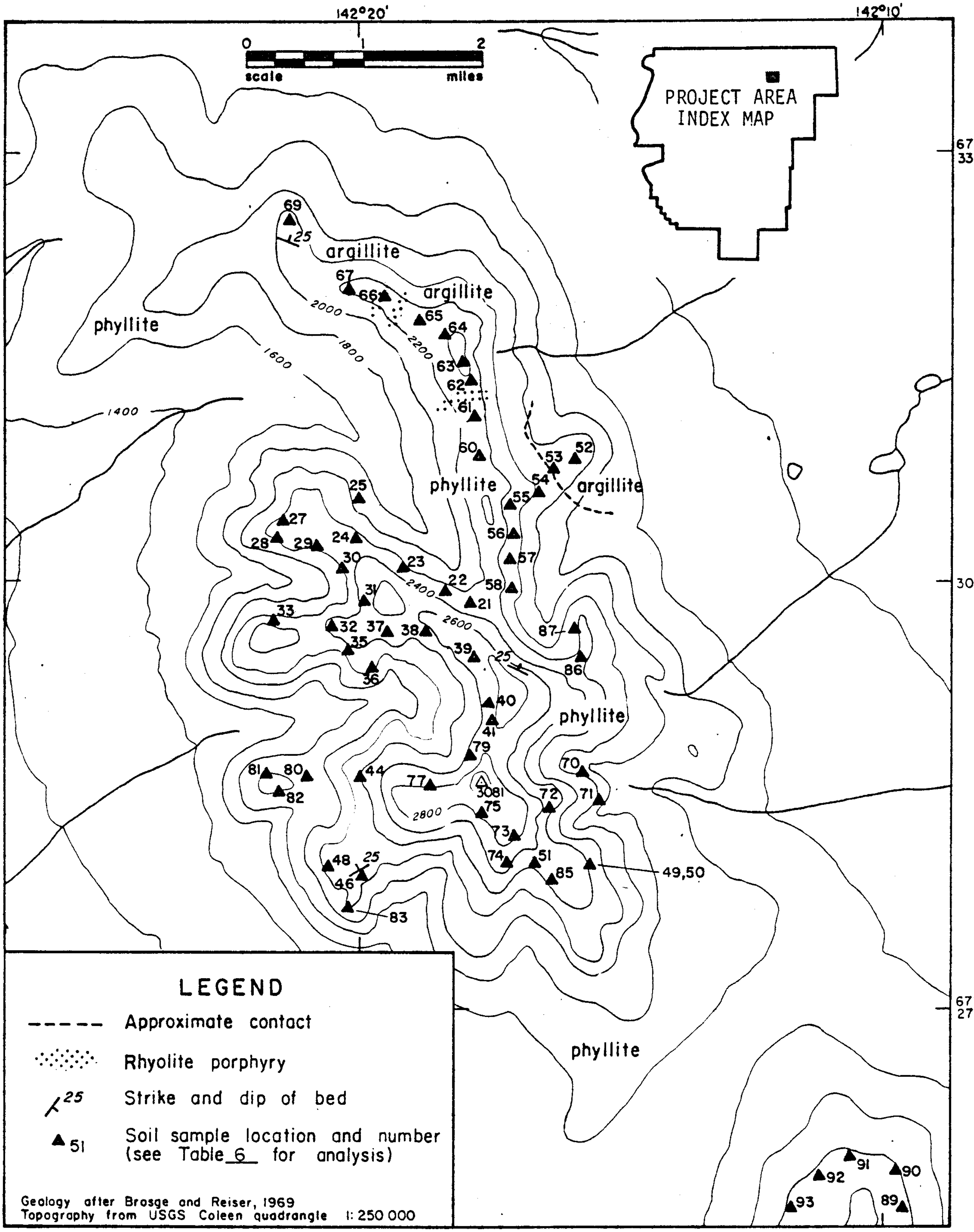


FIGURE 21.- Rabbit Mountain soil sample location map

TABLE 5 - Rabbit Mountain - stream sediment and rock analyses (ppm) 1/

Stream sediments

Map No.	Sample No.	Cu	Pb	Zn	Ag	U	Th
184	B499*	5	20	N	L	-	-
185	CR532	25	40	89	<5	1.0	20.0
186	CR531	28	40	87	<5	-	-
187	CR 23	22	50	90	<5	1.5	12.0
188	CR 24	28	40	110	<5	1.5	-
189	CR 25	26	60	92	<5	1.7	10.3
190	CR543	47	30	90	<5	0.8	13.8
191	CR542	27	30	80	<5	0.8	11.3
192	CR540	31	30	70	<5	1.6	12.0
693	CR544	50	30	70	<5	1.7	12.3

Rocks

Map No.	Cu	Pb	Zn	Ag	U	Th	Remarks
CR 5	15	120	150	<5	--	--	iron stained phyllite with secondary quartz
CR501	8	<30	60	<5	0.8	14.3	phyllite
CR503	7	90	70	<5	3.2	32.5	rhyolite
CR509	<5	100	20	<5	10.7	16.3	100' chip sample in argillite
CR510	<5	40	20	<5	9.0	10.5	rhyolite
CR514	23	<30	90	<5	--	--	gray slate with quartz veins
CR521	13	30	50	<5	1.0	10.0	iron stained gossan and slate
CR525	1100	112000	6700	115	1.8	7.5	high graded from small shear zone in black phyllite with galena
CR534	68	610	390	<5	1.6	12.0	800' chip sample from pyrite bearing quartzite
CR578	<5	30	20	<5	0.8	16.0	rhyolite

1/ Cu, Pb, Zn, Ag analyzed by USBM Reno Metallurgical Center by atomic absorption unless indicated (*); U by fluorometry; Th by colorimetry.

* Analysis by emission spectrograph.

TABLE 6 - Rabbit Mountain soil sample analyses (ppm) 1/

Map No.	Sample No.	Cu	Pb	Zn	Ag
21	CR 1	32	<30	80	<5
22	CR 2	17	30	77	"
23	CR 3	31	50	83	"
24	CR 4	24	40	77	"
25	CR 6	18	30	72	"
27	CR 8	29	50	80	"
28	CR 9	35	30	82	"
29	CR 10	28	30	83	"
30	CR 11	37	230	180	"
31	CR 12	25	<30	77	"
32	CR 13	28	30	91	"
33	CR 14	33	30	86	"
35	CR 16	28	30	77	"
36	CR 17	29	90	120	"
37	CR 18	26	<30	83	"
38	CR 19	40	110	120	"
39	CR 20	21	<30	80	"
40	CR 21	26	60	78	"
41	CR 22	36	40	73	"
44	CR 30	65	420	200	"
46	CR 32	33	<30	95	"
48	CR 34	41	80	110	"
49	CR 35	28	<30	59	"
50	CR 36	18	<30	77	"
51	CR 37	21	<30	68	"
52	CR 38	15	<30	51	"
53	CR 39	16	<30	46	"
54	CR 40	40	30	54	"
55	CR 41	38	40	72	"
56	CR 42	39	30	74	"
57	CR 43	39	30	73	"
58	CR 44	18	30	73	"
60	CR500	21	60	110	"
61	CR502	58	140	210	"
62	CR504	45	130	220	"
63	CR505	47	30	88	"
64	CR506	50	30	74	"
65	CR507	83	30	77	"
66	CR508	30	40	68	"
67	CR511	48	<30	69	"
69	CR513	20	<30	63	"
70	CR516	23	50	83	"
71	CR517	25	<30	77	"
72	CR518	30	60	140	"
73	CR519	66	30	110	"
74	CR520	33	30	87	"

1/ Analysis by USBM Reno Metallurgical Center, atomic absorption.

TABLE 6 - Rabbit Mountain soil sample analyses (ppm) 1/ (cont'd)

Map No.	Sample No.	Cu	Pb	Zn	Ag
75	CR522	40	40	85	<5
77	CR524	19	330	270	"
79	CR527	31	40	90	"
80	CR533	57	220	170	"
81	CR535	17	70	140	"
82	CR536	28	120	115	"
83	CR537	30	30	80	"
85	CR539	20	<30	86	"
86	CR 46	28	30	79	"
87	CR 57	26	40	80	"
89	CR 96	7	<30	10	"
91	CR 98	25	30	49	"
92	CR 49	23	<30	48	"
93	CR 50	23	<30	56	"

1/ Analysis by USBM Reno Metallurgical Center by atomic absorption.

the vicinity was reexamined and sampled in greater detail as part of the Bureau of Mines program.

The primary mineral targets are hydrothermal vein-type deposits, as well as perhaps massive, disseminated, or replacement mineralization in the black phyllites. The rhyolites were also examined for possible mineralization of intrusive origin.

Mineralization

Minor occurrences of malachite, chalcopyrite and galena were observed in gossans near sample No. CR 525, figure 20. Mineralization appeared controlled by fault traces or shear zones. Minor argillic alteration was noted, with silicification. The best of exposed mineralized zones were small lenses, no more than several feet wide by 30 feet along exposed strike, with spotty galena. Most observations were limited to weathered frost rubble and scree slopes.

Geochemistry

Sixty soil and ten stream silt samples (figures 20 and 21) were taken from exposed or tundra covered areas encircling the mountain. Due to the extensive weathering and soil formation, soil samples from the intermediate slopes were felt to be potentially most indicative of any extensive mineralization. Lower elevation sampling appeared futile due to very thick colluvium, the lack of ground water circulation and the swampy surface conditions.

Results from atomic absorption analyses of the soil, stream sediment and rock samples are listed in tables 5 and 6. Semiquantitative emission spectrographic data are included under the same map numbers in the appendix for stream sediments samples, Table A-1.

Soil samples indicate a moderate lead anomaly on both sides of the headwaters of a small creek draining the west side of the mountain. Values were inconsistent, but ranged up to 420 ppm.

Several rock samples in this area were also anomalous, including the occurrence of minor mineralization mentioned earlier. Random chips of pyritic quartzite taken over 800 feet along strike showed 610 ppm lead, 390 ppm zinc, and 68 ppm copper. Very small amounts of disseminated base metal sulfides were probably present, but were not observed.

Results and Recommendations

Vein-type occurrences do exist at Rabbit Mountain, but, considering the remote location, lack of extensive alteration and only very minor surface showings, they appear too small to be of economic interest.

The possibility of stratiform sulfides in the metasediments is suggested by the geochemistry, however, field investigations based on surface exposures have indicated that the mineralization would likely be of a very low grade.

It should be reiterated that this level of reconnaisance hardly represents a complete assessment, although no further work appears warranted at this site for the present study.

Thorough investigation was not feasible in the vegetated lower elevations surrounding Rabbit Mountain, and hence, these areas should not be included in the foregoing summary.

Rapid River Uranium and Tin Prospects

Geology

Minor occurrences and favorable geology and geochemistry indicating uranium and tin mineralization were identified in highly altered granitized (anatectite) zones of the Devonian(?) Old Crow batholith. The intrusive as previously described is generally a multi-phase, sericitized, equigranular, biotite granite which in the region of the mineralization displays widespread muscovite and chloritic alteration. Generally the area discussed here lies within the intermediate level of the batholith (fig. 5) which consists of coarse- to fine-grained biotite granite, muscovite and muscovite/biotite granitics, quartz-biotite and tourmaline-aplite phases, as well as massive quartz veins (frequently cataclastic). The sites of mineralization are further characterized by breccia and resilicification, secondary muscovite development, and hematization of granitoid material, with primary hematite disseminated and pervasive in quartz veins up to 8 inches wide in some cases.

The Old Crow intrusive is a broadly domed body with granitization of the former host rock (the outer zone described earlier) primarily within its upper reaches. Underlying this is the intermediate multi-phase zone which apparently contains the mineralization.

On the surface the granite is highly weathered, with widespread permanently frozen saprolite development which inhibits mineral evaluation. Vegetation of scrub black spruce and tundra is nearly continuous and rock outcrop is generally limited to frost-jacked rubble.

A complex structure due to extensive shearing and possible northeasterly offsets is evident from airphoto studies. Mineral occurrences and geochemical soil anomalies appear at least spatially related to this post-intrusive structural pattern (fig. 22). The cause, age and orientation of the structural

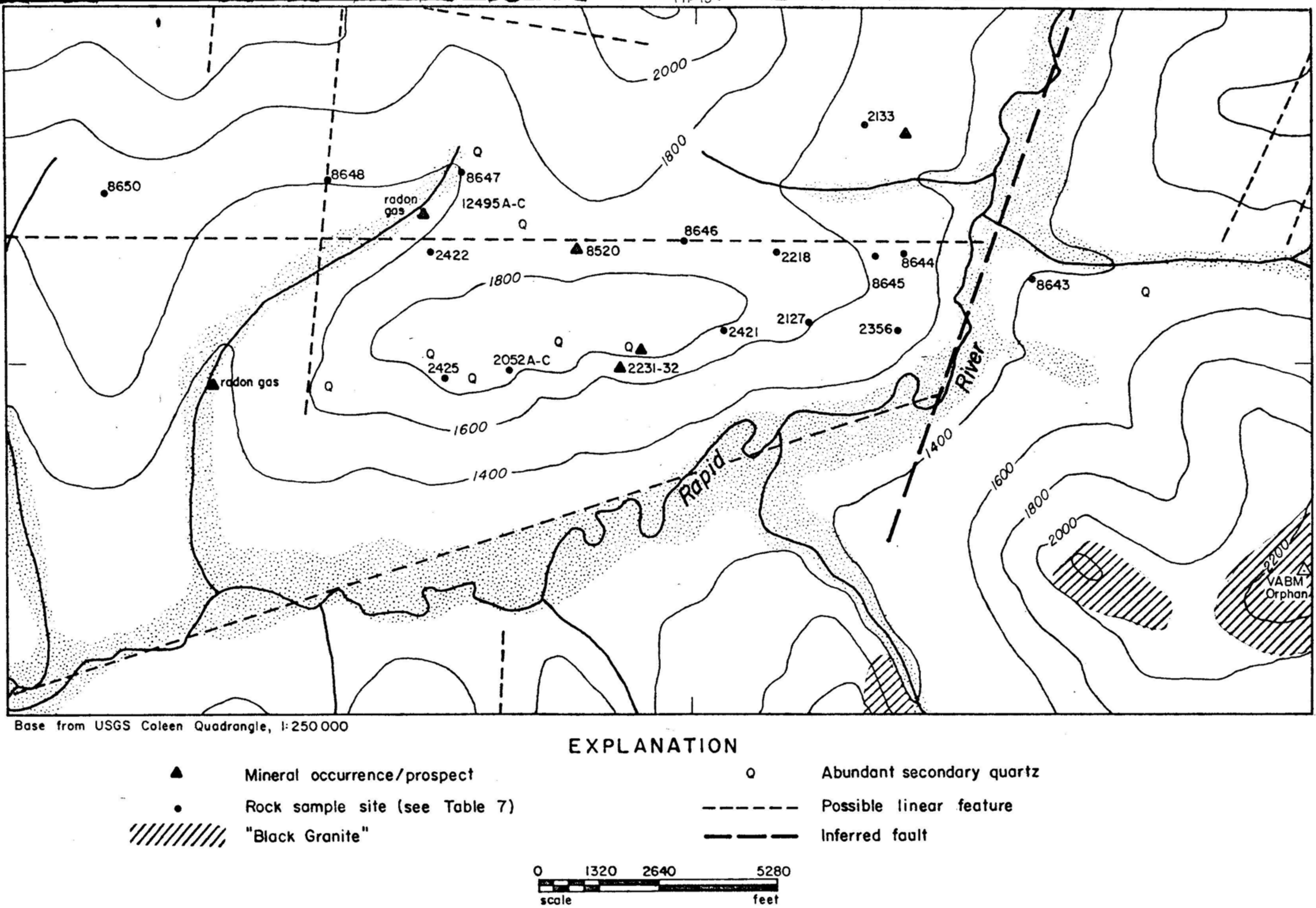


FIGURE 22.- Rapid River--rock sample location map

deformation has not yet been resolved but the regional proximity to the Kaltag lineament (<u>33</u>) is suggested to be a contributing factor.

Mineralization

Cassiterite occurs in amounts up to 40 percent of panned concentrates in the Rapid River, region as described in the accompanying report on placer potential of the Old Crow Hills. Monazite, allanite and occasionally scheelite are also abundant, although the primary sources have not yet been found. Monazite frequently exceeds 50% of the heavy mineral fraction of stream gravels.

At sample location 2231 secondary uranium minerals and anomalous amounts of tin, copper, lead, zinc, and arsenic were found to occur occasionally disseminated as pods in leached and brecciated vein quartz rubble over a distance of 800 feet on a ridge top.

X-ray diffraction showed the presence of xenotime (YPO_4), a mineral often containing uranium, thorium, and rare earths, uranophane [$Ca(UO_2)_2(SiO_3)_2(OH)_2.5H_2O$] and arsenuranylite [$Ca(UO_2)_4(AsO_4)_2(OH)_4.6H_2O$]. Metatorbernite [$Cu(UO_2)_2(PO_4)_2.8H_2O$] was tentatively identified in this sample. Fluorometric analysis indicated 1,600 ppm uranium. Bedrock examination was limited to the frost rubble along the ridge top.

Rock samples taken within the uranium-bearing quartz vein (2231 and 2232) show variable amounts of sericite and muscovite as fracture fillings, as well as abundant hematite. These rock sample analyses, along with others from this area, are listed in Table 7.

Air photo examination indicates this ridge to be a more resistant block, bounded on the north by a strong topographic lineation about a half mile wide and at least three miles long. High concentrations of cassiterite were found in a creek immediately to the west. It appears that the cassiterite is derived from similar vein or replacement sources associated with this lineation.

Within the lineation valley an outcrop of leached frost rubble at location no. 12495 was identified by T.C. Mowatt (32) as a metamorphosed highly altered granitoid with feldspar replaced by sericite and with secondary muscovite and hematite. The rock is moderately cataclastic and contains unidentified opaques. The rubble outcrops were found to be radioactive and typical samples contained 50 to 115 ppm uranium, 80 to 300 ppm tin and 30 to 850 lead. Rubble occurred over a tundra area of 250 by 250 feet from which a natural spring emanated noticeable amounts of radon gas. Creek water for several hundred yards below this site was measured during an examination in September and found to have levels up to 1,200 cps by a hand held scintillometer. One and a quarter miles below this site the creek water was again similarily radioactive, but no rock rubble was visible there (fig. 22). A visit in July showed no detectable radon.

Near and downslope of location OC 2133 a uranium soil anomaly was found in a tundra-covered area approximately 2,400 by 600 feet in extent (fig. 23). No bedrock was observed within this area although tourmaline/muscovite aplite rubble was found nearby. Residual soil samples (Map No. 1 through 9; Table 8) were taken over the zone from depths of about 18 inches, immediately above the continuous permafrost layer. At this depth, there was no visually recognizable organic material. Soil was relatively dry silt with minor sand and traces of residual rock fragments of sericitic granite and quartz.

Uranium analyses (table 7) were done by fluorometric procedures. Thorium was analyzed by colorimetry. It should be noted that thorium values were usually lower than the uranium.

Table 7. - Rock Sample Analyses (ppm) *

Map Location	Ag[1/]	B[2/]	Be[2/]	Cu[1/]	Cu[2/]	Ga[2/]	Ni[2/]	Mo[1/]	Mo[2/]	Pb[1/]	Pb[2/]	Sn[2/]	W[2/]	Zn[1/]	Zn[2/]	U[3/]
2052A		20	5		150	1	300		<10		100	<20	<50		--	
2052B		30	7		150	<.2	150		"		70	"	"		--	
2052C		1000	20		100	0.7	150		"		100	"	"		--	
2127		100	5		500	3	500		70		700	70	L		--	
2133		1500	50		150	1	300		70		<20	<20	<50		--	4.7
2218		>2000	7		200	<.2	500		<10		"	"	"		--	
2231	2.8	10	2	290	20	"	10	5	"	590	150	"	"	210	--	1600
2232		150	7		200	"	100		"		3000	100	"		1500	
2356		30	"		20	L	150		"		100	<20	L		--	
2421		50	10		100	1	"		"		150	"	<50		--	
2422	<3	50	L	280	500	<.2	L	7	"	125	L	L	"	322	--	
2425	"	100	"	9	20	3	150	8	"	27	<20	200	"	74	--	
8520	"			77				<15		3300		200[4/]		1400		30
8643																
8644	<3	200	<1	14		8	10	<15		18		9	--	10		5.7
8645	"	90	"	250		4	9	"		44		9	--	39		2.9
8646	"	"	4	3.7		20	20	"		60		20	--	180		4.9
8647	"	100	3	18		<3	10	"		65		30	--	510		14.0
8648	"	"	<1	5.4		7	"	"		23		7		25		1.8
8650	"	90	2	"		10	100	"		<15		30		100		3.4
11313A																2.3
12495A	<3			120				<15		30		200[4/]		15		110
12495A-2	"			69				"		"		300[4/]		20		80
12495B	"			150				"		850		"		75		35
12495C	"			7				"		125		<100[4/]		40		2.6

1/ Samples analyzed by atomic absorption methods
2/ Samples analyzed by emission spectrographic methods
3/ Uranium by fluorometry
4/ Tin by quantitative - x-ray analyses
< Less than detection limits used
\- Not analyzed for
L Detected but lower than detection limits

* Rock sample descriptions listed on following page

TABLE 7 - Rock sample analyses continued

Map location number	Rock sample descriptions
2052A	fine-grained biotite granite
B	gray-green, fine-grained siliceous granitic rock
C	sheared granitic rock with disseminated hematite and highly altered biotite
2127	gray-green siliceous granitic rock (?)/micaceous quartzite(?) with some limonite-stained vugs and secondary(?) muscovite
2133	green, fine-grained granite/aplite with muscovite and tourmaline
2218	siliceous tourmaline bearing granite
2231	fractured vein quartz and sheared siliceous green granitic(?)/quartzite(?) rock with leached vugs and secondary green and yellow uranium minerals, some disseminated hematite, goethite and manganese.
2232	random chips along 300 feet of vein quartz rubble near site of #2231. Bismuth analyzed 70 ppm.
2356	sheared, iron-stained, fine-grained biotite granite
2421	gray-green siliceous sericitic granitic rock with argillic alteration
2422	dark siliceous dike(?) rubble in area of coarse biotite granite
2425	gray-green siliceous granitic rock with iron-staining
8520	intermingled aplite and coarse grained granitoid, sericitic with biotite altered to chlorite, primary muscovite
8644	granitic with schistose fabric and quartz porphyroblast
8645	highly altered porphyritic quartz/muscovite/sericite/aplite, some black opaques and iron minerals, limonite stained vugs
8646	granitoid/pegmatite texture (cataclastic), sericite and carbonate altered feldspars, chloritic alteration of biotite, secondary muscovite, manganese stain
8647	metamorphic/cataclastic strongly altered granitoid, apparent primary muscovite, sericite alteration of feldspars. Black opaques and hematite as fracture fillings.

TABLE 7 - Rock sample analyses continued

Map location number	Rock sample descriptions
8648	porphyritic aplite with feldspars altered to sericite; chloritic alteration of biotite, both primary and secondary muscovite
8650	metamorphosed granodiorite/diorite dike(?) with hornblende/actinolite; epidote, argillic and sericitic alteration of plagioclase; biotite altering to chlorite
11313A	veined quartz (coarsely crystalline) and iron minerals
11313D	(not analysed) - metamorphic/cataclastic, altered granitic, complexly deformed feldspars altered to sericite; minor muscovite and hematite development
12140	fine grained quartz, muscovite, biotite/chlorite granitic
12495A	Altered, metamorphosed granitoid (cataclastic), feldspars altered to sericite and muscovite, faint chloritic development and finely disseminated hematite. Several stages of alteration are apparent; sericite, muscovite and muscovite/hematite fracture coatings.
12495A-2	metamorphosed granitoid with muscovite (secondary?) a major constituent, sericitic alteration of feldspars with ferruginous and argillaceous black opaques
12495B	similar to above
12495C	metamorphosed sericitic granitic, extensive secondary(?) muscovite; breccia fabric and intensively leached.

This prospect was first found with a hand-held scintillometer, from which radioactive contours, in counts per second, were derived. Elsewhere in the region, above-surface background readings averaged about 150 cps over similar tundra terrain, and 200 cps over exposed granite. Readings over the tundra anomaly ranged up to three to four times this level.

Soil (no. 2128) from a small radiometric anomaly at location 2127 (fig. 22), contained 20 ppm uranium, as well as 2,400 ppm lead and 1,360 ppm zinc. Rubble at this site was a silicic, chloritic granitic rock with limonite vugs and secondary muscovite. A soil sample near no. 8645 also contained 29 ppm uranium.

