Division of Geological & Geophysical Surveys

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ESTIMATED MINERAL POTENTIAL OF LANDS AVAILABLE FOR STATE SELECTION 1991-1993

by

DGGS Staff

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INTRODUCTION

BACKGROUND

As a result of the 1959 Alaska Statehood Act, the State of Alaska gained selection rights to 104.6 million acres of land from the U.S. Government, nearly 28 percent of the total land area of Alaska. Congress made available this land grant to provide an area for community development and to foster future economic and resource development that would make the future state independent of federal support assistance. The Statehood Act confirmed four territorial land grants totaling about 1.22 million acres, leaving 102.6 million acres of general grant lands and 800,000 acres of community grant lands available for selection.

The 1959 legislation mandated that the state should select the general grant lands within 25 years, by 1984. The 1971 Alaska Native Claims Settlement Act (ANCSA) and the 1980 Alaska National Interest Conservation Act (ANILCA) froze Alaska's selection rights to previously open federal lands. However, ANILCA granted a ten-year extension for the state to complete its land selection by January 1, 1994. So far, Alaska has received title to about 85 million acres, leaving about 20 million acres of land to be acquired. The final deadline for the State of Alaska to file for its remaining lands under the Statehood Act is January 3, 1994.

LAND SELECTION ASSIGNMENTS

The Department of Natural Resources Divisions were directed by former Commissioner Harold Heinze to establish a selection team to review remaining federal lands that are eligible for state selection and to finalize state selections by the 1994 deadline. The team consists of the Divisions of Land, Water, Oil and Gas, Forestry, Mining, Geological & Geophysical Surveys, Parks and Outdoor Recreation, the State Pipeline Coordinators Office (SPCO), the Departments of Fish and Game, Transportation and Public Facilities, Commerce and Economic Development, Community and Regional Affairs, and the Alaska Energy Authority.

The Division of Geological & Geophysical Surveys (DGGS) was assigned the task of evaluating the eligible federal lands for mineral and energy potential and providing SPCO with geotechnical information for potential transportation corridors.

AREAS AVAILABLE FOR SELECTION

The selection team reviewed approximately 52 million acres of federal public domain land managed by the U.S. Bureau of Land Management. The federal lands available for selection have been subdivided into 35 separate evaluation units on the basis of legal and geographic characteristics (fig. 1). The largest blocks of land are found in the western and southwestern parts of the state. The mineral characteristics of the 35 units are summarized in this report. The units are numbered 1 through 36, but number 25, the National Petroleum Reserve Alaska (NPRA) is not available to land selection and, therefore, was not assigned.

MINERAL ASSESSMENT METHODOLOGY

Mineral resource assessment was a key element in the land selection project. Separate phases of the mineral assessment program are shown in figure 2. The first phase of the evaluation process involves a compilation of previously published geologic, geochemical, and geophysical information for each evaluation unit. The most comprehensive source of broad, regional geologic data has been the U.S. Geological Surveys Alaska Mineral Resource Assessment Program (AMRAP), which provides regional geological mapping and geochemical, geophysical, and radiometric age-dating coverage for about 30 percent of the land selection areas. Other important data sources are the U.S. Department of Energy National Uranium Resource Evaluation (NURE) project, which provides regional geochemical and geophysical coverage for many of the land tracts, and the U.S. Bureau of Mines computerized Mineral Availability System (MAS) data file. Detailed geological and mineral deposit studies conducted by DGGS in southeastern Alaska, in south-central Alaska, on the Seward Peninsula, in southwestern Alaska, and along the pipeline corridor cover portions of six land selection areas. These studies are valuable sources of detailed mineral endowment information.