At location no. 8520 about one mile further west, a frost boil area detected by radiometrics contains 120 ppm uranium, 3,100 ppm lead and 3,100 ppm zinc. Rock chips from nearby consisted of a vuggy, green silicic, muscovite granitic with similar metal values.

At location no. 11313 (fig. 24) approximately six miles to the north, the area flanking the west side of VABM Barren is characterized by considerable fracturing and chloritic/argillic alteration with general muscovite development. A series of six soil samples traversing this zone contained 15 to 21 ppm uranium.

On the south and southeast sides of VABM Barren extensive areas of "two-mica" granites and aplites, locally containing tourmaline, were observed. These rocks are intruded in at least one case by porphyritic rhyolite.

At location no. 12140 frost-heaved boulders of a highly altered fine grain muscovite and minor biotite to chlorite granite were slightly radioactive. A composite chip sample along 100 feet of this rubble contained 31 ppm uranium.

No tin analyses are yet available from the VABM Barren vicinity.

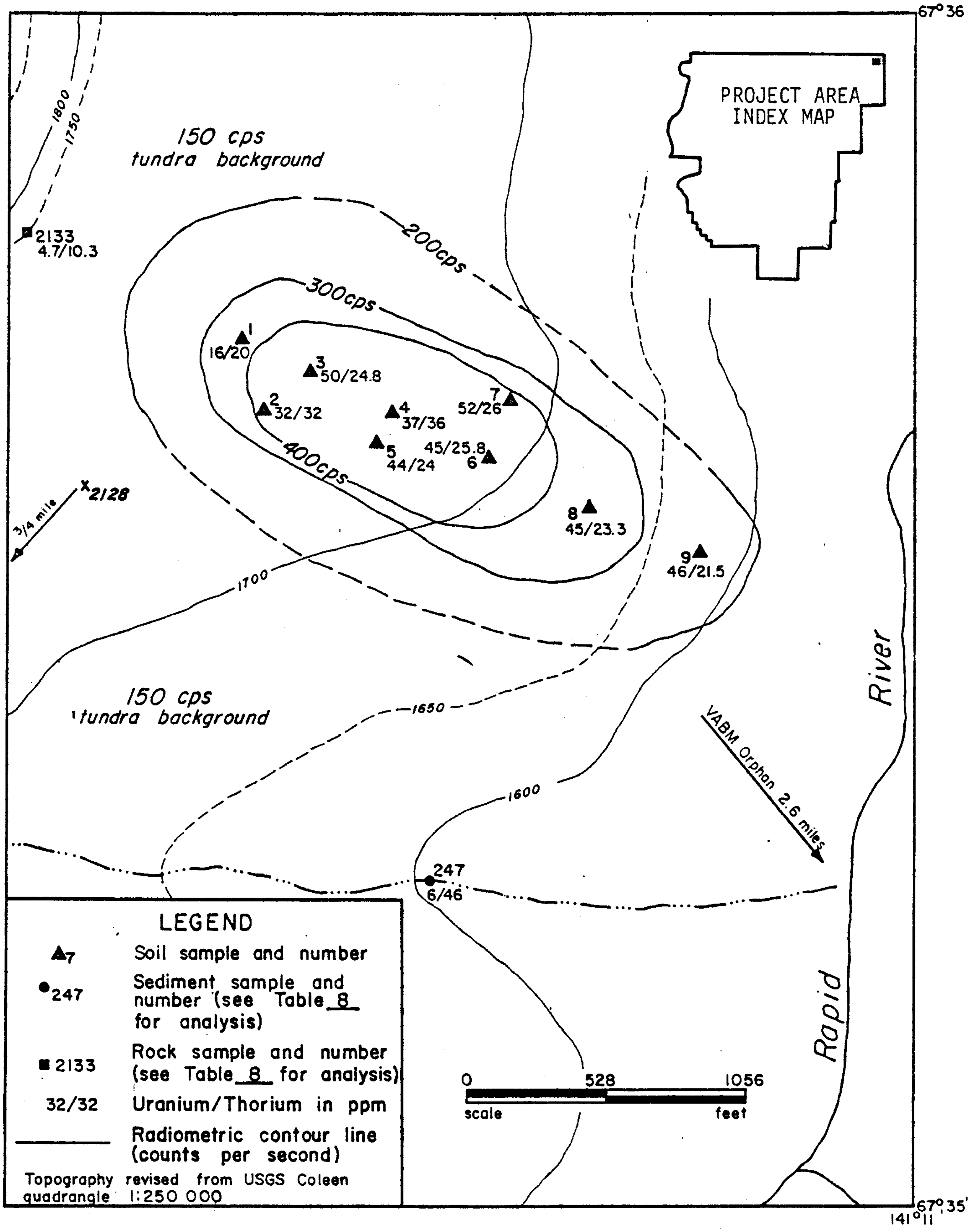
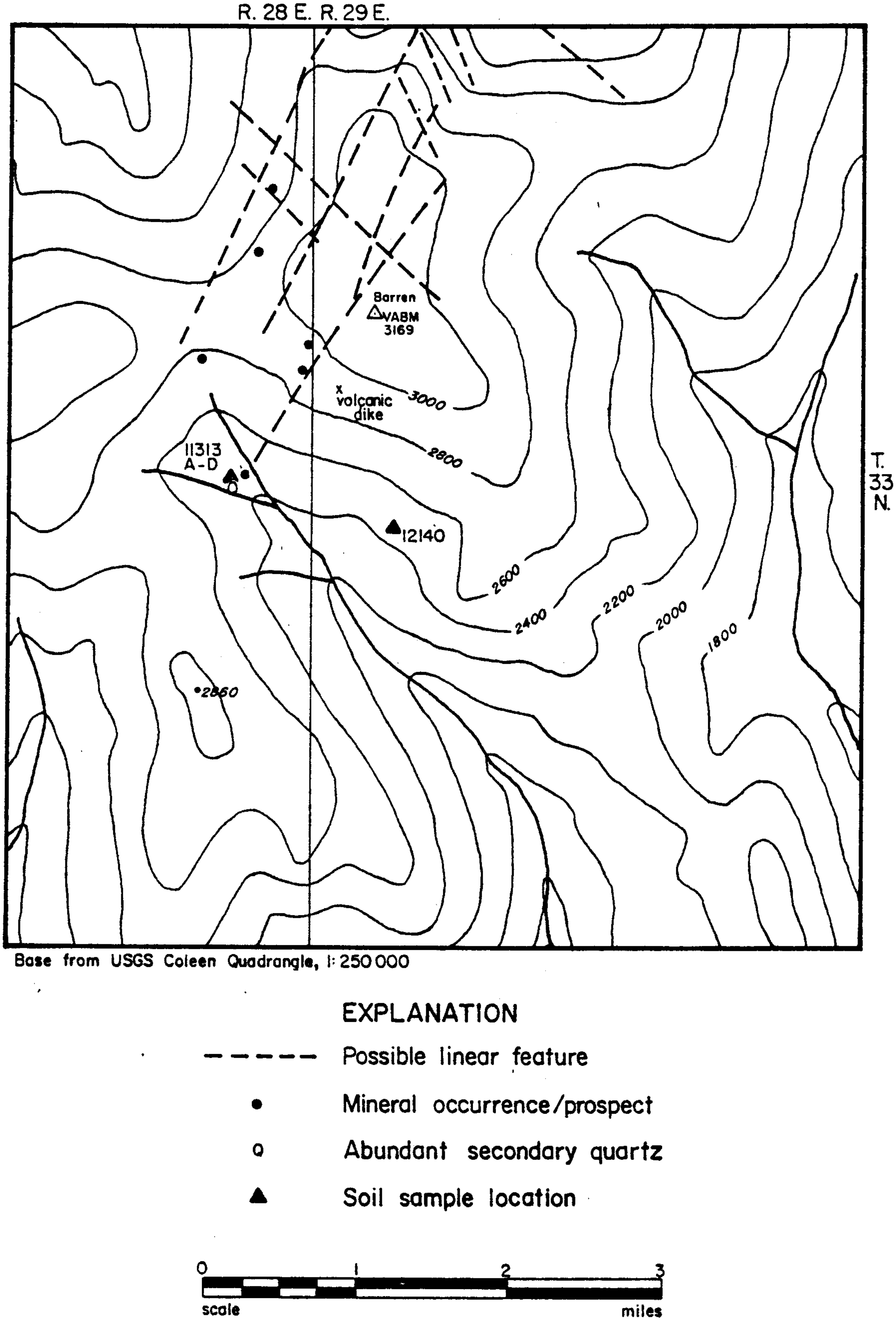


FIGURE 23.- VABM Orphan prospect and sample location map

TABLE 8 - VABM Orphan - Sample analyses (in ppm)

Map #	Sample #	Sample	Fluorometric U	Colorimetric Th	Atomic absorption Cu	Pb	Zn	Ag	As
1	2134	Soil	16	20	26	21	60	0.1	5
2	2132	Soil	32	32	42	26	53	0.1	5
3	2130	Soil	50	24.8	20	32	66	0.1	5
4	2224	Soil	37	36	120	38	54	0.1	5
5	2225	Soil	44	24	32	19	64	0.1	5
6	2135	Soil	45	25.8	20	27	66	0.1	5
7	2136	Soil	52	26	99	27	68	0.1	5
8	2137	Soil	45	23.3	25	19	60	0.1	5
9	2138	Soil	46	21.5	21	15	56	0.1	5
- -	2128	Soil	20	58	28	2400	1360	0.3	10
(near 8520 fig. 22)	8519	Soil	120	- -		3100	3100		- -
247	2129	Sediment	6	46					



Base from USGS Coleen Quadrangle, 1:250 000

FIGURE 24.- VABM Barren uranium prospect

Stream sediment samples (OC 2240 and OC 2238; fig. A-1, Appendix A) from the upper-most tributaries to the Rapid River were found to contain 50 and 100 ppm Sn, 500 and 700 ppm W, and 63 and 120 ppm Th, and 10 and 11 ppm U respectively. No follow-up investigation of this area was possible, however the unusually high values of these elements, considering the poor response to stream geochemistry elsewhere in the Old Crow terrane, may suggest sulfide phases of a different depositional type (i.e. porphyry or volcanic breccia pipes) for the tin and tungsten, and possibly molybdenum.

Geochemistry

Stream sediment sampling in this highly weathered terrain was found to be poorly correlative of mineralization, probably due to lack of subsurface water, and to extensive permafrost clay. The highest value found for uranium was 25.8 ppm from CC-74, but generally most values were less than 10ppm. Anomalous tin was detected at only several locations, such as described above. Lead gave a poor but correlative response to the apparently mineralized areas.

Stream sediment values are probably more of a function of composition/mineralization of very limited bedrock exposures in the Old Crow region than of buried mineralization below the permafrost level.

Soil sampling from subsurface material in frost boils was generally effective in isolating some mineralized localities, but soils near the radiometric location no. 12495 contained no appreciable values of tin or uranium and were only weakly anomalous for lead and zinc as contrasted to rock sample analyses from that same site.

There appears to be a direct association of lead, zinc, and occasionally copper, boron, yttrium, and arsenic with the uranium and possibly tin. These can be used as path-finders for soil and bedrock sampling.

Although considerable contents of thorium minerals, primarily monazite, occur in the heavy mineral fractions of the streams, there was no such concentration in rock and soil samples where anomalous tin or uranium were found.

Soil samples taken north of the ridge in figure 22 showed anomalous values of lithium, up to 0.5 percent at one site.

Results and Recommendations

Uranium mineralization occurs in hydrothermal vein-type and greisen-like breccia structures of the Old Crow batholith. Tin and minor tungsten apparently also occur in this environment, although they probably represent a different phase of mineralization.

Although most of these occurrences and anomalies appear rather isolated, the widespread distribution of sites found by this very brief survey would certainly suggest that this area warrants further study. Shallow drilling or augering should be undertaken on some of the radiometric targets. There is a direct association to alteration patterns and open-space fracturing which should be further investigated.

Further evaluations for contact mineralization or vein systems of tin, tungsten, and uranium should be made north of Spike Mountain and the west end of the batholith where the apical zone of the intrusive is overlain by metasedimentary units. Evidence of tin mineralization was apparent in the argillite tactites near the copper-zinc prospect.

Old Crow Hills Placer Prospects

(T. 30-32 N., R. 27-29 E., figure 8)

Geology

Potential alluvial and residual placers of tin, tungsten and rare-earth elements occur within and downstream of the Old Crow batholith (see earlier discussion on the geology of the granitic terrane). Extensive gravel deposits of the Rapid River and Strangle Woman Creek drainages have formed, uninterrupted by glaciation, apparently since the batholith was unroofed. The absence of roof pendants suggests that the upper levels of the intrusive have been eroding for a substantial period of time. Alluvial surface material consists of poorly sorted coarse rounded cobbles, small boulders and sands typical of weathered granitic terrane. Extensive feldspar alteration has led to the development of widespread saprolite within which residual placers may have also formed.

Physiography

The Rapid River, a southwesterly flowing tributary to the Porcupine River, drains the southwest quadrant of the batholith, a drainage area of approximately 200 square miles of granitic rocks. Due to the subdued nature of the terrain, it is a relatively slow, meandering stream with a gradient of less than 20 feet per mile along the primary channel. Maximum annual variation in water level appears to be only 4 to 6 feet. The alluvial valley bottom ranges in width from 200 feet to over one half mile. The valley profile is broadly rounded, and the actual limits of alluvial gravels are difficult to discern. No outcrops of bedrock were observed along the river, except where sedimentary units are encountered fifteen miles downstream of the batholith. The lower portion of the stream forms a low canyon as it approaches the Porcupine River.

Interpretation of Landsat photos suggest that the broad, low-gradient Rapid River channel may be an ancient remnant of the Porcupine River.

Although the gravel benches can be expected to be permanently frozen, the active channel should be thawed, with limited drainage year-round. No residual overflow ice (aufeis) was encountered in the early summer season of 1976 and 1977.

Strangle Woman Creek has two major tributaries which flow north, then east to the Coleen River. They drain approximately 150 square miles of granitic terrane. Topography on the north side of the batholith is yet more subdued and eroded than on the south. Strangle Woman Creek has a higher gradient (estimated at 35 to 100 feet per mile) than the Rapid River and a corresponding higher percentage in coarse cobbles and boulders. There also appears to be less ground water drainage on the north side and apparently a lower annual precipitation.

The climate of this region is quite dry, averaging about 8 inches of annual precipitation (24). Lower elevations are normally snow free by late May.

History

White (43) reported radioactive minerals in the gravels from a site on the Rapid River. Elements other than uranium and thorium were not analyzed. Several panned concentrate samples from Sunaghun Creek, a separate smaller south flowing drainage with headwaters in the batholith (Appendix B) were reported by the Bureau of Mines (42) to contain anomalous amounts of lead, thorium, tin, tungsten, and lanthanum. There has been no known exploration by industry in the area.

Mineralization

A pan concentrate survey, followed by sluicing of larger gravel samples (0.1 cubic yard) at 15 locations (fig. 25) indicated the granitic gravels to be consistently enriched with monazite, cassiterite and scheelite, with minor amounts of zircon, niobium (mineral form unknown), allanite, xenotime, and powellite, table 9. Cassiterite nuggets up to 1/2 inch were found on Strangle Woman Creek.

Sampling was done with an 8 by 30 inch box with expanded wire riffles set in the stream and limited to the surface gravels only. Therefore, lacking subsurface sampling, the average tenor of the deposit cannot be evaluated at present. It can be presumed, however, that the amount of concentrate will increase substantially with depth, particularly in these coarse granitic sands and gravels. Based on the sluice samples, and ignoring inefficiencies of the sluicing recovery system, an average of approximately 0.99 lbs of concentrate per cubic yard occurs in the finer (approximately -1/2 inch) portions of the surface gravels. Recovery in the sluice box was considered to be poor particularly with the larger size fractions of heavy minerals.

Surface mineralization was significantly richer in the smaller tributaries, owing in part to the shallower depths to bedrock and less stratification.

No data is available on the depth of the gravels, therefore, estimates of total yardage can only be speculative at this time.

Geochemistry

There were 115 panned samples taken in the vicinity of the batholith. Analyses by a semiquantitative emission spectrograph method indicate a zone of highly anomalous tin, tungsten, and rare-earth elements at least 24 miles wide and about 18 miles north and south. The zone is bounded on the east end by the Canadian Border. Figures 25 and 27 indicate amounts of anomalous tin and

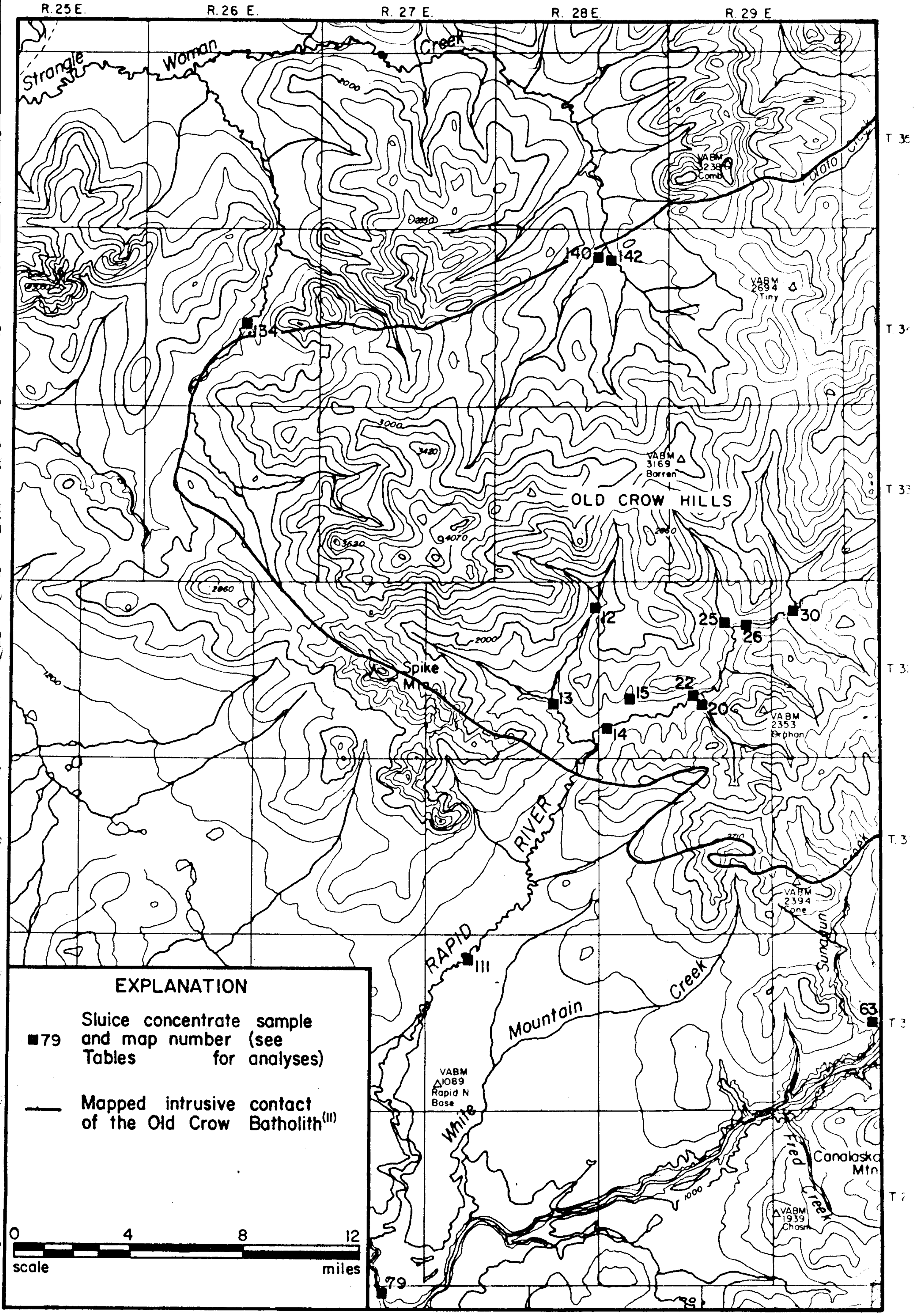


FIGURE 25.- Sluice sample sites--Old Crow Hills

TABLE 9 Petrographic Report
Sluice Samples

Number	26	25	13	15	14	22	20	12	30	134	142	14
rals:												
anite									M			
hibole						T						
atite			T		F	T						
ite					T	T						
tite-chlorite		S	S	M	M	M	M	A	A	S	M	T
siterite	S	A	A	A	F	M					S	F
omite	F											
dote	T		S	S	M	S				M	M	M
dspar-quartz							S	A	A			
net	S	S	M	S	A	S			M	P	S	A
thite	S	M	S	F	A	S	P	P	P	M	T	S
atite		F	T		T							S
enite	S	F	S	A	S	S				A	S	S
netite	T	T	T	T	T	T						
2				T								
ybdenite				T								
azite	A	S	P	A		A				M	P	A
ahedrite	M	M	F		M	F						
ellite f	S				F	F						T
eelite		F	T	F	T						T	F
ene	S											
maline	T	A	S	S	A	S	M		M	F	S	T
time	F	T		F		F					T	
on f	T	F	T	F	F	F				T	S	T

Legend:	P - Predominant	Over 50 percent
	A - Abundant	10 - 50 percent
	S - Subordinate	2 - 10 percent
	M - Minor	.5 - 2 percent
	F - Few	.1 - .5 percent
	T - Trace	Less than .1 percent

f - Fluorescent

TABLE 9 Petrographic Report

Sluice Samples, Continued

Sample Map No.		79	63
Minerals:			
allanite		T	
amphibole			T
ankerite			M
apatite			
augite		A	
baddeleyite			F
barite			M
biotite-chlorite			S
cassiterite		F	
chlorite		T	S
chondrodite		S	
chromite		M	
epidote		T	T
garnet		F	
goethite		M	S
hematite			
ilmenite		F	
magnetite			
MnO			
monazite		F	
octahedrite			
olivine		A	
powellite	f	T	-
pyrite		T	P
scheelite	f	T	—
sphene			
tourmaline		T	
zircon	f	T	T

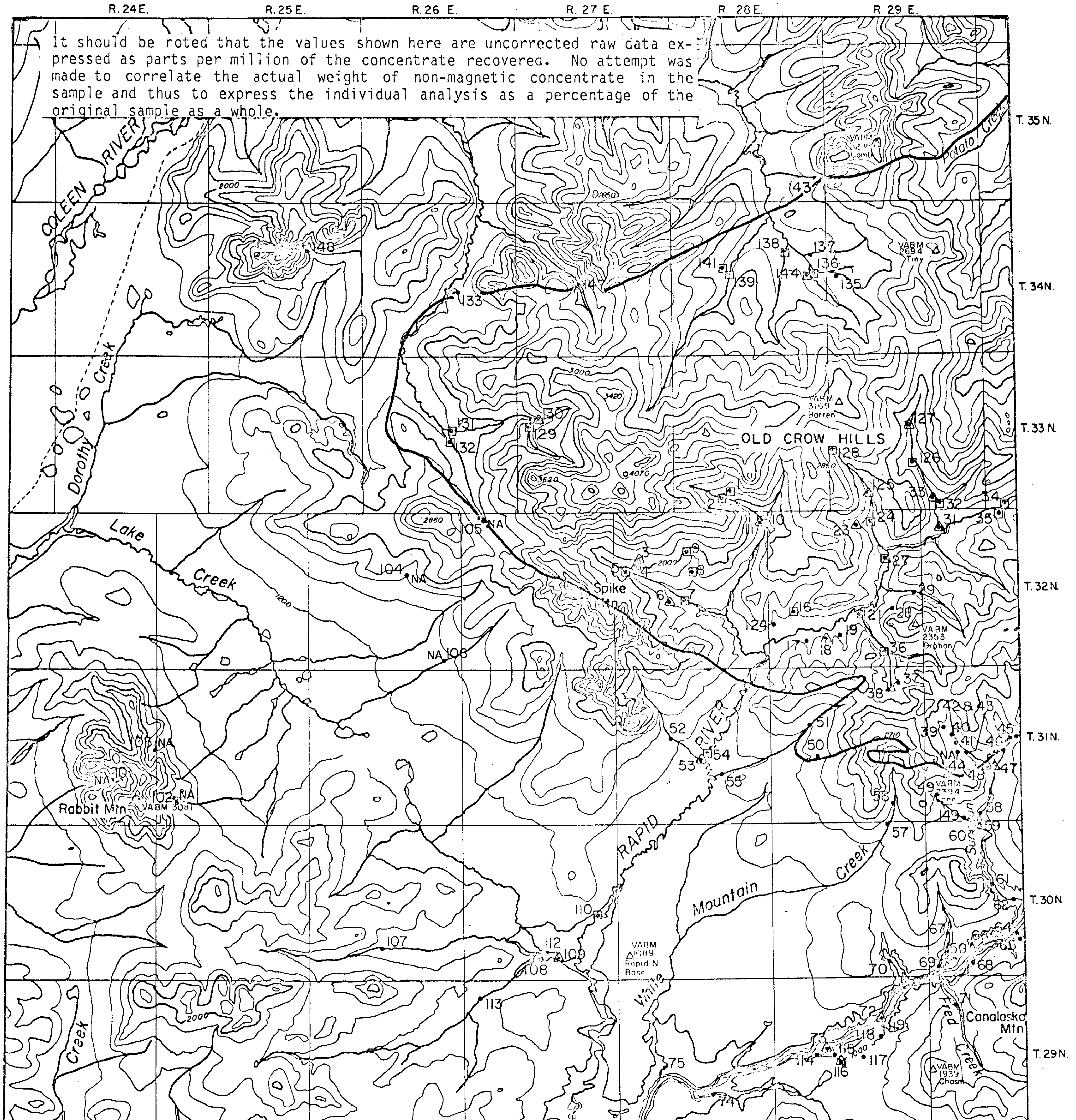
tungsten as a percentage of the concentrate recovered from one rounded full 14 inch pan (approximately 16 pounds) at each sample site. It should be noted that the values shown are uncorrected in terms of the actual amount of non-magnetic material recovered. They represent a percentage of the concentrate recovered, not a percentage of the sample (one full pan) as a whole, Table 10.

Sediment samples were also taken at most sample sites, however little correlation could be made to the pan concentrate results, due partly to the scarcity of fine material on the surface of the active channels, as well as the immobile nature of these elements. However, some above-background levels of arsenic, lead, and thorium were observed. Sediment results are listed in Appendix A, Table A-1.

Sluice samples were prepared and analyzed in the same manner as the pan concentrates. Analyses are shown in tables 11 and 12. Sluice samples were also tested for tin and tungsten by atomic absorption and for thorium by colorimetric procedures. For uranium analyses, the splits were intitially prepared using a hydrofluoric acid-nitric acid digestion. Fluorometric analyses gave values ranging from 51 to 325 ppm. Because higher concentrations of uranium were suspected in minerals such as monazite, allanite, and xenotime, duplicate samples were also prepared by lithium metaborate fusion followed by dissolution in 10 percent nitric acid and extraction into diisobutyl ketone containing aliquat 336. Fluorometric analysis by this latter procedure gave values 3 to 20 times higher, as shown in table 11.

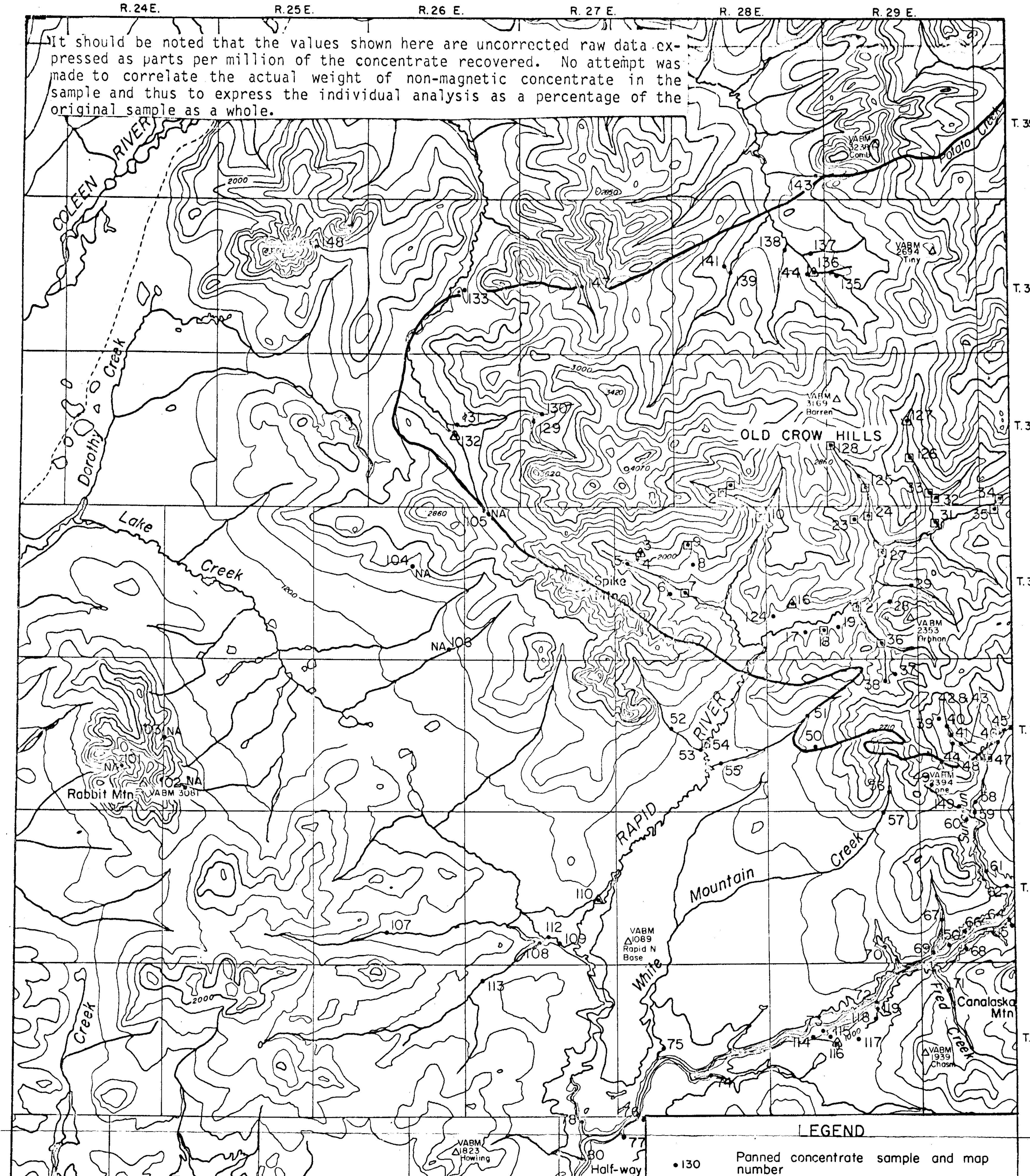
Geochemical results of the sampling suggest an association of these placer minerals with the intermediate zone of the batholith, as described earlier under the geology of the granitic terrane. Correlation of the higher values in the Strangle Woman drainage to particular phases of the intrusive, is somewhat more tenuous at this time. Interpretation of previous analyses (7) of rocks from the

It should be noted that the values shown here are uncorrected raw data expressed as parts per million of the concentrate recovered. No attempt was made to correlate the actual weight of non-magnetic concentrate in the sample and thus to express the individual analysis as a percentage of the original sample as a whole.



Base adapted from USGS Coleen Quadrangle, 1:250 000

FIGURE 26.- Tin analyses--Old Crow Hills



It should be noted that the values shown here are uncorrected raw data expressed as parts per million of the concentrate recovered. No attempt was made to correlate the actual weight of non-magnetic concentrate in the sample and thus to express the individual analysis as a percentage of the original sample as a whole.

Base adapted from USGS Coleen Quadrangle, 1:250 000

FIGURE 27.- Tungsten analyses--Old Crow Hills

o.	Number	Weight g	Sn (ppm)	W (ppm)	No.	Number	Weight g	Sn (111)	
1	1994	1.90	20,000	7,000	71	3200	na	N	
2	1992	2.56	20,000	10,000	72	1900	1:10	5,000	
3	2246	0.10	7,000	3,000	73	1895	0.53	5,000	
4	627	0.07	3,000	1,000	74	3181	na	N	
5	628	0.18	20,000	2,000	75	663	2.93	L	
6	2248	2.26	5,000	N	76	1882	11.97	L	
7	621	0.43	20,000	G	77	1880	7.16	300	
8	625	0.16	10,000	2,000	78	3179	na	N	
9	622	0.07	G	G	80	1875	36:42	L	
10	630	0.75	30,000	G	81	1872	3.18	L	
11	629	0.25	7,000	G	82	1868	2.60	L	
16	83	0.25	G	3,000	83	1885	5.40	L	
17	2353	1.61	500	N	84	667	0.20	L	
18	2354	0.25	7,000	5,000	85	1854	7.95	N	
19	2355	0.48	1,000	700	86	1852	8.20	L	
21	620	0.38	50,000	G	87	1850	8.34	L	
23	2053	1.67	7,000	7,000	88	1847	5.67	L	
24	2243	1.70	100,000	G	89	1842	17.01	300	
27	619	0.48	100,000	G	90	1840	2.16	700	
28	2411	1.01	700	700	91	1835	3.05	L	
29	2420	0.35	1,000	700	101	No Analyses			
31	2376	0.93	5,000	7,000	102	No Analyses			
32	2237	1.56	50,000	10,000	103	No Analyses			
33	2234	0.10	5,000	5,000	104	No Analyses			
34	2239	3.54	10,000	7,000	105	No Analyses			
35	2241	0.01	15,000	G	106	No Analyses			
36	2216	6.41	20,000	7,000	107	657	0.39	L	1
37	61	0.24	N	2,000	108	652	1.07	3,000	1
38	68	0.09	N	N	109	653	0.75	3,000	1
39	2330	1.84	150	N	110	647	0.77	60,000	3
40	5	0.25	2,000	N	112	12503	6.11	2,000	
41	1923	4.58	700	N	113	12500	3.70	2,000	
42	No Analyses				114	12549	0.62	2,000	
43	7	0.23	N	N	115	12545	0.55	2,000	
44	3197	na	500	500	116	12548	0.07	7,000	3
45	3195	na	30	N	117	11357	0.99	1,000	
46	3194	na	20	N	118	8181	0.30	500	
47	2101	1.55	5,000	7,000	119	8182	0.52	2,000	
48	2103	1.22	5,000	3,000	124	12492	0.62	2,000	
49.	2347	2.64	200	N	125	12166	0.56	5,000	7
50	2000	4.02	700	N	126	12176	2.41	20,000	5
51	89	0.15	L	N	127	8492	0.65	7,000	3
52	2100	4.29	700	N	128	12488	2.66	100,000	10
53	642	0.12	7,000	N	129	11384	1.21	15,000	
54	643	1.08	70,000	G	130	11382	0.46	7,000	
55	644	0.44	L	1,000	131	8504	2.99	10,000	1
56	23	0.24	L	N	132	8484	5.61	G	3
57	2312	2.97	300	N	133	12226	1.78	2,000	
58	10	0.08	L	N	135	12220	1.06	2,000	
59	12	1.32	L	N	136	12223	3.48	100,000	3
60	14	1.28	L	N	137	8438	2.78	2,000	
61	3192	na	2,000	L	138	8440	2.08	50,000	1
62	3182	na	N	N	139	12236	3.46	70,000	2
64	1971	2.57	500	N	141	12238	5.73	70,000	1
65	1973	6.87	300	N	143	8452	2.13	2,000	
66	1985	2.07	N	N	144	8436	1.79	20,000	1,
67	42	0.79	L	N	147	10992	1.50	5,000	
68	3202	na	N	N	148	12266	2.61	2,000	2,
69	49	0.51	L	L	149	11344	10.54	500	
70	55	0.25	L	N	150	11374	15.02	2,000	

TABLE 10 - Tin/Tungsten Analyses - Old Crow Hills

1/ Recovered -14 mesh non-magnetic heavy mineral fraction, in grams

G = greater than detection limits (100,000 ppm Sn and 10,000 ppm W)

N = not present

L = detected, but lower than detection limits

na = not available

TABLE 11 - Sluice Concentrate Sample Analyses

Sample Map No.	Quantity 1/ of Material Concentrated	Concentrate Recovered (non-magentic)	ANALYSES (in percent) Atomic Absorption 2/		Colormetric 3/	Fluorometric 3/	Semi-Quantitative Spectrographic 4/				Monazite (est'd. by fluorescence)
			Sn	W	Th	U	Ce	La	Nb	Y	
79	0.1 yd	13.68 grams	-	-	-	-	N	N	L	0.1%	10%
63	0.1 yd	24.49 grams	-	-	-	-	N	N	L	0.1	N
26	0.1 yd	48.90 grams	5.1%	0.66%	9.0%	0.09%	7.0%	2.0%	.05%	2.0	50
25	0.1 yd	11.67 grams	11.6	0.75	5.75	0.09	5.0	1.5	0.1	3.0	40-45
13	0.1 yd	28.34 grams	2.5	0.44	3.3	0.10	G	3.0	0.1	3.0	60
15	0.1 yd	45.43 grams	21.0	0.23	1.0	0.10	5.0	1.5	0.1	3.0	35
14	0.1 yd	37.67 grams	1.6	0.31	1.1	0.08	5.0	2.0	0.05	1.5	35
22	0.1 yd	34.169 grams	1.8	0.53	6.6	0.08	5.0	2.0	0.05	2.0	40
20	0.1 yd	12.37 grams	7.8	0.32	4.3	0.04	N	0.2	0.02	0.7	low
12	0.03 yd	7.13 grams	4.8	0.35	3.4	0.1	G	3.0	0.1	1.5	60
30	0.03 yd	9.52 grams	1.45	0.66	1.2	0.09	3.0	4.5	0.02	1.0	25
134	0.1 yd	26.44 grams	1.05	0.03	-	-	L	L	N	>0.2	low
142	0.1 yd	99.72 grams	1.6	0.24	-	-	G	>2.0	N	>0.2	>50
140	0.1 yd	106.95 grams	15.0	0.23	-	-	G	L	0.2	G	20-40
111	0.1 yd	75.28 grams	2.5	0.14	-	-	>0.3	0.1	N	>0.2	5

N - not detected
L - detected
-- not analyzed for

1/ The material concentrated consisted of the coarse sand to silt fraction of the creek gravels.

2/ Analyzed by Resource Associates of Alaska, Fairbanks.

3/ Analyzed by Alask [illegible]

TABLE 12 - Trace Elements in Sluice Concentrates

mple o No.	Quantity 1/ of Material Concentrated	Concentrate Recovered (non-magnetic)	Trace Element Analysis by Semi-Quantitative Spectrographic Method 2/ (ppm)																	
			Ag	As	B	Ba	Be	Bi	Co	Cr	Cu	Mo	Ni	P	Pb	Pt	Sb	Sr	V	Zn
79	0.1 yd	13.68 grams	3	N	1000	N	3	50	70	1000	300	10	1000	-	150	N	N	-	150	700
63	0.1 yd	24.49 grams	L	N	200	>5000	3	100	70	1500	500	20	300	-	5000	N	N	-	50	1000
26	0.1 yd	48.90 grams	L	N	700	N	15	L	L	1000	150	20	100	-	2000	N	N	-	100	N
25	0.1 yd	11.67 grams	15	N	5000	N	10	L	N	1000	500	50	1500	-	2000	L	N	-	100	N
13	0.1 yd	28.34 grams	10	N	1000	N	20	150	L	1000	50	20	1500	-	5000	N	N	-	200	N
15	0.1 yd	45.43 grams	10	N	2000	N	5	L	N	1000	700	20	2000	-	5000	L	N	-	150	N
14	0.1 yd	37.67 grams	10	N	2000	N	10	150	N	1000	300	10	500	-	2000	N	N	-	150	N
22	0.1 yd	34.169 grams	5	N	2000	N	15	150	N	1000	300	10	300	-	1000	N	N	-	100	N
20	0.1 yd	12.37 grams	20	3000	5000	N	20	150	L	1000	500	20	200	-	2000	N	N	-	100	100
12	0.03 yd	7.13 grams	2	1500	1000	N	15	150	L	500	700	20	200	-	2000	N	N	-	200	N
30	0.03 yd	9.52 grams	5	N	2000	N	15	100	N	500	300	10	150	-	500	N	N	-	50	N
34	0.1 yd	26.44 grams	30	N	2000	i	200	N	L	>5000	150	300	3	-	2000	N	N	-	5000	L
42	0.1 yd	99.72 grams	70	N	5000	N	L	>1000	>2000	1000	150	L	150	-	3000	N	N	-	>10000	L
40	0.1 yd	106.95 grams	50	N	2000	N	300	L	N	L	150	L	N	-	7000	N	500	-	>10000	L
11	0.1 yd	75.28 grams	L	N	2000	i	3	N	N	N	150	L	L	-	L	N	i	-	2000	N

The material concentrated consisted of the coarse sand to silt fraction of creek gravels. Separation was done with an 8" x 30" expanded metal sluice box set in active channel.

\> - above level shown
\- - not analysed
i - interference

L - detected
N - not detected

Old Crow batholith indicated anomalous zirconium to tin ratios, and coinciding lead and zinc occurrences which appear related to the possible occurrence of tin, tungsten, lithium, beryllium, tantalum, and niobium mineralization (cf. 5). This relationship has been documented for similar deposits in the Soviet Union.

Complete emission spectrographic results of the pan concentrate samples are listed in Appendix B.

Results and Recommendations

Tin, tungsten, thorium, and rare-earth elements, with lesser amounts of uranium, lead and niobium are consistently present and may exist in recoverable amounts as extensive placer deposits of the Rapid River, Sunaghun and Strangle Woman Creek drainages. Both Strangle Woman Creek and the Rapid River appear amenable to dredging or dragline placer mining if sufficient grade of mineralization is proven. Further exploration of these deposits is certainly warranted. The possibility of residual placer deposits should also be further investigated.

The geologic setting of the Old Crow batholith is similar, in general, to the weathered and eroded tin bearing granites in other parts of the world, such as Malaysia, where a considerable portion of the U.S. supplies of tin are mined from placer deposits.

Further work should include bulk sampling of subsurface gravels with a more accurate method of recovery of the concentrate than was possible in this preliminary study. Drilling will eventually be necessary to define the depth and extent of the gravels, and their grade.

A major factor that will determine the amount of potential reserves in the Old Crow area is the distance downstream of the granite over which enriched gravels can be found. In this study anomalous tin was found at least 10 miles downstream of the batholith on the Rapid River. In addition, the Porcupine River has carried tin values even further distances along its present channels.

Porcupine Ancient Channel Placers
(T. 29 N., R. 29 E.)

Geology

Segments of ancient alluvial channels of the Porcupine River are found at elevations of 100 to 300 feet above the present water course. The Porcupine River in this region has cut deep canyons into steeply dipping marine sedimentary rocks. The depth of the present canyon is as much as 600 feet.

Alluvial deposits are tightly confined within the canyon walls and range in width from approximately 600 to 2,000 feet. At least ten miles of perched, abandoned channels were observed in the upper canyon area. A well defined three mile segment was chosen for specific study for this report.

Bedrock in the vicinity consists of shale, carbonates, and quartzites. No felsic intrusive rocks are known to occur within ten miles of this locality. Gabbroic dikes and basalt lavas are found several miles to the southeast.

Alluvial material is primarily chert, quartz, quartzite and includes minor amounts of granitic material derived from outcrops of the Old Crow batholith upstream in Canada. The abandoned channels are covered with silt, are permanently frozen, and are thickly vegetated.

Mineralization

During the present study small amounts of heavy minerals were found in alluvial gravels of the present and ancient Porcupine River channel. These contained up to 0.7% tin and varying amounts of rare-earth elements. Pan concentrate sample locations are shown with their tin and tungsten content in figure 28. All samples except PR 12546 were taken from reworked surface exposures of water worn gravel. The sample at PR 12546 was taken from accumulated soils and colluvium that were laid down after the last gravels were deposited. It appears that the ancient gravel deposits are relatively thick, and heavy mineral accumulations if present in these large channel deposits would be largely concentrated close to bedrock. It was not possible to sample the tenor of the deposits at depth and therefore no estimate of potential merit will be attempted.

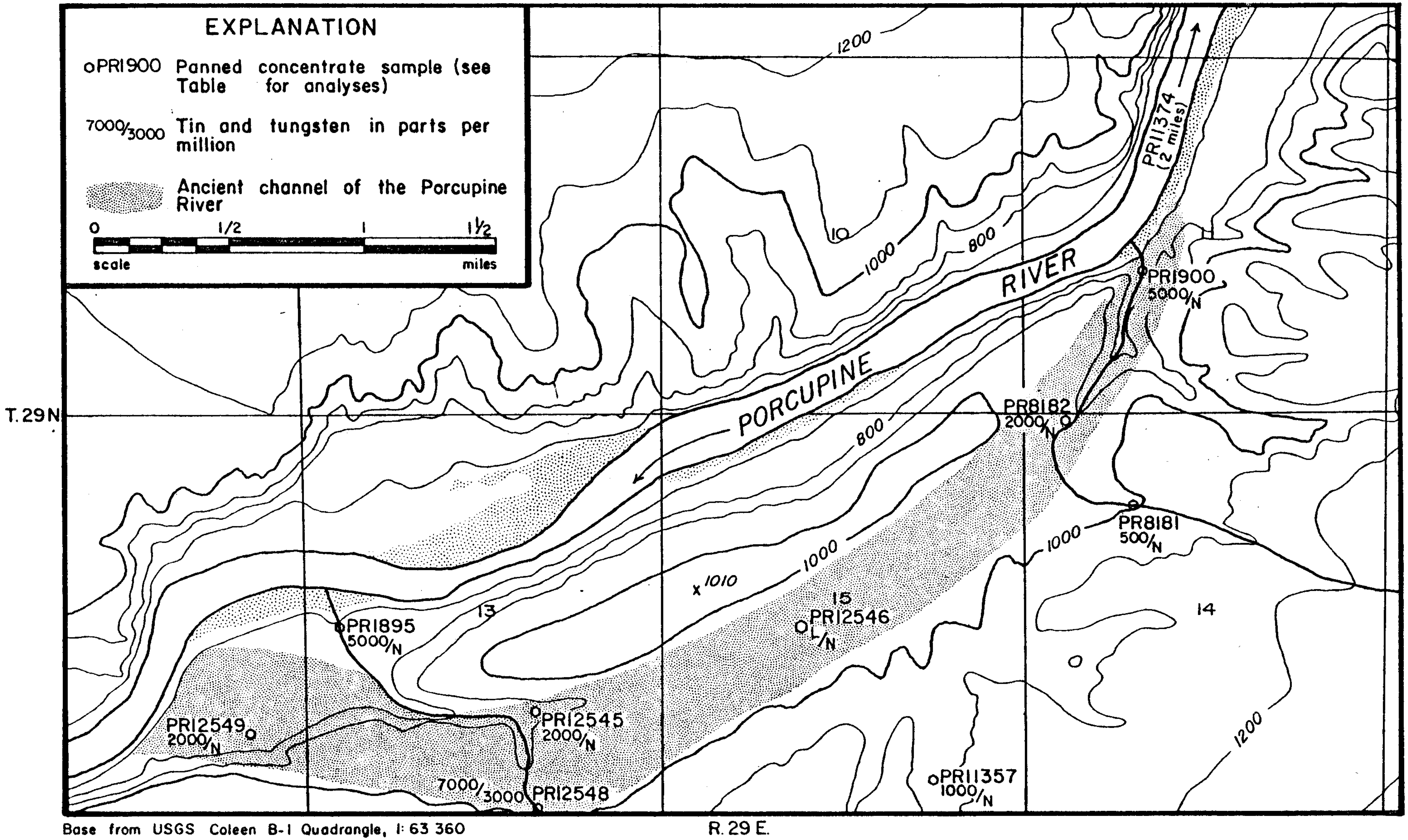
A sample (PR 11374) concentrated from active alluvium of the Porcupine River was found to contain cassiterite, monazite and other minerals (table 13) typical of concentrates of the Old Crow granitic region (refer to the discussion of the Old Crow Hills placer prospects).

The heavy minerals consisted of very fine sized fractions reflecting the effects of mechanical transport from sources 10 to 35 miles upstream in Canada. In that region there is an outpouring of granitic material in numerous small south flowing tributaries to the Porcupine River. It would be expected that overall grade of any potential placer mineralization would decrease as one progressed further downstream.

Geochemistry

Nine panned concentrates of alluvial material were sampled and analyzed (table 14) as described under the "Sampling and Analytical Procedures" section of this report. A series of stream sediment samples were also obtained from this area (Appendix A) but no anomalous values were found.

Panned sample PR 1900 contained 10,000 ppm zinc, which suggests local bedrock sources. Boron values were moderately high due to tourmaline. Some tungsten (PR 12598) was also detected in addition to the tin values. Generally tin and tungsten are not found in pan samples derived from the sedimentary bedrock formations along the Porcupine River.



Base from USGS Coleen B-1 Quadrangle, 1:63 360

FIGURE 28.- Porcupine ancient channel placer prospect

PR 113 -	74	
Minerals:		
ankerite	F	
apatite	--	
biotite	--	
cassiterite	T	
chlorite	T	
diopside	--	
dolomite	A	
epidote	M	
garnet	M	
goethite	A	
hematite	T	
hornblende	--	
ilmenite	--	
monazite	T	
powellite f	--	
scheelite f	--	
sphene	--	
staurolite	--	
tourmaline	T	
zircon f	T	

Legend:	P - Predominant	Over 50 percent
	A - Abundant	10 - 50 percent
	S - Subordinate	2 - 10 percent
	M - Minor	.5 - 2 percent
	F - Few	.1 - .5 percent
	T - Trace	Less than .1 percent
	X - Detected	
	- Sought but not detected	
	f - Fluorescent	

Petrography by W. L. Gnagy, Alaska Field Operations Center, Juneau

Table 13 - Heavy minerals in Porcupine River Gravels

le er	PR1895	PR1900	PR8181	PR8182	PR11357	PR12545	PR12546	PR12548	P
	5	1.5	L	30	30	5	5	7	
	N	N	N	N	N	N	N	N	
	N	N	N	N	N	N	N	N	
	3000	2000	1500	2000	2000	2000	2000	2000	
	N	2000	G	G	G	L	N	G	
	70	100	15	N	50	100	70	3	
	N	N	N	N	N	L	L	20	
	N	N	N	N	N	L	N	L	
	30	30	L	L	N	300	700	L	
	1000	1500	L	G	3000	1000	1000	2000	
	150	150	50	150	150	100	20	200	
	5000	7000	1500	L	1500	3000	5000	1500	3
	N	N	L	L	L	L	L	L	
	L	L	N	N	N	N	N	N	
	200	1500	L	L	L	300	50	30	
	N	200	L	50	100	–	–	–	
	N	N	N	N	N	N	N	N	
	N	N	N	N	N	N	N	N	
	5000	5000	500	2000	1000	2000	L	7000	2
	–	–	–	–	–	–	–	–	
	–	–	–	–	–	–	–	–	
	500	1000	700	1500	1500	1500	2000	1500	1
	N	N	N	N	N	N	N	3000	
	3000	5000	L	G	G	G	G	G	
	1500	10,000	N	N	N	N	N	N	
	G	G	G	G	G	G	G	G	

- greater than
- not found
- detected
not analyzed

TABLE 14 - Analyses of concentrate samples from an ancient channel of the Porcupine River

Coleen River Barite Occurrence
(T. 31 N., R. 22, 23 E., figure)

Geology

Barite and minor copper values were found associated with an extensively sheared and faulted area of the Christian River sequence and the adjoining Triassic Shublik Formation (12). Interlayered gabbros, argillites and cherts were found on the ridge immediately west of this location, figure 29. Basalt and cherts and intensely sheared black shales mapped as the Shublik were observed in outcrop along the river bluff. The shales were iron-stained and contained numerous quartz veins and iron nodules.

Northeasterly trending and intersecting linears (figure 10) cut through this location generally parallel to the course of the Coleen River.

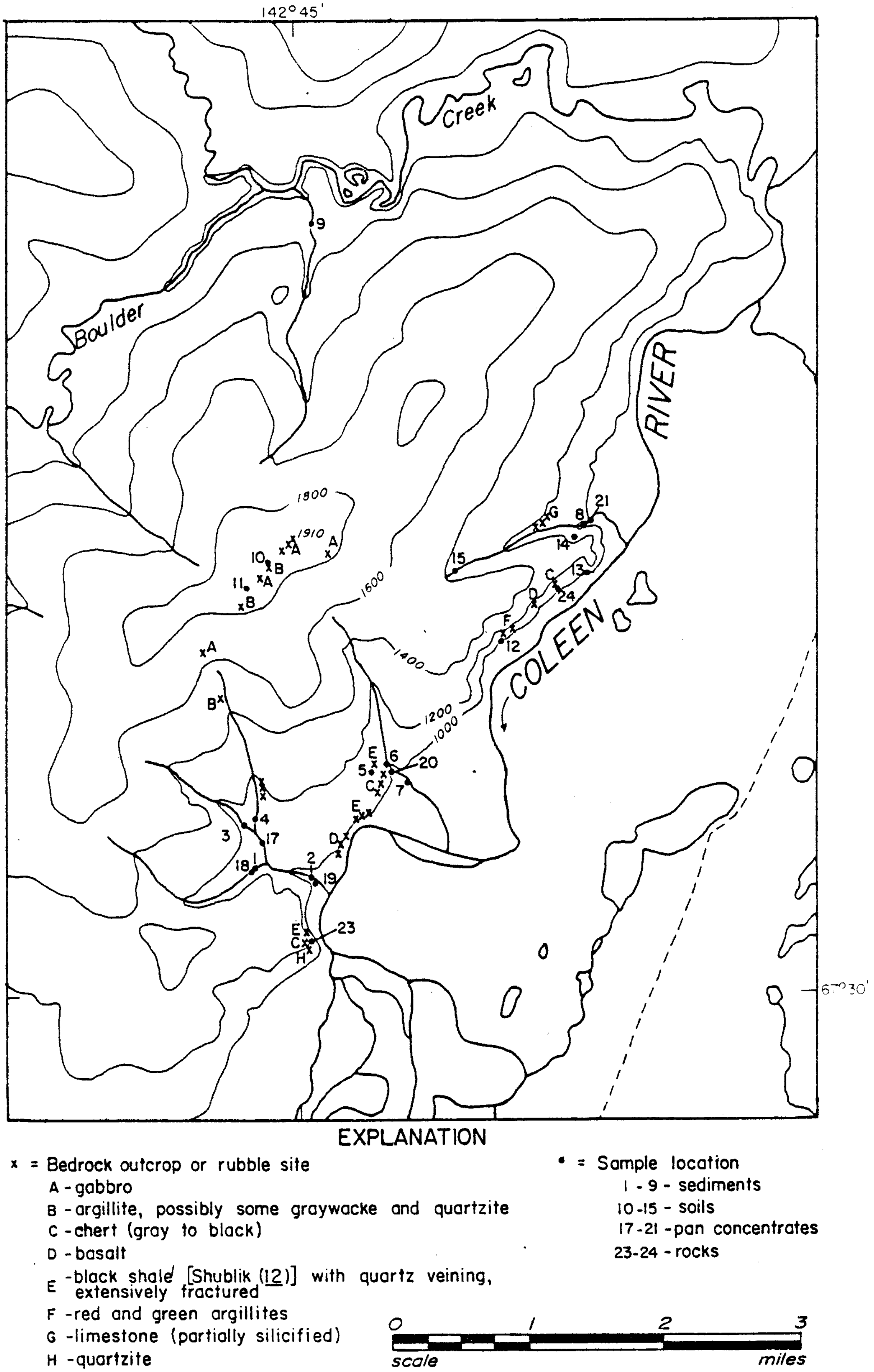
Bedrock outcrops are very limited in the area except for along the river bluff. Vegetation is dense and continuous.

Mineralization and Geochemistry

Massive white to gray barite was observed only as creek float at locations 1, 18, and to a lesser extent at 6. Due to the heavy vegetation cover no barite mineralization was seen in place. Minor copper and zinc oxides were observed at location 23. One slightly mineralized sample of chert contained 0.03% copper and 0.077% zinc.

Soils at locations 12 and 13, and sediments from locations 2 and 5 were somewhat anomalous (table 15) in copper (up to 460 ppm). These anomalies align well with the linears.

Pan sampling was also done at locations 17 to 21 and confirmed the presence of barite (analyses listed in Appendix B-2). The concentrate from location 21 also contained greater than 10,000 ppm vanadium, perhaps reflecting the high background level of vanadium in the Shublik shales. No traces of gold were detected in the pans.



EXPLANATION

x = Bedrock outcrop or rubble site
- A - gabbro
- B - argillite, possibly some graywacke and quartzite
- C - chert (gray to black)
- D - basalt
- E - black shale [Shublik (12)] with quartz veining, extensively fractured
- F - red and green argillites
- G - limestone (partially silicified)
- H - quartzite

• = Sample location
- 1 - 9 - sediments
- 10 - 15 - soils
- 17 - 21 - pan concentrates
- 23 - 24 - rocks

FIGURE 29.- Coleen barite occurrence

Barite in a similar form, color, and geologic setting also has been reported from the Christian River sequence near the Sheenjek River (figure 9) in beds up to 18 feet thick. This occurrence further suggests a strong barite potential in the Christian River mafic complex.

The Shublik Formation elsewhere in the Brooks Range is known to have somewhat higher concentrations of copper, zinc, and vanadium. Remobilization and possible deposition associated with the volcanic activity and/or the intersecting linears is the most likely explanation of the minor mineralization observed at the present locality, since no anomalies of these elements were found derived from the mafic complex.

TABLE 15 : Sample Analyses - Coleen Barite Occurrence

Map No.	Sample No.	Cu	Pb	Zn	Ag	Mo
STREAM SEDIMENTS						
1	PR 12517	23	N	98	N	N
2	TB 47	55	N	150	"	"
3	PR 12514	19	N	74	"	"
4	PR 12515	17	N	77	"	"
5	TB 44	140	30	170	"	"
6	PR 11377	32	N	110	"	"
7	TB 45	26	N	130	"	"
8	PR 12481	16	N	72	"	"
9	PR 11380	12	N	63	"	"
SOILS						
10	PR 12512d	23	N	85	"	"
11	PR 12513d	15	N	58	"	"
12	PR 11379d	460	25	180	"	"
13	PR 11376d	55	N	110	"	"
14	PR 12480d	17	N	71	"	"
15	PR 12479d	13	N	72	"	"
ROCKS						
23	TB 48	310	N	770	"	"
24	PR 11388R	37	N	20	"	"
PAN CONCEN.						
17	PR 12516p	(See Appendix B for Analyses)				
18	PR 12518p					
19	TB 46p					
20	PR 11378p					
21	PR 12482p					

The Shublik outcrops along the river were also examined in 1948 for radioactivity (43). However, no significant levels were found.

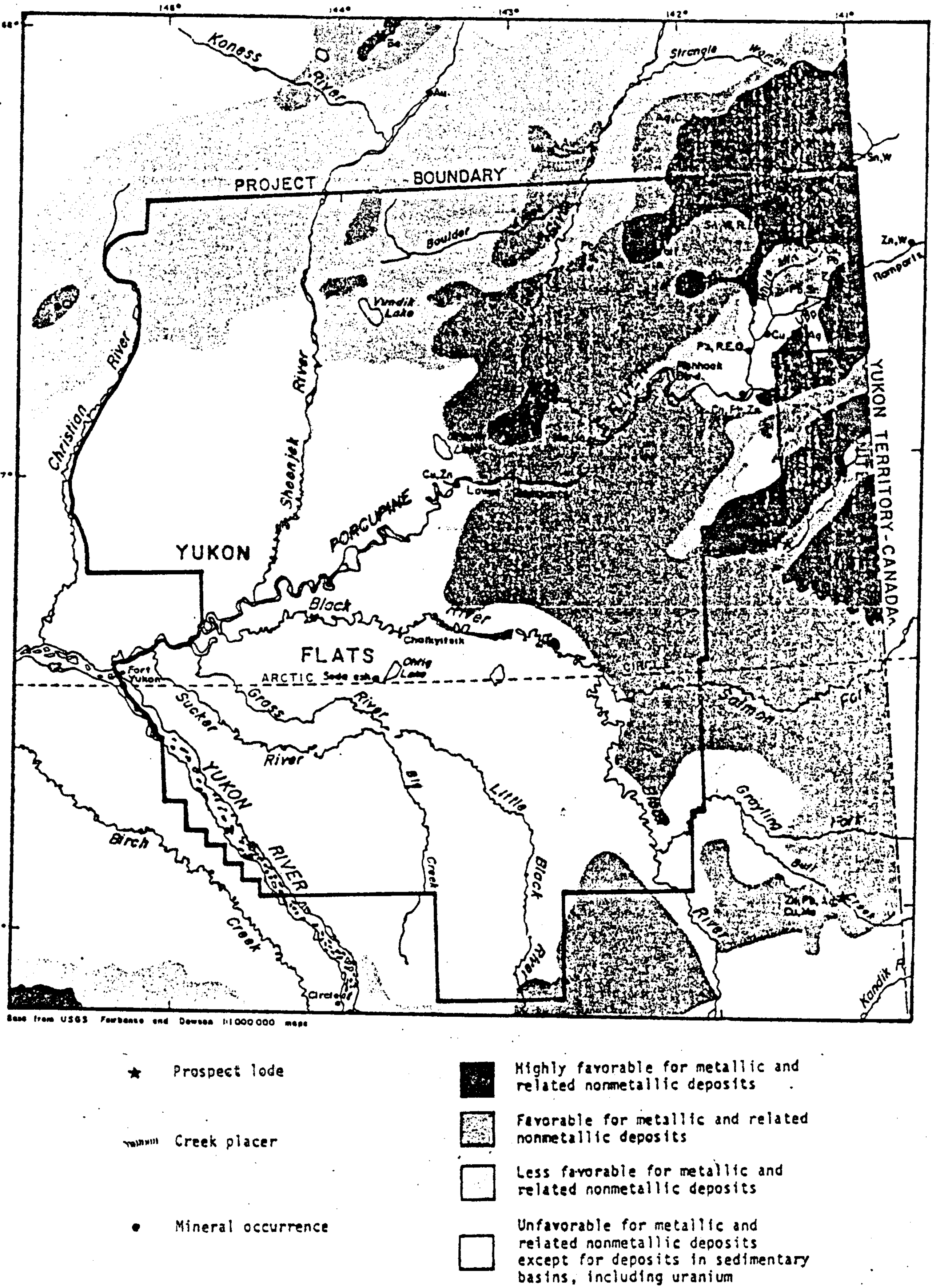
EXPLORATION POTENTIAL

The present work by the Bureau of Mines in the Porcupine River region was limited to a preliminary regional assessment of potential mineral resources. The principal objective of this report was to identify mineral occurrences of deposit types that may be found with known associated metallogenic provinces of the region. To actually delineate economic or sub-economic mineral reserves would require many times this magnitude of effort. For example, during the period 1955 to 1969, approximately $910 million was spent on mineral exploration in the United States (48). This amounts to $300 per square mile for this period alone, and new mineral discoveries are still being made. At this time, the total investment in mineral exploration in the Porcupine area amounts to less than $10 per square mile (this excludes basic geologic mapping). That a number of mineral occurrences have been found even with this low level of exploration effort is certainly indicative of the high favorability for mineralization of at least portions of the region (figure 30).

Strategic considerations: The following commodities are known to occur(*), or might be anticipated to occur in the study area. Geologic evidence indicates potential economic scale deposits may be found. The commodities are shown as a percentage of U.S. dependence on imports, Table 16.

CONCLUSION AND SUMMARY

1. Christian complex -- that area lying west of the Coleen River and somewhat north of the Porcupine River. Cost restrictions of the present study essentially prevented evaluation of this unit. The geology is very poorly known but indications suggest that the mafic/ultramafic ophiolite sequence and related rocks may be valuable for barite, chrome, platinoid metals, and gold. Mapping,



Base from USGS Fairbanks and Dawson 1:1000000 maps

FIGURE 30.- Mineral potential map of the Porcupine River region

*Minerals Presently Known to
Occur in or Near Project Area

U. S. Net Import Reliance 1/ As a Percent
of Apparent Consumption in 1976

Minerals And Metals	Known Localities	0% 25% 50% 75% 100%	Major Foreign Sources (1972-75)
*Columbium	Old Crow Hills	100	Brazil, Thailand, Nigeria
Cobalt		98	Zaire, Belgium-Luxembourg, Finland, Norway
*Manganese	Boulder Cr.	98	Brazil, Gabon, Austrailia, South Africa
*Tantalum	Old Crow Hills	94	Thailand, Canada, Australia, Brazil
Platinum Grp. Metals	Christian R. (Trace Amts. only)	92	U.K., U.S.S.R., South Africa
*Chromium	Christian R.	89	Phillipines, Turkey
*Tin	Old Crow Hills	85	Malaysia, Thailand, Bolivia
Asbestos		83	Canada, South Africa
*Nickel	Old Rampart	71	Canada, Norway, New Caledonia
*Gold	Procrastination Cr.	70	Canada, Switzerland, U.S.S.R.
*Antimony		61	South Africa, P.R. China, Bolivia, Mexico
Selenium		59	Canada, Japan, Mexico
*Tungsten	Old Crow Hills; Bear Mt.	59	Canada, Bolivia, Peru, Thailand
*Zinc	White Mt. Cr.; Old Crow H.	59	Canada, Mexico, Australia, Peru, Honduras
*Silver	White Mt.Cr.; Salmon Trout R.; Midnight H.; Bear Mt.	47	Canada, Mexico, Peru
Petroleum (inc. Nat. Gas Liq.)		41	Canada, Venezuela, Nigeria, Saudi Arabia
*Barium	Sheenjek R.; Coleen R.	38	Ireland, Peru, Mexico
Gypsum		38	Canada, Mexico, Jamaica
Titanium (ilmenite)		37	Canada, Australia
Vanadium		31	South Africa, Chile, U.S.S.R.
*Copper	White Mt.Cr.; Bear Mt.	15	Canada, Peru, Chile, South Africa
*Lead	Salmon Trout R.; White Mt. Cr; Midnight H; Bear Mt.	15	Canada, Peru, Australia, Mexico
Natural Gas	Eagle Plains, Yukon Terr.	4	Canada

1/ Net import reliance = imports-exports - Adjustments for Gov't and industry Stock changes (except for Petroleum and Natural Gas).

Apparent Consumption = U. S. Primary - Secondary production - Net import Reliance Petroleum and Nat. Gas includes industry stock changes.

IMPORTS ■

U. S. CAPACITY □

Bureau of Mines, U. S. Department of the Interior (import-export data from Bureau of the Census).

TABLE 16. - Potential mineral resources of the Porcupine Plateau area

heavy mineral surveys and soil sampling should be undertaken.

2. Sedimentary units -- Paleozoic shales and carbonates occur in the southeastern portion of the study area. As discussed in the text, these rocks are anomalous in lead, zinc, copper, barium and silver, and there are known mineral deposits in similar rocks to the east in Canada and immediately to the southeast in Native corporate lands. Uranium deposition in terrestrial sedimentary host rocks is another possibility which should be further studied. This region also contains portions of the Kandik and Yukon Flats basins which have petroleum potential. Detailed geologic mapping is required for further assessment of the mineral resources.
3. Old Crow granite vicinity -- investigation results suggest a geologic environment characteristic of a tin province, with significant values of tungsten, uranium, and rare-earth elements, both from placer and lode sources. This intrusive environment appears similar for example, to those of France and East Europe where uranium is produced. Elsewhere in the world, significant mineralization is known to be associated with leucocratic granites and/or related metamorphic rocks of granitic intrusives of this Devonian-Mississippian age. In addition to tin, tungsten, and uranium, other potential associated elements of interest would include beryllium, niobium, tantalum and molybdenum. Copper, lead, zinc, and silver occur in a variety of intrusive-related deposit types along the southern perimeter of the batholith.

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APPENDIX A - Table A-1

Sediment sample analyses (ppm)

L - Detected
N - Less than lowest detection limit
G - Greater than highest detection limit

- Not analyzed
i - interference

1/ Sample by U. S. Geological Survey refer to Brosge and Reiser, 1968 (11); and Brosge and others, 1977 (14).

Analyses by semi-quantitative emission spectrograph except Th by colorimetry; U by fluorometry; Cu, Pb, Zn and Ag by atomic absorption.

Detection limits -- Semi-quantitative emission spectrograph

Lowest detection limits
(ppm unless indicated as %)

Elements	Sample nos. prefixed by PR or OC	Sample nos. prefixed by CC,TB,CB,CR,CS
Si	7%	--
Al	1%	--
Fe	0.05%	--
Mg	0.02%	--
Ca	1%	--
Na	0.4%	--
K	interference	--
Ti	0.005%	--
Mn	5.0	--
Ag	1.0	20
As	1000.0	800
Au	50.0	20
B	5.0	100
Ba	1000.0	700
Be	1.0	10
Bi	20.0	200
Cd	100.0	400
Co	10.0	40
Cr	20.0	20
Cu	1.0	40
Ga	0.2	20
La	500.0	200
Li	--	10,000
Mo	10.0	10
Nb	100.0	800
Ni	2.0	20

Detection limits -- Semi-quantitative emission spectrograph, (continued)

Lowest detection limits
(ppm unless indicated as %)

Elements	Sample nos. prefixed by PR or OC	Sample nos. prefixed by CC,TB,CB,CR,CS
P	500.0	800
Pb	20.0	80
Pd	20.0	20
Pt	50.0	20
Sb	100.0	500
Sc	10.0	10
Se	--	300
Sn	20.0	60
Sr	50.0	30
Ta	interference	300
Te	500.0	200
V	20.0	40
W	50.0	200
Y	100.0	70
Zn	200.0	10
Zr	200.0	20

Map No.	1	2	3	4	5	6	7	8	
Sample No.	OC1959	OC 1960	OC1961	CC27	CC 19	OC1945	CC16	OC1930	CC 1
Fe %	1.5	3	7	8.2	6.6	7	6.5	Void No Sample	8.3
Mg %	7	5	3	1.4	1	3	1.5		1.9
Ca %	7	7	7	0.38	0.036	2	0.21		0.52
Na %	G	G	1.6	G	0.40	1.6	0.60		0.91
K %	—	—	—	2.9	N	—	2.1		2.6
Ti %	0.3	0.3	0.5	0.16	0.12	0.3	0.22		0.20
Mn	5000	3000	5000	1600	2400	5000	20000		2600
Ag	L	L	L	N	N	3	N		N
As	N	N	N	N	N	N	N		N
Au	N	N	N	N	N	N	N		N
B	150	200	150	N	N	200	N		N
Ba	2000	L	1000	N	N	L	N		N
Be	2	10	3	N	N	7	N		N
Bi	20	L	L	N	N	20	N		N
Cd	N	N	N	N	N	L	N		N
Co	N	N	N	N	N	N	N		N
Cr	1000	20	20	90	50	20	100		90
Cu	150	300	150	60	N	100	N		N
Ga	3	1.5	1	20	N	L	20		20
La	N	N	N	N	N	N	N		N
Li	N	N	N	N	N	N	N		N
Mo	N	N	N	10	10	N	N		10
Nb	L	L	L	N	N	L	N		N
Ni	200	300	150	N	20	1500	70		80
P	1000	L	L	N	N	L	820		1000
Pb	700	150	150	480	N	70	840		140
Pd	N	N	N	N	N	N	N		N
Pt	N	N	N	N	N	N	N		N
Sb	N	N	N	N	N	N	680		750
Sc	N	N	N	20	10	N	N		N
Se	—	—	—	N	N	—	N		N
Sn	N	N	N	N	N	N	N		N
Sr	N	N	N	40	10	N	30		40
Ta	N	N	N	N	N	N	N		N
Te	N	N	N	N	N	N	N		N
V	150	150	150	50	60	70	80		60
W	N	N	N	N	N	N	N		N
Y	L	N	N	120	130	N	80		100
Zn	N	N	N	660	40	N	520		150
Zr	200	300	300	N	50	L	30		30
Th	13.3	15.3	12.8	14.5		11	11.8		11
U	6.6	7.8	3.5	3.8	3.1	5.3	2.1		2.3
Cu-AA	20	24	35	48	41	33	24		25
Pb-AA	81	62	92	390	110	72	230		30
Zn-AA	210	200	170	540	150	170	250		120
Ag-AA	N	N	N	N	N	N	<5		<5

Map No.	10	11	12	13	14	15	16	17	1
Sample No.	OC2339	OC2323	OC2319	OC1950	CC28	CC96	CC95	OC2201	CC
Fe %	2	2	15	1.5	3.9	5.9	4.0	3.0	3.
Mg %	3	5	5.0	5.0	1.1	4.9	2.9	5.0	3.
Ca %	5	5	10	5	0.13	0.35	0.26	7	0.
Na %	G	G	G	G	0.46	0.40	0.41	1.6	0.
K %	—	—	—	—	N	2.9	3.6	—	4.
Ti %	0.3	0.2	1.0	0.2	0.12	0.15	0.12	0.3	0.
Mn	3000	1500	5000	3000	1600	2400	2000	G	810
Ag	2	2	3	L	N	N	N	2	L
As	N	N	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N	N	N
B	150	150	150	150	N	N	N	150	N
Ba	L	N	3000	L	N	N	N	1000	N
Be	2	2	7	7	N	N	N	3	N
Bi	15	N	20	L	N	N	N	L	N
Cd	N	N	N	N	N	N	N	N	N
Co	N	30	L	N	N	N	40	N	N
Cr	L	20	500	L	40	60	60	50	70
Cu	50	20	200	150	N	N	N	150	N
Ga	50	30	2	2	N	N	N	2	N
La	N	N	N	N	N	N	N	N	N
Li	N	N	N	N	N	N	N	N	N
Mo	N	N	N	N	N	N	20	N	10
Nb	N	L	L	L	N	N	N	L	N
Ni	50	20	200	200	N	50	70	150	30
P	1500	1500	1000	1000	N	N	N	1000	N
Pb	100	70	500	150	N	460	N	1000	N
Pd	N	N	N	N	N	N	N	N	N
Pt	N	N	N	N	N	N	N	N	N
Sb	N	N	N	N	N	N	N	N	N
Sc	N	N	N	N	20	N	30	N	20
Se	—	—	—	—	N	N	N	—	N
Sn	N	N	N	N	N	N	N	N	N
Sr	N	N	N	N	10	30	30	N	20
Ta	N	N	N	N	N	N	N	N	N
Te	N	N	N	N	N	N	N	N	N
V	150	150	300	150	50	50	70	150	60
W	N	N	N	N	N	N	N	N	N
Y	N	N	L	L	N	N	80	N	15
Zn	N	N	N	N	70	810	810	N	25
Zr	L	L	L	L	50	40	100	300	110
Th	12.5	10.8	16.5	14.3	14	12.5	11.3	12	
U	3.7	3.2	7.4	7.8	4.2	3.1	2.7	4.1	5.
Cu	25	38	51	50	30	32	32	35	31
Pb	85	110	100	70	90	370	780	650	50
Zn	170	290	210	220	190	370	930	1200	
Ag	N	N	N	N	N	N	N	N	89

Map No.	19	20	21	22	23	24	25	26	
Sample No.	CC93	CC92	CC91	CC90	CC88	CC87	CC86	CC71	CC
Fe %	6.3	6.4	5.3		5.0	2.7	6.5	5.9	6
Mg %	3.2	1.4	0.89	1.1	1.3	1.3	1.2	0.93	1.
Ca %	0.30	0.33	0.16	0.21	0.33	0.21	0.26	0.021	0.
Na %	0.36	0.57	G	0.78	1.0	0.65	0.77	0.67	G
K %	2.5	1.9	2.8	3.3	2.2	2.9	1.7	2.4	5.
Ti %	0.13	0.19	0.13	0.17	0.17	0.15	0.14	0.10	0.1
Mn	9500	1600	330	350	470	320	490	430	59
Ag	N	N	N	L	N	L	N	N	N
As	N	N	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N	N	N
B	N	N	N	120	N	N	N	N	N
Ba	N	N	N	N	N	N	N	N	N
Be	N	N	N	N	N	N	N	N	N
Bi	N	N	N	N	N	N	N	N	N
Cd	N	N	N	N	N	N	N	N	N
Co	N	N	N	N	N	N	N	N	N
Cr	50	80	60	70	120	90	100	60	60
Cu	N	N	N	50	N	N	N	N	N
Ga	N	20	40	30	30	N	30	N	30
La	N	N	N	N	N	N	N	N	N
Li	N	N	N	N	N	N	N	N	N
Mo	N	20	10	20	10	N	10	10	N
Nb	N	N	N	N	N	N	N	N	N
Ni	50	40	N	30	40	50	N	N	N
P	N	N	N	N	N	N	N	N	N
Pb	300	N	N	N	N	N	N	N	24
Pd	N	N	N	N	N	N	N	N	N
Pt	N	N	N	N	N	N	N	N	N
Sb	N	N	N	N	N	N	N	N	N
Sc	N	20	20	20	20	10	20	10	10
Se	N	N	N	N	N	N	N	N	N
Sn	N	N	N	N	N	N	N	N	N
Sr	30	30	30	20	30	20	40	20	30
Ta	N	N	N	N	N	N	N	N	N
Te	N	N	N	N	N	N	N	N	N
V	N	90	70	80	80	60	80	50	50
W	N	N	N	N	N	N	N	N	N
Y	N	190	110	200	130	130	N	130	N
Zn	1200	430	80	60	100	30	70	30	13
Zr	N	90	30	60	50	70	30	30	N
Th	14	11	—	—	14.5	17.3	11.3	18.8	29
U	10.2	4.1	—	2.9	2.2	2.4	1.8	7	13.
Cu	34	29	17	15	19	16	17	26	14
Pb	530	170	60	40	40	40	30	60	20
Zn	1000	370	120	90	100	90	75	75	13
Ag	N	N	N	N	N	N	N	N	N

Coleen

Map No.	28	29	30	31	32	33	34	35	3
Sample No.	CC67	CC65	CC64	CC63	CC66	CC69	OC2334	OC2331	OC2
Fe %	2.6	2.7	3.4	3.4	3.1	3.2	1	0.5	0.3
Mg %	0.91	0.88	0.79	1.1	1.0	1.0	2	0,2	0.2
Ca %	0.19	0.21	0.24	0.25	0.16	0.17	3	0.2	2.
Na %	G	G	G	G	G	G	1,6	1.6	1.6
K %	4.6	5.3	2.5	3.1	4.8	3.8	—	—	—
Ti %	0.089	0.090	0.13	0.10	0.084	0.11	0.3	0.01	0.0
Mn	560	700	330	420	450	360	300	100	20
Ag	N	N	N	N	N	N	L	N	N
As	N	N	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N	N	N
B	N	N	N	N	N	N	100	200	100
Ba	N	N	N	N	N	N	L	N	N
Be	N	N	N	N	N	N	2	5	5
Bi	N	N	N	N	N	N	10	N	N
Cd	N	N	N	N	N	N	N	N	N
Co	N	N	N	N	N	N	N	N	N
Cr	40	50	50	50	70	50	L	L	L
Cu	N	N	N	N	N	N	20	15	L
Ga	20	20	N	20	20	20	20	N	2
La	N	N	N	N	N	N	L	L	N
Li	N	N	N	N	N	N	N	N	N
Mo	N	N	N	N	N	N	N	N	N
Nb	N	N	N	N	N	N	L	L	N
Ni	N	N	N	N	N	N	50	20	5
P	N	N	N	N	N	N	1000	1000	N
Pb	N	130	N	N	N	N	N	N	N
Pd	N	N	N	N	N	N	N	N	N
Pt	N	N	N	N	N	N	N	N	N
Sb	N	N	N	N	N	N	N	N	N
Sc	N	10	10	N	20	N	N	N	N
Se	N	N	N	N	N	N	—	—	—
Sn	N	N	N	N	N	N	N	N	N
Sr	20	30	30	30	30	20	N	N	N
Ta	N	N	N	N	N	N	N	N	N
Te	N	N	N	N	N	N	N	N	N
V	N	N	40	N	N	N	100	N	N
W	N	N	N	N	N	N	N	N	N
Y	N	90	N	N	120	N	N	N	N
Zn	50	60	60	70	50	90	N	N	N
Zr	20	20	40	20	50	20	L	N	N
Th	26.3	53.5	21.3	26.8	28.3	43	12.8	37.5	57.5
U	12.7	12.3	6.1	13.1	12.7	10.2	3.9	8.6	7.
Cu	8	8	10	13	7	10	16	9	6
Pb	100	100	50	50	60	90	16	39	16
Zn	70	80	60	80	50	90	100	67	3
Ag	N	N	N	N	N	N	N	N	N

Coleen

Map No.	37	38	39	40	41	42	43	44	4
Sample No.	CC6	OC1924	CC1	CC2	CC3	OC2102	CC4	OC1922	OC2
Fe %	No Analysis	7.0	No Analysis	No Analysis	No Analysis	10	No Analysis	7.0	0.
Mg %		1.5				3		7.0	1
Ca %		2.0				5		7.0	3
Na %		1.6				G		G	G
K %		—				—		—	—
Ti %		0.15				0.3		G	0.0
Mn		5000				G		3000	36
Ag		2				15		1	N
As		N				N		N	N
Au		N				N		L	N
B		200				150		150	150
Ba		N				N		1500	L
Be		5				5		2	2
Bi		L				20		20	N
Cd		L				L		N	N
Co		N				30		50	N
Cr		L				200.		100	L
Cu		150				200		100	10
Ga		L				30		3	10
La		N				N		N	L
Li		N				N		N	N
Mo		N				L		N	N
Nb		L				L		L	L
Ni		150				150		70	10
P		1000				1500		1000	100
Pb		70				500		L	N
Pd		N				N		N	N
Pt		N				N		N	N
Sb		N				N		N	N
Sc		N				N		N	N
Se		—				—		—	—
Sn		N				N		N	N
Sr		N				N		N	N
Ta		N				L		N	N
Te		N				N		N	N
V		L				200		300	30
W		N				150		N	N
Y		N				N		N	N
Zn		N				N		N	N
Zr		L				1000		1000	N
Th	—	12.5	33.5	37.3	24.3	27	—	12.8	1
U	3.4	4.8	5.0	2.9	8.2	9	3.1	3.8	4
Cu	13	27	13	11	15	13	12	35	
Pb	50	63	160	40	40	57	40	25	
Zn	52	150	140	80	100	190	86	120	9
Ag	N	N	N	N	N	N	N	N	

Coleen

Map No.	46	47	48	49	50	51	52	53	5
Sample No.	OC2346	CC21	CC22	OC2313	OC1948	CC24	CC25	OC1947	CC
Fe %	10	5.0	6.9	1	1.5	6.3	G	1.5	3.4
Mg %	5	1.4	1.0	1	0.3	1.2	2.2	3.0	1.
Ca %	7	0.13	0.16	3	3.0	2.2	2.6	7.0	0.2
Na %	G	0.86	G	G	1.6	G	G	G	0.7
K %	—	1.3	2.5	—	—	1.8	3.1	—	1.3
Ti %	G	0.13	0.10	0.10	0.07	0.15	0.26	0.2	0.1
Mn	3000	730	1600	300	500	1600	11000	2000	95
Ag	2	N	N	N	N	N	N	L	N
As	N	N	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N	N	N
B	200	N	N	150	150	N	100	150	N
Ba	2000	N	N	L	N	N	N	N	N
Be	2	N	N	2	2	N	N	2	N
Bi	15	N	N	N	L	N	N	L	N
Cd	N	N	N	N	L	N	N	N	N
Co	N	N	N	N	N	N	N	N	N
Cr	200	110	40	L	L	50	150	20	70
Cu	150	N	80	10	50	N	N	150	N
Ga	100	N	N	20	N	N	20	/	N
La	N	N	N	N	N	N	N	N	N
Li	N	N	N	N	N	N	N	N	N
Mo	N	10	N	N	N	N	20	N	10
Nb	L	N	N	N	L	N	N	L	N
Ni	50	30	N	20	30	N	90	150	40
P	1500	N	N	1500	1000	N	N	1000	N
Pb	200	N	N	N	N	N	100	70	N
Pd	N	N	N	N	N	N	N	N	N
Pt	N	N	N	N	N	N	N	N	N
Sb	N	N	N	N	N	N	N	N	N
Sc	N	20	N	N	N	N	20	N	20
Se	—	N	N	—	—	N	N	—	N
Sn	N	N	N	N	N	N	N	N	N
Sr	N	20	20	N	N	50	60	N	20
Ta	L	N	N	N	N	N	N	N	N
Te	N	N	N	N	N	N	N	N	N
V	300	70	N	30	N	N	120	50	80
W	50	N	N	N	N	N	N	N	N
Y	N	180	N	N	L	N	180	L	120
Zn	N	50	140	N	N	100	140	N	50
Zr	1000	40	N	L	L	30	60	300	70
Th	9.75	—	—	11.5	9.5	8.3	10.5	7.3	11.
U	2.9	1.3	5.4	3.3	2.7	2.9	2.7	3.3	3.
Cu	25	28	25	21	31	43	33	34	2
Pb	33	30	60	48	27	30	50	40	40
Zn	170	110	160	150	120	90	130	170	13
Ag	N	<5	<5	N	N	<5	<5	N	<5

Coleen

Map No.	55	56	57	58	59	60	61	62	
Sample No.	OC 2316	CC9	CC11	CC13	R427	PR1967	PR1970	PR 1972	PR 1
					1/		Void	Void	V
Fe %	1	4.7	5.6	5.3		7			
Mg %	2	0.91	1.2	3.4		5			
Ca %	7	0.21	0.23	0.081		7			
Na %	G	G	1.0	0.79		G			
K %	—	4.1	3.1	4.6		—			
Ti %	0.3	0.060	0.13	0.15		1			
Mn	1500	1100	1100	720		3600			
Ag	L	N	N	N		3			
As	N	N	N	N		N			
Au	N	N	N	N		N			
B	100	N	N	N		300			
Ba	L	N	N	N		1000			
Be	2	N	N	N		2			
Bi	N	N	N	N		N			
Cd	N	N	N	N		N			
Co	N	N	N	N		L			
Cr	50	30	80	80		2000			
Cu	10	N	N	N		150			
Ga	30	N	20	20		2			
La	L	N	N	N		N			
Li	N	N	N	N		N			
Mo	N	N	20	10		L			
Nb	N	N	N	N		L			
Ni	20	20	50	60		1500			
P	1500	N	N	N		L			
Pb	N	N	N	N		100			
Pd	N	N	N	N		N			
Pt	N	N	N	N		N			
Sb	N	N	N	N		L			
Sc	N	N	30	20		N			
Se	—	N	N	N		—			
Sn	N	N	N	N		N			
Sr	N	30	30	20		N			
Ta	N	N	N	N		N			
Te	N	N	N	N		N			
V	200	N	60	50		200			
W	N	N	N	N		N			
Y	N	N	100	110		N			
Zn	N	50	70	60		N			
Zr	200	N	60	70		500			
Th	10.3		23.0	12.5		–			
U	3.0	1.9	2.9	1.4		–			
Cu	37	23	26	39		–			
Pb	27	40	40	<30		–			
Zn	130	77	100	87		–			
Ag	N	<5	<5	<5		—			

Coleen

Map No.	64	65	66	67	68	69	70	71	7
Sample No.	CCa1007	PR1982	PR1981	PR1983	PR1980	PR1978	PR1984	PR1987	PR 19
Fe %	3.5	5	7	2	7	1	1.5	1	2
Mg %	8.6	7	3	7	7	7	0.7	7	5
Ca %	G	15	5	15	15	15	2	15	15
Na %	0.12	1.6	1.6	1.6	0.8	1.2	0.4	1.6	G
K %	2.9	—	—	—	—	—	—	—	—
Ti %	0.090	0.3	G	0.3	1	0.5	0.2	0.2	0.5
Mn	620	2000	500	5000	2000	1000	500	3000	300
Ag	N	1.5	1.5	0.2	1.5	N	N	1.5	2
As	N	N	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N	N	N
B	N	300	300	200	150	150	100	100	150
Ba	N	1000	G	N	2000	N	1000	N	N
Be	N	L	L	1.5	1	2	1	L	2
Bi	N	N	N	N	N	N	N	N	N
Cd	N	N	N	N	N	N	N	N	N
Co	N	N	N	N	N	N	L	N	N
Cr	60	200	1000	200	1500	150	500	200	100
Cu	N	100	100	100	150	20	20	150	15
Ga	N	1.5	2	1.5	1.5	1	N	1	1
La	N	N	N	L	N	N	500	L	L
Li	N	N	N	N	N	N	N	N	N
Mo	10	N	N	L	L	N	L	N	N
Nb	N	L	L	L	L	L	L	L	L
Ni	40	100	300	200	500	50	100	300	700
P	N	L	L	1000	L	L	N	L	L
Pb	N	100	L	100	200	100	70	200	N
Pd	N	N	N	N	N	N	N	N	N
Pt	N	N	N	N	N	N	N	N	N
Sb	N	N	N	L	L	N	N	N	L
Sc	N	N	N	N	N	N	N	N	N
Se	N	—	—	—	—	—	—	—	—
Sn	N	N	N	N	N	N	N	N	N
Sr	30	N	N	N	N	N	N	N	N
Ta	N	N	L	N	L	N	L	N	L
Te	N	N	N	N	N	N	N	N	N
V	N	200	300	500	300	150	N	100	300
W	N	N	L	N	L	N	N	N	N
Y	90	N	N	N	N	N	N	N	N
Zn	60	N	N	N	N	N	N	N	N
Zr	40	L	1000	500	500	L	L	500	10
Th	—	10.5	14.3	9.0	8.0	8.5	6.8	4.8	10
U		2.1	4.9	6.8	4.3	2.4	2.2	2.2	3

Coleen

Map No.	73	74	75	76	77	78	79	80	8
Sample No.	CCa 1002	PR 1911	CC 50	CC48	CC47	OC 1964	CC45	CC 44	CC
Fe %	4.1	1.5	0.80	1.5	0.75	0.7	0.41	2.2	L
Mg %	4.8	7	1.8	5.7	1.3	0.3	5.6	2.6	0.
Ca %	8.4	15	0.60	3.0	0.49	0.7	G	4.4	0.
Na %	0.13	G	0.049	0.10	N	0.4	0.12	0.11	N
K %	2.4	—	1.4	2.6	N	—	1.5	1.4	N
Ti %	0.087	0.3	0.088	0.10	0.041	0.1	0.080	0.074	0.
Mn	1200	3000	210	360	170	150	250	730	5
Ag	N	1	N	L	N	N	N	N	N
As	N	N	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N	N	N
B	N	200	N	N	N	100	N	N	N
Ba	890	2000	N	N	N	L	N	N	N
Be	N	1.5	N	N	N	L	N	N	N
Bi	N	N	N	N	N	N	N	N	N
Cd	N	N	N	N	N	N	N	N	N
Co	N	N	N	N	N	N	N	N	N
Cr	50	300	30	60	N	L	30	30	N
Cu	N	50	N	N	N	20	N	N	N
Ga	N	1.5	N	N	N	N	N	N	N
La	N	N	N	N	N	N	N	N	N
Li	N	N	N	N	N	N	N	N	N
Mo	10	N	N	N	N	N	N	10	N
Nb	N	L	N	N	N	L	N	N	N
Ni	40	100	20	40	N	150	N	N	N
P	N	L	N	N	N	L	N	N	N
Pb	N	L	N	N	N	150	N	N	N
Pd	N	N	N	N	N	N	N	N	N
Pt	N	N	N	N	N	N	N	N	N
Sb	N	N	N	N	N	N	N	N	N
Sc	N	N	N	N	N	N	N	10	N
Se	N	—	N	N	N	—	N	N	N
Sn	N	N	N	N	N	N	N	N	N
Sr	30	N	N	10	N	N	N	N	N
Ta	N	N	N	N	N	N	N	N	N
Te	N	N	N	N	N	N	N	N	—
V	70	200	N	60	N	N	N	N	N
W	N	N	N	N	N	N	N	N	N
Y	70	N	80	160	N	N	110	90	N
Zn	60	N	N	60	N	N	N	100	10
Zr	70	L	140	60	120	1000	60	170	12
Th	—	4.3	4.5	—	4.0	—	—	7.8	—
U	—	2.9	1.8	—	1.7	—	—	2.0	—
Cu	—	—	9	14	6	7	N	8	0.5
Pb	—	—	30	70	40	73	30	50	30
Zn	—	—	30	100	25	34	30	120	30
Ag	—	—	9	N	N	N	N	N	N

Coleen

Map No.	82	83	84	85	86	87	88	89	9
Sample No.	CC 41	CC 38	CC 37	CC 36	CC 35	CC 34	CC 33	CC 32	CC 3
Fe %	0.93	1.3	1.0	2.0	1.4	1.3	1.9	2.0	2.9
Mg %	0.069	0.054	0.063	0.45	0.27	0.13	0.23	0.26	0.19
Ca %	0.020	0.016	0.019	0.091	0.094	0.035	0.050	0.049	N
Na %	0.056	0.092	0.091	0.15	0.21	0.21	0.30	0.43	0.12
K %	N	1.6	1.5	N	1.4	1.5	N	N	N
Ti %	0.13	0.18	0.16	0.086	0.15	0.11	0.10	0.11	0.12
Mn	170	60	100	380	400	270	360	370	550
Ag	N	L	L	N	N	N	N	N	N
As	N	N	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N	N	N
B	N	N	N	N	N	N	N	N	N
Ba	N	N	N	N	N	N	N	N	N
Be	N	N	N	N	N	N	N	N	N
Bi	N	N	N	N	N	N	N	N	N
Cd	N	N	N	N	N	N	N	N	N
Co	N	N	N	N	N	N	N	N	N
Cr	30	40	40	20	40	40	N	50	30
Cu	N	N	N	N	N	N	N	N	N
Ga	N	N	N	N	N	N	N	N	N
La	N	N	N	N	N	N	N	N	N
Li	N	N	N	N	N	N	N	N	N
Mo	10	20	10	N	N	N	N	10	N
Nb	N	N	N	N	N	N	N	N	N
Ni	N	20	30	N	30	20	N	20	N
P	N	N	N	N	N	N	N	N	N
Pb	N	90	N	N	N	N	N	N	N
Pd	N	N	N	N	N	N	N	N	N
Pt	N	—	N	N	N	N	N	N	N
Sb	N	N	N	N	N	N	N	N	N
Sc	10	10	10	N	10	10	10	20	10
Se	N	N	N	N	N	N	N	N	N
Sn	N	N	N	N	N	N	N	N	N
Sr	N	N	N	N	N	N	10	10	N
Ta	N	N	—	N	N	N	N	N	—
Te	—	N	—	N	—	N	N	N	N
V	N	N	N	N	N	N	N	60	N
W	N	N	N	N	N	N	N	N	N
Y	80	120	120	N	90	90	N	160	N
Zn	N	N	N	20	N	N	N	N	N
Zr	210	420	320	140	320	80	60	250	90
Th	5.3	7	—	6.5	—	5.8	—	6.8	—
U	1.5	1.3	—	2.4	—	1.7	—	1.6	—
Cu	N	N	5	11	8	7	12	11	14
Pb	N	N	N	30	N	N	N	N	40
Zn	10	10	9	30	40	30	35	35	35
Ag	N	N	N	N	N	N	N	N	N

Coleen

Map No.	91	92	93	94	95	96	97	98	9
Sample No.	CC30	CC51	CC52	CC54	CC56	CC57	CC58	CC59	CC
Fe %	6.6	1.9	1.5	2.6	2.0	1.4	0.45	1.4	1.
Mg %	1.2	0.13	0.087	1.1	1.4	3.2	0.069	2.0	2.
Ca %	0.11	0.024	N	0.45	0.73	1.8	0.093	1.9	0.
Na %	G	0.21	0.10	0.16	0.091	0.079	0.20	0.091	0.0
K %	3.5	1.5	N	1.6	1.9	1.8	2.8	1.6	2.
Ti %	0.13	0.14	0.079	0.089	0.077	0.080	0.13	0.088	0.
Mn	460	140	150	620	370	370	N	410	36
Ag	N	N	N	N	N	N	L	N	N
As	N	N	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	L	N	N
B	N	N	N	N	N	N	N	N	N
Ba	N	N	N	N	N	N	N	N	N
Be	N	N	N	N	N	N	N	N	N
Bi	N	N	N	N	N	N	N	N	N
Cd	N	N	N	N	N	N	N	N	N
Co	N	N	N	N	N	N	N	N	N
Cr	70	40	30	40	50	50	60	40	4
Cu	N	N	N	N	N	N	N	N	N
Ga	30	N	N	N	N	N	20	N	N
La	N	N	N	N	N	N	270	N	N
Li	N	N	N	N	N	N	N	N	N
Mo	10	N	N	N	N	N	20	N	N
Nb	N	N	N	N	N	N	N	N	N
Ni	30	20	N	20	20	30	50	20	5
P	N	N	1100	N	N	N	N	N	N
Pb	N	N	N	N	N	N	N	N	N
Pd	N	N	N	N	N	N	—	N	N
Pt	N	N	N	N	N	N	—	N	N
Sb	N	N	590	N	N	N	N	N	N
Sc	20	10	N	N	N	N	30	N	N
Se	N	N	N	N	N	N	1000	N	N
Sn	N	N	N	N	N	N	60	N	N
Sr	20	N	N	N	10	10	N	10	1
Ta	N	N	—	N	N	N	—	N	N
Te	N	N	—	N	N	N	—	N	N
V	50	40	N	N	N	N	60	N	5
W	N	N	N	N	N	N	N	N	N
Y	110	100	N	70	90	100	190	140	14
Zn	40	N	N	30	40	70	N	50	8
Zr	90	130	190	40	20	40	100	70	14
Th	9.8	8.5	—	11.3	—	—	—	5.8	6.
U	2.7	1.2	1.4	2.2	2.3	16	0.7	2	2.
Cu	20	9	8	15	13	16	5	10	16
Pb	N	N	N	30	40	40	N	30	30
Zn	60	30	20	60	90	100.	30	75	13
Ag	N	N	N	N	N	N	N	N	N

Coleen

Map No.	100	101	102	103	104	105	106	107	1
Sample No.	PR 1907	PR 1906	PR 1902	PR 1901	PR 1899	PR 1897	PR 1896	PR 1894	CCa
Fe %	1.5	1	1	1	1.5	3	3	1.6	6.
Mg %	5	2	7	3	7	7	7	3.0	8.
Ca %	10	2	15	3	7	7	7	5.0	0.
Na %	0.8	0.8	1.2	0.6	G	0.4	0.4	1.2	0.
K %	—	—	—	—	—	—	—	—	2.
Ti %	0.5	0.3	0.2	0.5	G	1	G	0.3	0.
Mn	1500	700	5000	2000	500	2000	2000	2000	0.0
Ag	1.5	1	L	L	L	2	L	L	N
As	N	N	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N	N	N
B	150	150	70	150	150	150	150	150	N
Ba	N	N	N	1500	2000	3000	3000	1500	N
Be	1	L	L	L	2	L	L	N	N
Bi	N	N	N	N	N	N	N	N	N
Cd	N	N	N	N	N	N	N	N	N
Co	L	N	N	N	20	L	N	N	40
Cr	1000	500	200	1000	1500	1500	1000	20	14
Cu	50	50	20	50	150	300	200	50	N
Ga	N	N	N	L	7	L	L	L	N
La	L	N	L	N	N	N	N	N	N
Li	N	N	N	N	N	N	N	N	N
Mo	N	N	N	N	50	L	N	N	2
Nb	L	L	L	N	N	N	N	N	N
Ni	500	500	150	300	700	1000	500	200	19
P	N	N	L	L	L	L	L	L	N
Pb	L	L	200	L	70	150	150	L	N
Pd	N	N	N	N	N	N	N	N	N
Pt	N	N	N	N	N	N	N	N	N
Sb	N	N	N	N	N	N	N	N	N
Sc	N	N	N	N	N	N	N	N	20
Se	—	—	—	—	—	—	—	—	N
Sn	N	N	N	N	N	N	N	N	N
Sr	N	N	N	N	N	N	N	N	50
Ta	N	N	N	N	N	L	L	N	N
Te	N	N	N	N	N	N	N	N	N
V	200	200	300	150	500	100	150	L	60
W	N	N	N	N	N	N	N	N	N
Y	N	N	N	N	N	N	N	N	90
Zn	N	N	N	N	N	N	N	N	60
Zr	500	L	L	1000	G	G	1000	L	60
Th	12.5	34.0	18.8	16.3	31.5	12.8	37.5	28.0	—
U	3.4	2.5	1.2	3.2	5.8	1.8	3.0	3.8	—

Coleen

Map No.	109	110	111	112	113	114	115	116	1
Sample No.	PR1892	PR1891	CCa1016	PR1890	PR1889	R404	R403	PR1881	CC
Fe %	7	7	3.3	7	15	1/	1/	10	9
Mg %	7	5	3.9	3	7			7	2
Ca %	10	10	0.39	3	15			7	2
Na %	G	G	0.24	1.6	N			1.2	G
K %	—	—	2.7	—	—			—	2
Ti %	G	G	0.13	0.3	G			1	0.
Mn	3000	1500	0.044	3000	G			G	2
Ag	2	1	L	3	3			7	N
As	N	N	N	N	N			N	N
Au	N	N	N	N	N			N	N
B	100	100	N	100	150			150	N
Ba	L	L	N	N	1500			1500	N
Be	L	2	N	3	2			3	N
Bi	N	N	N	N	N			N	N
Cd	N	N	N	N	N			N	N
Co	30	N	N	20	20			70	5
Cr	500	500	90	100	500			500	25
Cu	150	150	N	150	300			500	N
Ga	3	1.5	N	L	3			.7	3
La	N	N	N	N	N			N	N
Li	N	N	N	N	N			N	N
Mo	N	N	10	N	N			N	30
Nb	L	L	N	L	L			L	N
Ni	300	200	60	200	300			500	17
P	3000	1000	N	5000	3000			2000	94
Pb	70	50	N	L	70			200	N
Pd	N	N	N	N	N			N	N
Pt	N	N	N	N	N			N	N
Sb	N	N	N	N	N			N	59
Sc	N	N	20	N	N			N	2
Se	—	—	N	—	—			—	N
Sn	N	N	N	N	N			N	N
Sr	N	N	30	N	N			N	12
Ta	N	N	N	N	N			N	N
Te	N	N	N	N	N			N	N
V	300	200	50	L	700			150	12
W	N	N	N	N	N			N	N
Y	N	N	110	N	N			N	13
Zn	N	N	30	N	N			N	13
Zr	200	L	70	L	200			200	90
Th	16.3	19.3	—	12.3	13.3			53.8	—
U	2.5	3.0	—	2.6	3.9			3.0	—
Cu	—	—	—	—	—			—	37
Pb	—	—	—	—	—			—	N
Zn	—	—	—	—	—			—	12
Ag	—	—	—	—	—			—	N

Coleen

Map No.	118	119	120	121	122	123	124	125	
Sample No.	PR 1879	PR 1874	CC665	PR1871	PR1869	CC666	PR1867	PR1866	PR
Fe %	7	0.7	3.5	5	10	3.6	10	15	
Mg %	7	7	0.66	3	3	0.75	7	7	
Ca %	15	15	0.17	1	5	0.017	15	15	
Na %	G	G	0.51	1.2	1.6	0.085	G	G	
K %	—	—	N	—	—	N	—	—	
Ti %	G	0.3	0.14	1	1	0.14	0.7	G	
Mn	5000	2000	700	2000	3000	720	3000	3000	
Ag	1	N	N	L	1	N	2	2	
As	N	N	N	N	N	N	N	N	
Au	N	N	N	N	N	N	N	N	
B	100	150	N	300	200	N	100	50	
Ba	N	N	N	N	L	N	N	1000	
Be	N	L	N	3	N	N	L	N	
Bi	N	N	N	N	N	N	N	L	
Cd	N	N	N	N	N	N	N	N	
Co	N	N	N	N	N	N	50	100	
Cr	200	500	50	200	200	40	200	300	
Cu	70	15	N	50	70	N	150	150	
Ga	3	1	N	1.5	3	N	3	3	
La	N	500	N	N	N	N	N	N	
Li	N	N	N	N	N	N	N	N	
Mo	N	N	10	N	N	N	N	N	
Nb	L	N	N	L	N	N	L	1000	
Ni	50	150	30	150	100	40	200	300	
P	2000	2000	N	L	L	N	3000	3000	
Pb	L	N	N	L	N	N	N	N	
Pd	N	N	N	N	N	N	N	N	
Pt	N	N	N	N	N	N	N	N	
Sb	N	N	N	N	N	N	N	N	
Sc	N	N	10	N	N	N	N	N	
Se	—	—	N	—	—	N	—	—	
Sn	N	N	N	N	N	N	N	N	
Sr	N	N	30	N	N	20	N	N	
Ta	N	N	N	N	N	N	N	N	
Te	N	N	N	N	N	N	N	N	
V	300	200	60	200	300	40	300	300	
W	N	N	N	N	N	N	N	N	
Y	N	N	N	N	N	N	N	N	
Zn	N	N	110	N	N	70	N	N	
Zr	500	L	240	300	500	190	L	300	
Th	10.0	12.5	—	32.5	31.8	—	26.0	10.5	
U	2.3	2.8	—	4.8	3.9	—	2.7	2.4	
Cu	—	—	18	—	—	24	—	—	
Pb	—	—	N	—	—	N	—	—	
Zn	—	—	90	—	—	130	—	—	
Ag	—	—	N	—	—	N	—	—	

Coleen

Map No.	127	128	129	130	131	132	133	134	
Sample No.	PR 1845	PR1856	PR 1849	PR 1851	PR 1853	Rock	CC668	R 620	R
Fe %	5	15	10.0	1.5	15.0	Void	1.9	11	1
Mg %	1.5	7	7.0	5.0	7.0		4.7		
Ca %	3	15	15.0	7.0	7.0		3.7		
Na %	1.6	G	G	G	G		0.32		
K %	—	—	—	—	—		1.2		
Ti %	0-1	G	0.3	G	0.5		0.10		
Mn	300	3000	1000	300	1500		220		
Ag	3	3	3	3	2		N		
As	N	N	N	N	N		N		
Au	N	N	N	N	N		N		
B	100	100	50	150	150		N		
Ba	1500	2000	N	3000	2000		N		
Be	2	3	L	2	3		N		
Bi	20	20	20	20	20		N		
Cd	N	N	N	N	N		N		
Co	N	100	50	N	70		N		
Cr	100	1000	150	300	500		50		
Cu	20	150	150	100	150		N		
Ga	L	3	1	2	3		N		
La	N	N	N	N	N		N		
Li	N	N	N	N	N		N		
Mo	N	N	N	N	N		N		
Nb	L	1000	L	1000	L		N		
Ni	150	500	500	200	300		40		
P	2000	3000	1000	2000	2000		N		
Pb	N	L	N	N	L		N		
Pd	N	N	N	N	N		N		
Pt	N	N	N	N	N		N		
Sb	N	N	N	N	N		N		
Sc	N	N	N	N	N		N		
Se	—	—	—	—	—		N		
Sn	N	N	N	N	N		N		
Sr	N	N	N	N	N		30		
Ta	N	N	N	N	N		N		
Te	N	N	N	N	N		N		
V	50	300	150	300	300		50		
W	N	N	N	N	N		N		
Y	N	N	N				70		
Zn	N	N	N	N	N		60		
Zr	G	1000	300	G	L		60		
Th	20.3	9.0	6.5	14.0	11.5		—		
U	2.7	2.5	5.0	3.3	3.4		—		
Cu	—	—	—	—	—		22		
Pb	—	—	—	—	—		N		
Zn	—	—	—	—	—		100		
Ag	—	—	—	—	—		N		

Coleen

Map No.	136	137	138	139	140	141	142	143	1
Sample No.	R377	PR1841	PR1839	PR1838	R582A	PR1837	PR1836	PR1834	B
Fe %	1/	7	2	7	1/	7	1.5	2	1
Mg %		2	5	5		7	3	3	
Ca %		2	10	7		15	7	7	
Na %		0.8	0.8	G		1.6	G	G	
K %		—	—	—		—	—	—	
Ti %		0.3	1	0.5		0.2	0.3	0.3	
Mn		300	1000	500		300	300	2000	
Ag		3	2	3		L	N	L	
As		N	N	N		N	N	N	
Au		N	N	N		N	N	N	
B		150	150	150		50	70	150	
Ba		N	N	2000		L	L	N	
Be		3	N	2		L	L	N	
Bi		20	N	20		N	20	N	
Cd		N	N	N		N	N	N	
Co		N	N	50		N	N	N	
Cr		100	300	300		100	500	100	
Cu		150	15	50		15	20	20	
Ga		1	1.5	1.5		0.5	1	1	
La		N	N	N		N	N	N	
Li		N	N	N		N	N	N	
Mo		N	N	N		N	N	N	
Nb		L	L	L		L	L	L	
Ni		150	150	200		10	150	100	
P		1000	N	2000		2000	2000	N	
Pb		N	N	L		N	L	N	
Pd		N	N	N		N	N	N	
Pt		N	N	N		N	N	N	
Sb		N	N	N		N	N	N	
Sc		N	N	N		N	N	N	
Se		—	—	—		—	—	—	
Sn		N	N	N		N	N	N	
Sr		N	N	N		N	N	N	
Ta		N	N	N		N	N	N	
Te		N	N	N		N	N	N	
V		150	300	200		30	300	200	
W		N	N	N		N	N	N	
Y		N	N	N		N	N	N	
Zn		N	N	N		N	N	N	
Zr		200	500	G		G	1000	200	
Th		36.5	—	—		8.5	17.5	—	
U		2.3	—	—		2.1	4.2	—	

Coleen

Map No.	145	146	147	148	149	150	151	152
Sample No.	PR1833	PR1831	PR1828	TB54	TB53	TB56	TB58	PR1826
Fe %	7	5	7	3	3	4	3	1.5
Mg %	5	5	7	6	8	7	4	3
Ca %	10	15	15	2	2	3	2	7
Na %	G	G	G	N	N	N	N	1.6
K %	—	—	—	3	3	4	3	—
Ti %	G	0.3	1	0.5	N	0.5	0.5	0.07
Mn	2000	5000	G	400	500	200	400	1000
Ag	1	3	3	N	N	N	N	L
As	N	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N	N
B	150	300	200	90	90	100	90	150
Ba	2000	1500	L	300	300	500	400	N
Be	N	3	5	N	N	N	N	3
Bi	N	L	30	N	N	N	N	N
Cd	N	N	N	N	N	L	N	N
Co	N	30	30	N	N	N	N	N
Cr	500	300	300	N	N	20	10	70
Cu	150	200	500	N	N	L	L	70
Ga	1	2	3	N	N	N	N	L
La	N	L	N	N	N	N	N	N
Li	N	N	N	N	N	L	N	N
Mo	N	30	N	N	N	N	N	N
Nb	N	L	L	N	N	L	N	L
Ni	200	200	300	N	N	L	L	70
P	2000	2000	2000	N	N	N	N	2000
Pb	N	150	500	N	N	N	N	50
Pd	N	N	N	N	N	N	N	N
Pt	N	N	N	N	N	N	N	N
Sb	N	N	L	N	N	L	L	N
Sc	N	N	N	N	N	N	N	N
Se	—	—	—	N	N	N	N	—
Sn	N	N	N	N	N	N	N	N
Sr	N	N	N	20	10	10	20	N
Ta	N	N	N	N	N	N	N	N
Te	N	N	N	N	N	N	N	N
V	300	500	300	N	N	N	N	L
W	N	L	L	N	N	N	N	N
Y	N	N	N	N	N	N	N	N
Zn	N	700	L	N	10	30	10	N
Zr	500	500	1000	N	N	N	N	L
Th	9.5	13.5	10.8	—	—	—	—	9.8
U	2.9	5.7	3.5	—	—	—	—	2.3

Coleen

Map No.	154	155	156	157	158	159	160	161	1
Sample No.	PR1825	PR1824	PR1816	B78	B77	B79	B80	B81	R
Fe %	Void	Void	1.5	1/	1/	1/	1/	1/	1
Mg %			3						
Ca %			5						
Na %			1.6						
K %			—						
Ti %			0.3						
Mn			500						
Ag			L						
As			N						
Au			N						
B			100						
Ba			N						
Be			1.5						
Bi			N						
Cd			N						
Co			N						
Cr			100						
Cu			50						
Ga			N						
La			N						
Li			N						
Mo			N						
Nb			L						
Ni			150						
P			1000						
Pb			N						
Pd			N						
Pt			N						
Sb			N						
Sc			N						
Se			—						
Sn			N						
Sr			N						
Ta			N						
Te			N						
V			L						
W			N						
Y			N						
Zn			N						
Zr			L						
Th									
U									

Coleen

Map No.	164	165	166	167	168	169	170	171	1
Sample No.	B82	B83	B84	B85	B86	CB3005	R194	R179	TB
	1/	1/	1/	1/	1/		1/	1/	
Fe %						10.			4
Mg %						7.3			3
Ca %						5.2			7
Na %						G			N
K %						1.3			4
Ti %						0.29			0.8
Mn						1800			50
Ag						N			L
As						N			N
Au						N			L
B						N			N
Ba						N			400
Be						N			N
Bi						N			N
Cd						N			L
Co						40			N
Cr						120			L
Cu						N			L
Ga						N			N
La						N			L
Li						N			L
Mo						20			L
Nb						N			L
Ni						70			L
P						N			N
Pb						N			N
Pd						N			N
Pt						N			L
Sb						N			L
Sc						30			N
Se						N			L
Sn						N			L
Sr						50			40
Ta						N			L
Te						N			L
V						120			L
W						N			L
Y						90			L
Zn						140			N
Zr						50			L
Th						—			—
U						—			—

Coleen

Map No.	173	174	175	176	177	178	179	180	
Sample No.	TB51	TB47	TB44	TB45	R185	R178	B1	TB41	B
Fe %	3	5	5	4	1/	1/	1/	4	
Mg %	2	3	5	2				2	
Ca %	8	0.3	N	1				0.3	
Na %	N	N	N	N				N	
K %	3	5	3	3				3	
Ti %	N	0.9	0.5	0.6				0.7	
Mn	200	2000	600	300				1000	
Ag	N	—	N	N				N	
As	N	N	N	N				N	
Au	N	N	N	N				N	
B	100	100	100	90				90	
Ba	300	5000	20000	40				400	
Be	N	N	N	N				N	
Bi	N	N	N	N				N	
Cd	N	L	L	L				L	
Co	N	N	N	N				N	
Cr	N	70	60	20				20	
Cu	N	L	L	L				L	
Ga	N	L	N	N				N	
La	N	N	N	N				N	
Li	N	100	L	L				L	
Mo	N	N	N	N				N	
Nb	N	L	N	N				L	
Ni	L	L	L	L				L	
P	N	N	N	N				N	
Pb	N	N	N	N				N	
Pd	N	N	N	N				N	
Pt	N	N	N	N				N	
Sb	L	L	L	L				L	
Sc	N	N	N	N				N	
Se	N	N	N	N				N	
Sn	N	L	N	N				N	
Sr	L	L	L	N				L	
Ta	N	N	N	N				N	
Te	N	N	N	N				N	
V	N	L	N	N				N	
W	N	N	N	N				N	
Y	N	N	N	N				N	
Zn	N	L	L	L				N	
Zr	N	N	N	N				N	
Th	—	—	—	—				—	
U	—	—	—	—				—	

Colec-

Map No.	182	183	184	185	186	187	188	189	1
Sample No.	CR577	B500	B499	CR532	CR531	CR23	CR24	CR25	CR
Fe %	2.3			6.2	5.8	2.6	6.3	5.3	5.
Mg %	1.2			1.4	1.2	4.6	1.9	1.4	2.
Ca %	0.25			N	0.24	0.12	0.16	0.26	N
Na %	0.55			0.69	G	0.59	0.76	G	0.3
K %	N			1.6	1.4	4.7	1.5	N	1.2
Ti %	0.15			0.16	0.21	0.13	0.18	0.16	0.1
Mn	520			1300	1500	740	1500	1700	12
Ag	N			N	L	L	N	N	N
As	N			N	N	N	N	N	N
Au	N			N	N	N	N	N	N
B	N			130	N	N	120	N	N
Ba	N			N	N	N	N	N	N
Be	N			N	N	N	N	N	N
Bi	N			N	N	N	460	420	N
Cd	N			N	N	N	N	N	N
Co	N			N	N	N	N	N	N
Cr	50			60	100	70	60	70	50
Cu	N			N	240	N	N	N	N
Ga	N			N	N	N	N	N	N
La	N			N	N	230	N	N	N
Li	N			N	N	N	N	N	N
Mo	N			10	N	20	N	N	N
Nb	N			N	N	N	N	N	N
Ni	20			50	50	40	50	40	50
P	N			N	930	N	N	820	N
Pb	N			N	480	N	N	N	N
Pd	N			N	N	N	N	N	N
Pt	N			N	N	N	N	N	N
Sb	N			N	580	N	N	N	N
Sc	N			20	N	30	N	N	10
Se	N			N	N	N	N	N	N
Sn	N			N	N	N	N	N	N
Sr	20			10	40	20	30	40	N
Ta	N			N	N	N	N	N	N
Te	N			N	N	N	—	N	N
V	N			60	50	80	40	50	40
W	N			N	N	N	N	N	N
Y	80			110	90	130	N	N	100
Zn	50			40	120	30	110	100	50
Zr	100			50	N	140	N	20	30
Th	—			20	12.3	12	—	10.3	13.3
U	—			1	1.8	1.5	1.5	1.7	0.8
Cu	18			25	28	22	28	26	47
Pb	<30			40	40	50	40	60	30
Zn	70			89	87	90	110	92	90
Ag	<5			N	N	N	N	N	N

Coleen

Map No.	191	192	193	194	195	196	197	198	19
Sample No.	CR542	CR540	CR544	CR580	CC658	CC656	CC655	CC654	CC
Fe %	5.5	3.3	2.0	3.4	5.0	2.6	2.5	3.9	4.
Mg %	1.2	1.8	1.5	1.4	1.2	2.6	1.3	2.5	3.
Ca %	N	0.051	0.085	0.060	0.57	0.39	0.32	0.49	0.
Na %	G	0.28	0.40	0.50	G	0.85	0.63	G	G
K %	2.0	N	1.4	1.1	1.6	2.6	1.3	3.5	3.
Ti %	0.16	0.13	0.13	0.14	0.17	0.15	0.11	0.16	0.1
Mn	1000	710	380	2000	890	420	320	530	63
Ag	30	N	N	N	N	L	N	L	N
As	N	N	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N	N	N
B	N	N	N	N	N	N	N	N	N
Ba	N	N	N	N	N	N	N	N	N
Be	N	N	N	N	N	N	N	N	N
Bi	N	N	N	N	N	N	N	N	N
Cd	N	N	N	N	N	N	N	N	N
Co	N	N	N	N	N	N	N	N	N
Cr	50	30	50	50	80	80	50	110	80
Cu	110	N	N	N	N	N	N	N	N
Ga	N	N	N	N	N	N	N	30	N
La	N	N	N	N	N	N	N	N	N
Li	N	N	N	N	N	N	N	N	N
Mo	N	N	N	N	10	20	10	20	10
Nb	N	N	N	N	N	N	N	N	N
Ni	30	N	20	30	50	40	30	60	60
P	N	N	N	N	N	N	N	N	N
Pb	N	N	N	N	N	N	N	N	N
Pd	N	N	N	N	N	N	N	N	N
Pt	N	N	N	N	N	N	N	N	N
Sb	N	N	N	N	N	N	N	N	N
Sc	N	10	N	N	N	40	20	50	20
Se	N	N	N	N	N	N	N	N	N
Sn	N	N	N	N	N	N	N	N	N
Sr	N	10	20	20	70	40	40	50	60
Ta	N	N	N	N	N	N	N	N	N
Te	N	N	N	N	—	N	N	N	N
V	N	N	N	N	50	60	50	80	50
W	N	N	N	N	N	N	N	N	N
Y	70	90	110	80	N	100	N	130	120
Zn	70	N	30	70	100	40	30	50	40
Zr	N	110	70	70	40	400	130	670	570
Th	11.3	12	12.3	—	10.5	15	12.5	31.3	11.5
U	0.8	1.6	1.7	—	1.7	2.4	2.1	2.2	1.6
u	27	31	50	32	27	17	19	20	16
b	N	30	N	40	N	N	N	N	N
n	80	70	70	100	71	61	75	72	74
Ag	N	N	N	N	N	N	N	N	N

Coleen

Map No.	200	201	202	203	204	205	206	207	
Sample No.	R406A	CC649	CC645	CC646	CC641	OC2249	CC633	B177	CS.
Fe %	11	1.0	5.9	3.7	3.4	7	5.7	11	
Mg %		0.13	1.1	1.0	1.6	3	1.0		
Ca %		0.11	0.30	0.24	0.16	5	0.47		
Na %		G	G	G	0.93	G	1.0		
K %		3.8	3.2	6.5	2.3	—	2.0		
Ti %		0.013	0.14	0.089	0.15	1	0.16		
Mn		230	2300	870	1100	3000	2300		
Ag		N	N	N	N	3	N		
As		N	N	N	N	N	N		
Au		N	N	N	N	N	N		
B		N	100	N	N	150	N		
Ba		N	N	N	N	1500	N		
Be		N	N	N	N	2	N		
Bi		N	440	N	N	N	N		
Cd		N	N	N	N	N	N		
Co		N	N	N	N	20	N		
Cr		N	60	30	60	200	80		
Cu		N	N	N	N	200	N		
Ga		N	N	N	N	70	N		
La		N	N	N	N	N	N		
Li		N	N	N	N	N	N		
Mo		N	N	N	20	N	N		
Nb		N	N	N	N	L	N		
Ni		N	50	N	40	300	50		
P		N	N	N	N	1000	N		
Pb		N	N	N	N	N	N		
Pd		N	N	N	N	N	N		
Pt		N	N	N	N	N	N		
Sb		N	530	N	N	N	520		
Sc		N	10	N	20	N	N		
Se		N	N	N	N	—	N		
Sn		N	N	N	N	N	N		
Sr		20	40	30	20	N	40		
Ta		N	N	N	N	N	N		
Te		N	—	N	N	N	N		
V		N	40	N	80	200	50		
W		N	N	N	N	N	N		
Y		N	N	N	130	N	90		
Zn		N	180	60	70	N	80		
Zr		N	30	N	150	1000	50		
Th		10.8	—	—	—	14.3	10		
U		1.2	—	—	—	3.1	2		
Cu		5	28	14	30	18	22		
Pb		N	40	N	N	15	N		
Zn		19	110	62	86	78	81		
Ag		N	N	N	N	N	N		

Coleen

Map No.	209	210	211	212	213	214	215	216	2
Sample No.	CS2101	OC2245	B202A	OC2247	B181	B203	CC626	CC84	B 2
			1/		1/	1/			1
Fe %		7		5			2.5	5.3	
Mg %		1.5		2			1.1	0.91	
Ca %		3		3			0.29	0.29	
Na %		G		G			G	G	
K %		–		–			4.7	N	
Ti %		0.2		0.5			0.080	0.15	
Mn		1000		2000			400	520	
Ag		2		0.1			N	N	
As		N		N			N	N	
Au	No Analysis	N		N			N	N	
B		100		150			N	N	
Ba		L		2000			N	N	
Be		7		5			N	N	
Bi		L		L			N	N	
Cd		N		N			N	N	
Co		N		20			N	N	
Cr		150		70			40	60	
Cu		10		70			N	110	
Ga		10		30			30	20	
La		N		N			N	N	
Li		N		N			N	N	
Mo		N		N			10	10	
Nb		L		L			N	N	
Ni		100		150			20	N	
P		L		N			N	N	
Pb		100		N			N	420	
Pd		N		N			N	N	
Pt		N		N			N	N	
Sb		N		N			N	N	
Sc		N		N			30	20	
Se		–		–			N	N	
Sn		N		N			N	N	
Sr		N		N			30	40	
Ta		N		N			N	N	
Te		N		N			N	N	
V		300		300			N	60	
W		N		N			N	N	
Y		N		N			140	N	
Zn		N		N			30	100	
Zr		L		700			90	30	
Th	11	44.5		33.5			120	18.8	
U	1.3	13		5			14.8	12.7	
Cu	26	–		–			7	18	
Pb	N	–		–			50	50	
Zn	67	–		–			58	100	
Ag	N	–		–			N	N	

Colcem

Map No.	218	219	220	221	222	223	224	225	2
Sample No.	CC85	CC81	CC110	CC80	CC109	CC79	CC108	CC78	C
Fe %	6.0	5.2	3.0	4.7	1.3	6.5	4.0	5.9	0.
Mg %	1.1	0.56	1.4	1.0	0.22	0.93	1.7	0.80	0.
Ca %	0.016	0.19	0.10	0.16	0.071	0.21	0.22	0.20	0.
Na %	0.73	G	0.80	G	G	0.65	0.75	G	
K %	2.3	3.2	4.7	2.2	5.8	1.2	3.1	1.5	4
Ti %	0.15	0.22	0.10	0.13	0.031	0.16	0.12	0.11	
Mn	0.013	0.025	220	380	140	310	740	450	8
Ag	N	L	L	N	N	L	L	N	N
As	N	N	N	N	N	N	N	N	N
Au	N	L	N	N	N	N	N	N	N
B	N	N	N	N	N	N	N	N	N
Ba	N	N	N	N	N	N	N	N	N
Be	N	N	N	N	N	N	N	N	N
Bi	N	N	N	N	N	N	N	N	N
Cd	N	N	N	N	N	N	N	N	N
Co	N	N	N	N	N	N	N	N	N
Cr	100	130	80	66	20	80	60	50	N
Cu	N	N	N	N	N	80	N	N	N
Ga	30	40	N	20	N	20	N	30	N
La	N	N	N	N	N	N	N	N	N
Li	N	N	N	N	N	N	N	N	N
Mo	10	20	10	N	N	10	10	10	N
Nb	N	N	N	N	N	N	N	N	N
Ni	N	70	30	20	N	N	50	N	N
P	N	N	N	N	N	N	N	N	N
Pb	N	N	N	N	N	N	N	460	N
Pd	N	N	N	N	N	N	N	N	N
Pt	N	N	N	N	N	N	N	N	N
Sb	N	N	N	N	N	N	N	N	N
Sc	20	30	30	10	N	10	30	10	N
Se	N	N	N	N	N	N	N	N	N
Sn	N	N	N	N	N	N	N	N	N
Sr	30	30	20	20	10	30	30	30	N
Ta	N	N	N	N	N	N	N	N	N
Te	N	N	N	N	N	N	N	N	N
V	90	110	60	50	N	70	60	50	N
W	N	N	N	N	N	N	N	N	N
Y	N	180	140	100	N	N	110	70	N
Zn	50	N	N	40	N	80	N	90	N
Zr	N	70	70	30	N	40	120	30	N
Th	11.8	36.5	—	23.3	–	12.3	—	20	5.
U	3.3	2.9	2.5	1.8	—	1.6	4.2	11.1	1.
Cu	22	15	12	11	11	12	19	16	6
Pb	30	35	<30	40	30	N	40	60	N
Zn	60	50	52	60	17	80	62	80	1C
Ag	N	N	<5	N	<5	N	<5	N	N

Coleen

Map No.	227	228	229	230	231	232	233	234	
Sample No.	CC72	CC73	CC107	CC105	CC62	CC100	CC104	CC101	CC
Fe %	5.9	5.0	4.4	5.0	2.0	1.3	1.5	1.7	4
Mg %	0.72	0.82	0.85	0.85	1.1	0.64	0.59	0.30	1.
Ca %	0.27	0.14	0.21	0.31	0.30	0.25	0.20	0.19	0.
Na %	0.70	0.85	0.88	G	G	G	G	G	G
K %	1.2	2.0	2.0	2.8	4.8	5.8	6.2	3.4	3
Ti %	0.12	0.10	0.14	0.16	0.10	0.060	0.053	0.022	0.
Mn	880	470	460	1000	460	560	320	560	54
Ag	N	N	N	L	N	N	20	N	N
As	N	N	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N	N	N
B	N	100	N	N	130	150	N	N	N
Ba	N	N	N	N	N	N	N	N	N
Be	N	N	N	N	N	N	N	N	N
Bi	N	N	N	N	N	N	N	N	N
Cd	N	N	N	N	N	N	N	N	N
Co	N	N	N	N	N	N	N	N	N
Cr	70	70	70	70	50	30	40	N	80
Cu	N	N	N	N	N	N	N	N	N
Ga	N	30	20	N	20	20	N	N	20
La	N	N	N	N	N	N	N	N	N
Li	N	N	N	N	N	N	N	N	N
Mo	N	10	N	N	N	N	N	N	20
Nb	N	N	N	N	N	N	N	N	N
Ni	N	N	30	40	N	20	N	N	50
P	N	N	N	N	N	N	N	N	N
Pb	N	N	N	710	N	N	N	90	N
Pd	N	N	N	N	N	N	N	N	N
Pt	N	N	N	N	N	N	N	N	N
Sb	N	N	N	N	N	N	N	N	N
Sc	N	10	N	N	N	10	10	N	30
Se	N	N	N	N	N	N	N	N	N
Sn	N	N	N	N	N	N	N	N	N
Sr	30	30	40	40	30	30	20	30	40
Ta	N	N	N	N	N	N	N	N	N
Te	N	N	N	N	N	N	N	N	N
V	50	50	50	40	N	N	N	N	70
W	N	N	N	N	N	N	N	N	N
Y	N	80	N	N	N	120	110	N	90
Zn	90	70	80	50	40	N	N	20	50
Zr	30	N	20	N	150	N	N	N	110
Th	—	26.3	17.5	41	—	—	21.5	—	20.3
U	2.3	3.2	3.4	6.6	—	—	2.4	1.6	3.6
Cu	23	13	16	12	10	8	9	13	14
Pb	N	50	60	50	30	30	40	30	40
Zn	100	70	70	85	60	31	35	29	83
Ag	N	N	<5	<5	N	<5	<5	<5	<5

[illegible]

Map No.	236	237	238	239	240	241	242	243	=
Sample No.	CC102	OC2415	CC74	CC75	CC76	B217	CC82	OC2423	OC
Fe %	1.3	2	5.2	2.7	2.8	1/	1.3	0.7	1.
Mg %	0.22	1.5	0.89	0.73	0.86		0.53	0.05	1
Ca %	0.13	3	0.052	0.17	0.23		0.17	3	2
Na %	0.83	G	1.0	G	G		G	0.8	G
K %	4.9	–	2.3	2.7	4.6		5.2	–	–
Ti %	0.038	0.2	0.046	0.071	0.12		0.059	0.01	0.2
Mn	190	3000	1100	460	380		620	70	20
Ag	N	1	N	N	N		N	N	5
As	N	N	N	N	N		N	N	N
Au	N	N	N	N	N		N	N	N
B	N	70	N	N	N		N	N	N
Ba	N	L	N	N	N		N	100	15
Be	N	3	N	N	N		N	N	N
Bi	N	20	N	N	N		N	7	7
Cd	N	N	N	N	N		N	L	L
Co	N	N	N	N	N		N	N	N
Cr	N	500	20	20	60		N	N	N
Cu	N	100	60	N	N		30	N	70
Ga	N	1.5	30	20	N		N	10	15
La	N	N	N	N	N		N	L	2
Li	N	N	N	N	N		N	N	N
Mo	N	N	N	N	N		N	N	N
Nb	N	150	N	N	N		N	N	N
Ni	N	150	N	N	30		N	L	15
P	N	2000	N	N	N		N	20	15
Pb	N	N	N	N	N		N	L	15
Pd	N	N	N	N	N		N	N	10
Pt	N	N	N	N	N		N	N	N
Sb	N	N	N	N	N		N	N	N
Sc	N	N	N	N	10		N	L	N
Se	N	–	N	N	N		N	N	N
Sn	N	N	N	N	N		N	–	–
Sr	20	N	10	20	30		N	N	N
Ta	N	–	N	N	N		20	N	N
Te	–	N	N	N	N		N	N	–
V	N	300	N	N	40		N	N	N
W	N	N	N	N	N		N	N	200
Y	N	N	N	N	140		N	N	N
Zn	N	N	140	40	40		120	N	N
Zr	N	L	N	40	40		20	N	N
							N	N	N
Th	–	108	–	52.5	57		–	26.8	43
U	2.2	8.0	25.8	13.5	4.9		3.4		9
Cu	10	–	43	18	13		17	11	–
Pb	40	–	90	60	50		40	–	–
Zn	31	–	120	65	70		60	–	–
Ag	<5	–	N	N	N		N	–	–

Coleen

Map No.	245	246	247	248	249	250	251	252	2
Sample No.	OC 2419	B216	OC2129	OC2222	B215	B 214	OC2377	OC2375	OC
		1/			1/	1/			
Fe %	1		0.5	2			2	1.5	7
Mg %	2		0.1	1.5			1	0.7	3
Ca %	3		1	5			2	1.5	7
Na %	G		1.6	G			G	G	G
K %	–		–	–			–	–	–
Ti %	0.3		0.02	0.5			0.1	0.07	0.5
Mn	1500		150	1000			1000	2000	200
Ag	L		N	2			2	L	2
As	N		N	N			N	N	N
Au	N		N	N			N	N	N
B	100		150	200			150	150	70
Ba	1000		N	L			1000	N	500
Be	3		7	7			5	10	5
Bi	20		N	L			L	L	L
Cd	N		L	N			N	L	N
Co	N		N	N			N	N	L
Cr	300		L	500			100	500	20
Cu	700		15	150			50	15	7
Ga	2		L	70			3	L	5
La	–N		L	N			N	500	N
Li	N		N	N			N	N	N
Mo	N		N	N			N	N	N
Nb	150		200	L			L	150	N
Ni	100		100	300			100	150	15
P	2000		1500	1000			L	1500	L
Pb	50		N	100			50	50	10
Pd	N		N	N			N	N	N
Pt	N		N	N			N	N	N
Sb	N		N	N			N	N	N
Sc	N		N	N			N	N	N
Se	–		–	–			–	–	–
Sn	N		N	N			N	N	5
Sr	N		N	N			N	N	N
Ta	–		–	N			N	–	L
Te	N		N	N			N	N	N
V	200		N	300			N	N	3
W	N		N	L			N	N	7
Y	N		N	N			N	N	N
Zn	N		N	N			N	N	N
Zr	L		N	1000			N	N	G
Th	25.5		46	56			69	78	12
U	7		6	17			8	6	11

Coleen

Map No.	254	255	256	257	258	259	260	261	2
Sample No.	OC2238	B213	OC2236	OC2235	B209	OC2242	OC1988	R512L	OC 1
		1/			1/			1/	
Fe %	2		0.5	2		0.5	7		2
Mg %	1.5		0.2	0.3		0.2	3		2
Ca %	3		1	2		2	5		5
Na %	G		0.6	G		G	G		G
K %	—		—	—		—	—		—
Ti %.	0.15		0.02	0.03		0.03	G		0.2
Mn	1000		1000	1000		200	1000		20
Ag	1		N	1		N	2		1
As	N		N	N		N	N		N
Au	N		N	N		N	N		N
B	150		100	150		150	150		15
Ba	2000		N	N		L	5000		20
Be	5		10	10		5	7		5
Bi	L		L	N		N	L		N
Cd	N		100	N		N	N		N
Co	N		N	N		N	N		N
Cr	150		L	100		L	300		20
Cu	20		3	70		10	100		20
Ga	20		N	2		3	G		3
La	N		500	N		500	N		50
Li	N		N	N		N	N		N
Mo	N		N	N		N	N		N
Nb	L		150	N		N	L		L
Ni	100		L	200		50	150		30
P	L		1500	L		L	1000		L
Pb	50		N	70		N	150		20
Pd	N		N	N		N	N		N
Pt	N		N	N		N	N		N
Sb	N		N	N		N	L		N
Sc	N		N	N		N	N		N
Se	—		—	—		—	—		—
Sn	100		N	N		N	N		70
Sr	N		N	N		N	N		N
Ta	N		—	N		N	N		N
Te	N		N	N		N	N		N
V	300		N	N		N	500		30
W	500		N	N		N	N		N
Y	N		N	N		N	N		N
Zn	N		N	N		N	N		N
Zr	1000		N	N		N	500		10
Th	62.5		86.5	42		78	15.8		134
U	10		8	7.6		12	6.5		16

Coleen

Map No.	263	264	265	266	267	268	269	270	2
Sample No.	OC1990	R512R	OC2374	OC1991	OC1993	B186	B187	CC662	CC
Fe %	1.5	1/	1.5	3	1.5	1/	1/	4.8	3.
Mg %	2		0.7	0.15	0.5			0.86	1.
Ca %	5		2	2	3			0.14	0.
Na %	G		G	G	G			G	G
K %	—		—	—	—			1.7	2.
Ti %	0.3		0.07	0.03	0.05			0.20	0.
Mn	300		2000	1000	700			370	47
Ag	1		N	L	L			N	N
As	N		N	N	N			N	N
Au	N		N	N	N			N	N
B	70		30	50	100			N	N
Ba	2000		L	N	L			N	N
Be	3		2	5	5			N	N
Bi	N		L	N	N			N	N
Cd	N		N	N	N			N	N
Co	L		N	N	N			N	N
Cr	300		700	50	20			130	7
Cu	10		70	50	100			N	N
Ga	70		L	N	3			20	2
La	N		N	N	L			N	N
Li	N		N	N	N			N	N
Mo	N		N	N	N			N	2
Nb	L		150	N	L			N	N
Ni	150		150	150	150			60	4
P	1000		1500	N	N			N	N
Pb	50		N	100	L			90	10
Pd	N		N	N	N			N	N
Pt	N		N	N	N			N	N
Sb	N		N	L	N			N	N
Sc	N		N	N	N			N	10
Se	—		—	—	—			N	N
Sn	N		N	N	N			N	N
Sr	N		N	N	N			40	3
Ta	N		—	N	N			N	N
Te	N		N	N	N			N	—
V	200		N	N	N			90	90
W	N		N	N	N			N	N
Y	N		N	N	N			N	90
Zn	N		N	N	N			110	7
Zr	700		N	N	L			30	70
Th	33.3		145	148	45			11.5	12.
U								1.7	1.3
Cu	11		10	16	10			26	14
Pb	—		—	—	—			<30	<3
Zn	—		—	—	—			87	46
Ag	—		—	—	—			<5	<5

Map No.	272	273	274	275	276	277	278	279	28
Sample No.	B191	B1947	B195	B200	B199	B197	R499	R502	RR49
	1/	1/	1/	1/	1/	1/	1/	1/	1/
Fe %									
Mg %									
Ca %									
Na %									
K %									
Ti %									
Mn									
Ag									
As									
Au									
B									
Ba									
Be									
Bi									
Cd									
Co									
Cr									
Cu									
Ga									
La									
Li									
Mo									
Nb									
Ni									
P									
Pb									
Pd									
Pt									
Sb									
Sc									
Se									
Sn									
Sr									
Ta									
Te									
V									
W									
Y									
Zn									
Zr									
Th									
U									

Map No.	281	282	283	284	285	286	287	288	289
Sample No.	R484	R493	R490	R483	R484	R482	B324	R532	R53
	U	U	U	U	U	U	U	U	U
Fe %									
Mg %									
Ca %									
Na %									
K %									
Ti %									
Mn									
Ag									
As									
Au									
B									
Ba									
Be									
Bi									
Cd									
Co									
Cr									
Cu									
Ga									
La									
Li									
Mo									
Nb									
Ni									
P									
Pb									
Pd									
Pt									
Sb									
Sc									
Se									
Sn									
Sr									
Ta									
Te									
V									
W									
Y									
Zn									
Zr									
Th									
U									

Map No.	290	291	292	293	294	295	296	297	29
Sample No.	TB3051	R530	R529	R528	R527	R527L	R526	R521	R52
		11	11	11	11	11	11	11	11
Fe %	2.6								
Mg %	1.3								
Ca %	.075								
Na %	.56								
K %	3.1								
Ti %	.10								
Mn	730								
Ag	L								
As	N								
Au	N								
B	N								
Ba	N								
Be	N								
Bi	N								
Cd	N								
Co	50								
Cr	90								
Cu	N								
Ga	20								
La	270								
Li	N								
Mo	30								
Nb	N								
Ni	30								
P	N								
Pb	N								
Pd	N								
Pt	N								
Sb	N								
Sc	60								
Se	N								
Sn	N								
Sr	20								
Ta	N								
Te	N								
V	90								
W	N								
Y	130								
Zn	10								
Zr	170								
Th	—								
U	—								

APPENDIX B - Table B-1

Pan concentrate analyses (ppm)

(Sample nos. followed by "B"
are sluice box concentrates)

L - Detected
N - Less than lowest detection limit
G - Greater than highest detection limit

- Not analyzed
i - interference

All analyses except U and Th by semi-quantitative emission spectrography.

Detection limits--Semi-quantitative emission spectrograph

Lowest detection limits (ppm)

Elements	Sample nos. prefixed by PR or OC1/	Sample nos. prefixed by CC, CR, CS2/
Ag	1	interference
As	1000	200
Au	50	20
B	5	200
Ba	1000	40
Be	1	10
Bi	20	800
Ce	20,000	--
Co	10	10
Cr	20	20
Cu	1	800
La	500	200
Mo	10	40
Nb	100	70
Ni	2	40
Pb	20	400
Pt	50	40
Sb	100	3000
Sn	20	300
Th	--	--
U	--	--
V	20	20
W	50	600
Y	100	200
Zn	200	500
Zr	200	--

1/Analyses by Mineral Industry Research Laboratory, University of Alaska.

2/Analyses by U.S. Bureau of Mines, Reno Metallurgy Research Center.

PAN CONCENTRATE SAMPLES HISTOGRAMS

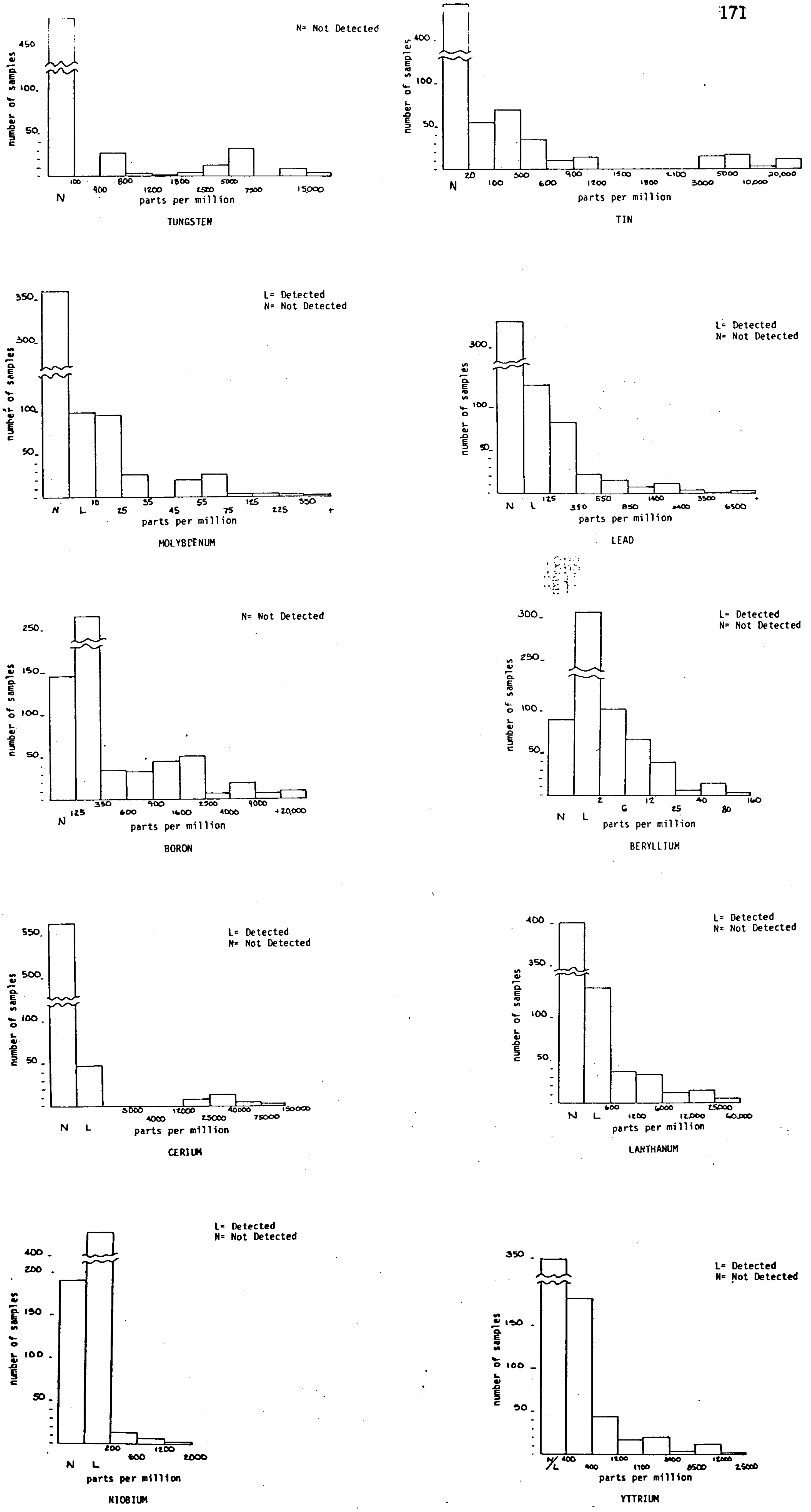

Figure B-1. - Histogram portrayal of concentrate sample results

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Map No.	1	2	3	4	5	6	7	8	9
Sample No.	OC 1994	OC1992	OC2246	CC 627	CC 628	CC2248	CC621	CC625	CC6
Ag	5	3	10	—	—	10	—	—	—
As	N	N	N	L	N	N	L	L	L
Au	N	N	N	N	N	N	N	N	N
B	700	1000	5000	5,000	10,000	2000	2000	1000	70
Ba	N	N	N	60	60	N	N	N	90
Be	5	5	15	10	30	10	10	30	10
Bi	150	100	L	L	N	L	L	L	L
Ce	30,000	100,000	N	—	—	N	—	—	—
Co	15	L	50	N	N	50	L	N	L
Cr	150	200	1500	N	N	200	N	N	N
Cu	150	150	300	N	N	150	L	L	N
La	50,000	50,000	15,000	10,000	20,000	700	60000	40000	600
Mo	N	N	30	N	L	N	L	L	L
Nb	L	L	L	L	L	L	L	L	N
Ni	100	50	1500	N	L	10	100	N	40
Pb	700	700	2,000	900	900	70	2000	1000	200
Pt	N	N	N	—	—	N	—	—	—
Sb	N	N	L	N	N	N	L	L	L
Sn	20,000	20,000	7000	3,000	20,000	5000	20000	10000	2200
Th	—	—	—	—	—	—	—	—	—
U	—	—	—	—	—	—	—	—	—
V	150	3000	300	200	100	300	N	N	N
W	7000	10,000	3000	1000	2000	N	G	2000	G
Y	1000	2000	2000	5000	9000	1500	20000	10000	1000
Zn	N	N	700	300	800	N	100	100	20
Zr	G	G	G	10000	4000	1000	8000	30000	1000

Map No.	10	11	12	13	14	15	16	17	1
Sample No.	CC630	CC629	OC2383B	OC2244B	OC2358B	OC2357B	CC93	OC2353	OC23
Ag	—	—	2	10	10	10	—	7	15
As	L	L	1500	N	N	N	L	N	N
Au	N	N	N	N	N	N	N	N	N
B	1000	400	1000	1000	2000	2000	8000	20,000	20,0
Ba	40	N	N	N	N	N	N	N	N
Be	N	10	15	20	10	5	N	10	20
Bi	L	L	150	150	150	L	N	N	L
Ce	—	—	G	G	50,000	50,000	—	N	30,0
Co	L	N	L	L	N	N	L	N	L
Cr	N	N	500	1000	1000	1000	N	1000	100
Cu	L	L	700	50	300	700	L	70	150
La	80000	60000	30,000	30,000	20,000	15,000	7000	1000	30,0
Mo	N	N	20	20	10	20	L	N	20
Nb	80	N	1000	1000	500	1000	L	L	L
Ni	100	L	200	1500	500	2000	N	150	70
Pb	2000	2000	2000	5000	2000	5000	1000	150	50
Pt	—	—	N	N	N	L	—	N	N
Sb	L	L	N	N	N	N	L	N	N
Sn	30000	7000	100,000	100,000	30,000	G	G	500	70
Th	—	—	34,000	33,000	11,000	10,000	—	—	—
U	—	—	1000	1000	800	1000	—	—	—
V	50	N	200	200	150	150	30	300	150
W	G	G	20,000	5000	3,000	3,000	3000	N	50
Y	30000	20000	15,000	30000	15,000	30,000	30000	3000	20,0
Zn	200	400	N	N	N	N	300	N	N
Zr	10000	7000	G	G	G	G	3000	G	G

Map No.	19	20	21	22	23	24	25	26	
Sample No.	CC2355	CC2360B	CC620	CC2359B	CC2053	CC2243	CC2223B	CC2221B	CC
Ag	7	20	—	5	10	5	15	L	—
As	N	3000	L	N	N	N	N	N	L
Au	N	N	L	N	N	N	N	N	N
B	20,000	5000	1000	2000	20,000	5000	5000	700	50
Ba	N	N	N	N	7	N	N	N	N
Be	15	20	30	15	N	10	10	15	20
Bi	N	150	L	150	N	N	L	L	L
Ce	N	N	—	50,000	N	N	50,000	70,000	—
Co	N	L	L	N	500	N	N	L	L
Cr	1500	1000	N	1000	20	200	1000	1000	N
Cu	100	500	L	300	2000	70	500	150	L
La	3000	2,000	40000	20,000	N	10,000	15,000	20,000	500
Mo	L	20	L	10	L	N	50	20	L
Nb	L	200	L	500	70	L	1000	500	L
Ni	300	200	L	300	150	150	1500	100	N
Pb	150	2000	2000	1000	N	150	2000	2000	200
Pt	N	N	—	N	N	N	L	N	—
Sb	N	N	L	N	N	N	N	N	L
Sn	1000	100,000	50,000	100,000	7000	100,000	G	G	100,0
Th	—	43,000	—	66,000	—	—	57,500	58,000	—
U	—	400	—	800	—	—	900	900	—
V	300	100	L	100	300	300	100	100	L
W	700	3000	G	5000	7000	20,000	10,000	5,000	G
Y	10,000	7000	G	20,000	N	N	30,000	20,000	120,0
Zn	N	1000	500	N	700	N	N	N	70
Zr	G	G	20000	G	G	G	G	G	800

Colora

Map No.	28	29	30	31	32	33	34	35	3
Sample No.	OC 24[illegible]	OC2620	OC2348	OC2376	OC2237	OC3254	OC2239	OC2241	OC
Ag	10	10	5	7	5	5	3	5	15
As	N	N	N	N	L	N	N	L	N
Au	N	N	N	N	N	N	N	N	N
B	20.000	5000	2000	10,000	5000	10,000	2000	2000	50
Ba	N	N	N	N	N	N	N	N	N
Be	70	15	15	15	20	15	7	70	5
Bi	L	N	100	N	150	N	N	150	50
Ce	N	N	30,000	L	50,000	N	L	30,000	30,0
Co	N	20	N	N	L	30	N	30	N
Cr	500	1500	500	150	500	2000	20	150	15
Cu	70	50	300	150	150	150	100	150	70
La	5000	1000	15,000	20,000	50,000	1500	15,000	20,000	20,0
Mo	N	L	10	N	N	N	L	70	30
Nb	L	L	200	L	L	L	L	L	L
Ni	70	200	150	10	70	700	10	N	N
Pb	1500	150	500	700	700	150	150	700	300
Pt	N	N	N	N	N	N	N	N	N
Sb	N	L	N	N	N	L	N	N	N
Sn	700	1000	10,000	5000	50,000	5000	10,000	15,000	20,0
Th	—	—	12,000	—	—	—	—	—	—
U	—	—	900	—	—	—	—	—	—
V	300	300	50	300	300	300	300	300	100
W	700	700	3000	7000	10,000	5000	7000	15,000	700
Y	10,000	1500	10,000	10,000	1500	N	N	N	N
Zn	N	700	N	N	N	N	N	N	N
Zr	G	G	G	G	G	N	G	G	G

Map No.	37	38	39	40	4	42	43	44	
Sample No.	CC61	CC68	CC2330	CC5	CC1123		CC7	3193	319
Ag	—	N	5	N	3		N	N	N
As	L	L	N	L	N		N	N	N
Au	N	N	N	N	N		N	N	N
B	7000	10000	10,000	10000	300		1000	70	15
Ba	100	N	1500	N	L		N	100	15
Be	20	30	15	20	3		N	3	5
Bi	L	L	N	L	N	Sample Lost	L	N	N
Ce	—	—	N	—	N		—	3000	300
Co	L	N	N	N	N		N	N	20
Cr	N	N	150	N	150		N	30	50
Cu	L	L	50	L	100		L	15	15
La	8000	N	700	1000	N		400	2000	15
Mo	L	N	N	L	N		N	15	N
Nb	L	L	L	L	N		L	30	20
Ni	N	N	50	L	10		N	7	15
Pb	800	900	300	L	300		L	200	30
Pt	—	N	N	N	N		N	N	N
Sb	L	N	N	L	N		N	N	N
Sn	N	N	150	2000	700		N	500	30
Th	—	—	—	—	—		—	700	50
U	—	—	—	—	—		—	—	—
V	200	N	150	N	100		N	100	15
W	2000	N	N	N	N		N	500	N
Y	10000	400	2000	3000	N		500	1500	30
Zn	200	200	N	600	N		60	N	N
Zr	10000	1000	G	1000	L		2000	500	200

Map No.	46	47	48	49	50	51	52	53	5
Sample No.	3194	CC2101	CC2103	CC2347	CC2000	CC89	CC2100	CC642	CC6
Ag	N	10	3	10	15	—	10	—	—
As	N	N	N	N	N	N	N	N	L
Au	N	N	N	N	N	N	N	N	L
B	700	2000	1500	700	300	5000	1500	900	100
Ba	500	L	N	1500	L	200	N	500	40
Be	15	50	30	7	5	20	5	N	N
Bi	N	N	N	N	L	N	L	N	L
Ce	10.000	50,000	20,000	N	N	—	N	—	—
Co	30	N	L	20	70	N	50	L	L
Cr	70	700	200	200	1500	N	500	N	N
Cu	20	100	70	150	700	L	150	L	N
La	5000	50,000	20,000	500	N	2000	N	3000	600
Mo	N	N	15	N	15	L	15	L	L
Nb	20	L	L	L	L	L	L	L	L
Ni	30	1500	15	150	300	L	150	L	L
Pb	300	700	700	70	20,000	N	150	600	200
Pt	N	N	N	N	N	—	N	—	—
Sb	N	N	N	N	N	L	N	L	L
Sn	20	5000	5000	200	700	L	700	7000	700
Th	1000	—	—	—	—	—	—	—	—
U	—	—	—	—	—	—	—	—	—
V	500	300	200	200	700	90	300	N	N
W	N	7000	3000	N	N	N	N	N	G
Y	500	L	N	N	N	4000	N	2000	200
Zn	N	N	N	N	3000	L	N	600	400
Zr	500	G	G	1000	N	3000	500	10000	700

Map No.	55	56	57	58	59	60	61	62	6
Sample No.	CC644	CC23	OC2312	CC10	CC12	CC14	3192	3182	PR9
Ag	—	—	15	—	—	—	15	N	L
As	L	L	N	N	L	L	N	N	N
Au	—	—	N	N	—	L	70	N	N
B	L	300	500	400	N	200	50	70	20
Ba	L	70	1500	200	300	200	700	1500	G
Be	N	N	10	N	N	N	2	2	3
Bi	L	N	L	N	L	L	N	N	10
Ce		—	N	—	—	—	N	N	N
Co	L	L	70	N	L	L	30	30	70
Cr	N	L	L	N	N	N	50	70	150
Cu	L	L	300	L	L	L	100	100	50
La	700	N	N	N	1000	200	N	70	N
Mo	N	N	N	N	N	N	N	N	20
Nb	L	L	L	L	N	L	N	N	L
Ni	L	L	150	L	L	L	70	30	30
Pb	L	L	2000	500	L	N	70	300	50
Pt	—	—	N	N	—	N	N	N	N
Sb	L	L	N	N	L	L	N	N	N
Sn	L	L	300	L	L	L	2000	N	20
Th	—	—	—	—	—	—	N	N	—
U	—	—	—	—	—	—	—	—	L
V	20	N	200	100	70	60	100	100	50
W	1000	N	N	N	N	N	L	N	N
Y	1000	200	N	200	300	100	20	30	50
Zn	500	800	1 00	900	700	700	N	N	100
Zr	4000	N	N	2000	500	900	150	150	G

Map No.	64	65	66	67	68	69	70	71	7
Sample No.	PR 1971	PR1973	PR1985	CC42	3202	CC49	CC55	3200	PR
Ag	3	5	10	—	N	—	—	N	1.5
As	N	N	N	L	N	L	L	N	N
Au	N	N	N	N	N	—	L	N	N
B	1500	500	1500	300	100	200	600	50	20
Ba	G	G	G	3000	2000	10000	1000	20,000	20
Be	30	20	100	N	3	N	N	2	10
Bi	N	L	N	L	N	N	L	N	N
Ce	N	N	N	—	N	—	—	N	N
Co	20	70	70	L	30	L	L	30	30
Cr	1000	700	1500	100	150	400	200	70	150
Cu	150	200	200	L	70	L	L	150	15
La	N	N	N	500	70	800	700	N	70
Mo	15	20	L	L	N	L	L	N	N
Nb	L	L	L	N	30	L	L	N	L
Ni	150	150	1500	N	50	L	N	70	15
Pb	1500	150	500	1000	150	3000	1000	150	20
Pt	N	N	N	—	N	—	—	N	N
Sb	N	N	N	N	N	L	N	N	N
Sn	500	300	N	L	N	L	L	N	50
Th	—	—	—	—	N	—	—	N	—
U	—	—	—	—	—	—	—	—	—
V	500	700	1000	200	150	500	60	100	100
W	N	N	N	N	N	L	N	N	N
Y	700	2000	3000	700	70	2000	800	20	500
Zn	1500	1500	3000	500	N	800	700	700	10
Zr	G	G	G	40,000	1000	60000	30000	150	G

Map No.	73	74	75	76	77	78	79	80	8
Sample No.	PR1895	3191	CC663	PR1882	PR1950	3179	PR1884	PR1875	CC1
Ag	5	N	N	5	2	N	3	2	10
As	N	N	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N	N	N
B	3000	N	N	150	100	300	1000	200	50
Ba	N	2000	N	G	N	1000	N	N	50
Be	70	N	N	L	1	3	3	1	2
Bi	N	N	L	L	N	N	50	N	L
Ce	N	N	—	N	N	500	N	N	N
Co	30	70	L	150	100	50	70	100	10
Cr	1000	500	900	1500	1500	700	1000	1500	20
Cu	150	30	L	300	150	30	300	100	15
La	5000	N	N	N	N	300	N	N	N
Mo	N	N	N	20	N	N	10	N	50
Nb	L	20	L	L	L	20	L	L	L
Ni	200	500	200	500	500	300	1000	300	30
Pb	N	N	N	N	N	30	150	N	15
Pt	N	N	N	N	N	N	N	N	N
Sb	N	N	L	N	L	N	N	L	L
Sn	5000	N	L	70	300	N	5000	70	L
Th	—	N	—	—	—	N	—	—	—
U	—	—	—	—	—	—	L	—	—
V	500	150	N	300	300	200	150	200	150
W	N	N	N	N	N	N	N	N	N
Y	3000	20	N	N	N	70	700	N	N
Zn	1500	N	100	N	700	N	700	N	15
Zr	G	150	L	300	200	200	1000	N	G

Map No.	82	83	84	85	86	87	88	89	90
Sample No.	CC1868	CC1885	CC667	PR1854	PR1852	PR1850	PR1847	PR1842	PR
Ag	10	3	—	10	5	5	2	3	5
As	N	N	L	N	N	N	N	L	N
Au	N	N	N	N	N	N	N	N	N
B	700	300	3000	50	150	300	150	200	200
Ba	G	G	200	L	N	L	5000	G	300
Be	N	N	10	L	L	L	L	N	50
Bi	L	L	L	N	L	L	N	L	N
Ce	N	N	—	N	N	N	N	N	N
Co	70	70	L	100	100	150	70	70	30
Cr	G	2000	2000	1500	1500	2000	1500	5000	150
Cu	150	100	L	150	70	150	100	150	100
La	N	700	20000	N	N	N	N	N	100
Mo	20	N	L	N	N	30	N	70	N
Nb	L	L	L	L	L	L	L	L	L
Ni	300	150	L	1500	1500	1500	300	200	200
Pb	300	150	L	N	N	N	N	N	N
Pt	N	N	—	N	N	N	N	N	N
Sb	3000	L	L	N	L	L	L	L	L
Sn	L	70	L	N	L	2	70	300	700
Th	—	—	—	—	—	—	—	—	—
U	—	—	—	—	—	—	—	—	—
V	1500	500	300	300	300	300	300	2000	300
W	N	N	G	N	N	N	N	N	N
Y	700	1000	8000	N	N	N	N	N	200
Zn	700	700	400	N	N	N	N	1000	300
Zr	G	G	30000	N	N	N	L	N	G

Map No.	91	92	93	94	95	96	97	98	9
Sample No.	PR1835	PR1832	T352	PR1927	VOID	CB3004	CB3003	CB3010	T34
Ag	5	2	—	5	No Sample taken	—	—	—	3
As	N	N	L	N		L	L	L	L
Au	N	N	N	N		N	N	—	L
B	300	150	500	1500		N	N	L	N
Ba	G	3000	6000	2000		70	50	L	900
Be	N	L	N	N		N	N	N	N
Bi	N	N	L	N		L	L	L	L
Ce	N	N	—	N		—	—	—	—
Co	70	N	L	50		L	L	L	N
Cr	1500	N	700	2000		300	500	N	30
Cu	150	70	L	70		L	L	L	L
La	1000	N	700	N		300	200	N	N
Mo	N	50	L	N		L	L	L	L
Nb	L	L	L	L		L	L	L	L
Ni	300	70	L	300		L	L	L	L
Pb	N	N	N	N		N	L	L	N
Pt	N	N	—	N		—	—	—	—
Sb	L	N	L	L		L	L	L	L
Sn	50	N	4000	150		L	L	L	L
Th	—	—	—	—		—	—	—	—
U	—	—	—	—		—	—	—	—
V	700	300	400	700		1000	2000	1000	30
W	N	N	1000	N		1000	2000	L	N
Y	700	N	600	700		N	80	L	N
Zn	N	1000	400	700		500	500	300	30
Zr	G	G	20000	G		200	400	L	L

Map No.	100	101	102	103	104	105	106	107	
Sample No.	CR 526	CR 530	CR 579	CR 541	CC 659	CC 2003	CC 2006	CC 657	CC
Ag	no analyses	no analysis	no analysis	no analysis	no analysis	no analysis	no analysis	—	—
As								L	N
Au								—	N
B								400	10
Ba								30000	N
Be								N	N
Bi								L	L
Ce								—	—
Co								L	L
Cr								2000	20
Cu								L	L
La								1000	30
Mo								L	L
Nb								L	L
Ni								L	L
Pb								L	N
Pt								—	—
Sb								L	L
Sn								L	30
Th								—	-
U								—	-
V								800	30
W								1000	100
Y								300	60
Zn								1000	10
Zr								9000	50

Map No.	109	110	111	112	113	114	115	116	1
Sample No.	CC 653	CC 647	OC 12502B	OC 12503	OC 12500	PR 12549	PR 12545	PR 12548	PR 11
Ag	—	—	L	L	30	7	5	7	3
As	L	L	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N	N	N
B	1000	2000	2000	2000	2000	2000	2000	2000	20
Ba	N	600	I	N	I	N	5000	N	I
Be	N	N	3	L	N	70	100	3	5
Bi	L	L	N	N	N	L	L	20	N
Ce	—	—	G	N	N	N	L	L	N
Co	L	N	N	N	150	70	300	L	N
Cr	2000	N	N	5000	G	700	1000	2000	30
Cu	L	L	150	30	70	70	100	200	15
La	6000	20000	1000	L	L	3000	3000	1500	15
Mo	L	L	L	L	L	L	L	L	L
Nb	L	L	N	N	N	N	N	N	N
Ni	70	L	L	150	150	150	300	30	L
Pb	L	1000	L	N	N	—	—	—	10
Pt	—	—	N	N	N	N	N	N	N
Sb	L	L	I	I	1000	N	N	N	I
Sn	3000	60000	7000	2000	2000	2000	2000	7000	100
Th	—	—	—	—	—	—	—	—	—
U	—	—	—	—	—	—	—	—	—
V	200	N	2000	3000	1500	1000	1500	1500	150
W	1000	3000	2000	N	N	N	N	3000	N
Y	3000	10000	G	1500	1000	G	G	G	G
Zn	200	500	N	N	L	N	N	N	N
Zr	10000	4000	G	G	G	G	G	G	G

Map No.	118	119	120	121	122	123	124	125	
Sample No.	PR 8181	PR 8182	PR 12482	PR 11378	PR 12516	PR 12518	OC 12492	OC 12166	OC
Ag	L	30	10	5	N	2	L	7	
As	N	N	N	N	N	N	N	N	
Au	N	N	N	N	N	N	N	N	
B	1500	2000	100	10	N	15	2000	2000	1
Ba	I	I	3000	G	N	G	I	N	
Be	15	N	N	1·5	1.5	N	70	30	
Bi	N	N	L	L	L	N	N	N	
Ce	N	N	L	N	N	N	N	L	
Co	L	L	L	150	300	300	N	N	
Cr	L	G	1000	1000	300	300	N	700	
Cu	50	150	150	70	70	150	70	100	
La	1500	L	3000	L	2000	5000	L	500	30
Mo	L	L	L	L	L	L	L	L	L
Nb	N	N	N	N	N	N	N	300	15
Ni	L	L	30	2	L	L	L	150	1
Pb	L	50	–	–	–	–	700	200	–
Pt	N	N	N	N	N	N	N	N	N
Sb	I	I	N	N	N	N	N	N	N
Sn	500	2000	700	300	N	N	2000	5000	20
Th	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
V	700	1500	G	1000	1000	700	1500	3000	15
W	N	N	N	N	N	N	N	7000	50
Y	L	G	1000	L	700	200	2000	G	G
Zn	N	N	N	N	N	N	N	L	N
Zr	G	G	G	G	G	G	G	G	G

Map No.	127	128	129	130	131	132	133	134
Sample No.	OC 8492	OC 12488	OC 11384	OC 11382	OC 8604	OC 8484	OC 12276	OC 117358
Ag	7	15	10	3	7	30	50	30
As	N	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N	N
B	2000	2000	2000	2000	2000	2000	1500	2000
Ba	L	I	G	G	N	2000	N	I
Be	7	L	15	20	5	L	30	200
Bi	500	100	L	50	20	N	L	N
Ce	N	G	G	G	G	G	L	L
Co	700	N	L	500	300	N	N	L
Cr	L	L	700	L	150	1500	2000	G
Cu	100	150	150	70	100	300	70	150
La	5000	N	5000	3000	5000	1000	1500	L
Mo	N	L	L	N	N	N	L	300
Nb	N	1000	N	N	N	N	700	N
Ni	N	N	N	N	N	7	N	3
Pb	L	7000	1500	700	100	100	1500	2000
Pt	N	N	N	N	N	N	N	N
Sb	N	N	N	N	N	N	N	N
Sn	7000	100,000	15,000	7000	10000	G	2000	50000
Th	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–
V	1000	1500	3000	150	1000	3000	1500	5000
W	3000	10,000	700	300	1500	3000	L	N
Y	G	G	G	G	G	G	G	G
Zn	L	N	L	N	N	15	L	L
Zr	G	G	G	G	G	G	G	G

Map No.	136	137	138	139	140	141	142	143	1
Sample No.	OC12223	OC8438	OC8440	OC12236	OC12241B	OC12238	bC12234B	OC8452	O
Ag	30	15	7	7	50	70	70	15	3
As	N	N	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N	N	N
B	5000	2000	2000	1500	2000	2000	5000	1000	20
Ba	N	G	1000	N	N	I	N	N	L
Be	L	15	7	700	300	70	L	L	7
Bi	50	N	500	30	L	L	G	N	L
Ce	G	L	G	G	G	G	G	L	G
Co	N	N	N	N	N	N	G	N	N
Cr	5000	L	L	L	L	2000	1000	1000	500
Cu	150	70	200	150	150	70	150	150	15
La	5000	3000	10000	L	L	10000	G	3000	30
Mo	L	N	N	L	L	300	L	N	L
Nb	N	N	N	2000	2000	N	N	N	N
Ni	L	N	N	N	N	L	150	3	N
Pb	1500	300	7000	3000	7000	7000	3000	L	20
Pt	N	N	N	N	N	N	N	N	N
Sb	N	N	N	N	500	N	N	N	N
Sn	100000	2000	50000	70000	G	70000	100000	2000	200
Th	—	—	—	—	—	—	—	—	—
U	—	—	—	—	—	—	—	—	—
V	3000	1500	3000	10000	G	1500	G	1500	30
W	3000	N	1500	2000	10000	1000	3000	N	150
Y	G	G	G	G	G	G	G	2000	G
Zn	N	N	N	N	L	L	L	L	L
Zr	G	G	G	G	G	G	G	G	G

Map No.	145	146	147	148	149	150			
Sample No.	PR 11330	PR11328	OC 10992	OC 12266	PR 11394	PR 11374			
Ag	100	15	3	30	5	30			
As	N	N	N	N	N	N			
Au	N	N	N	N	N	N			
B	150	200	1500	700	150	2000			
Ba	G	G	G	N	I	G			
Be	15	7	7	15	2	N			
Bi	N	N	50	L	N	N			
Ce	N	N	L	N	N	N			
Co	150	30	300	N	N	100			
Cr	5000	5000	100	5000	N	L			
Cu	200	70	150	1500	30	200			
La	L	L	5000	1000	L	L			
Mo	200	L	L	L	L	70			
Nb	N	N	N	N	N	700			
Ni	500	50	N	15	L	150			
Pb	N	N	500	L	N	50			
Pt	N	N	N	N	N	N			
Sb	N	I	N	N	I	I			
Sn	200	N	5000	2000	500	2000			
Th	—	—	—	—	—	—			
U	—	—	—	—	—	—			
V	1500	1500	300	1500	L	3000			
W	N	N	300	2000	N	N			
Y	L	2000	G	150	L	G			
Zn	7000	5000	N	20	N	7000			
Zr	1000	700	G	G	N	G			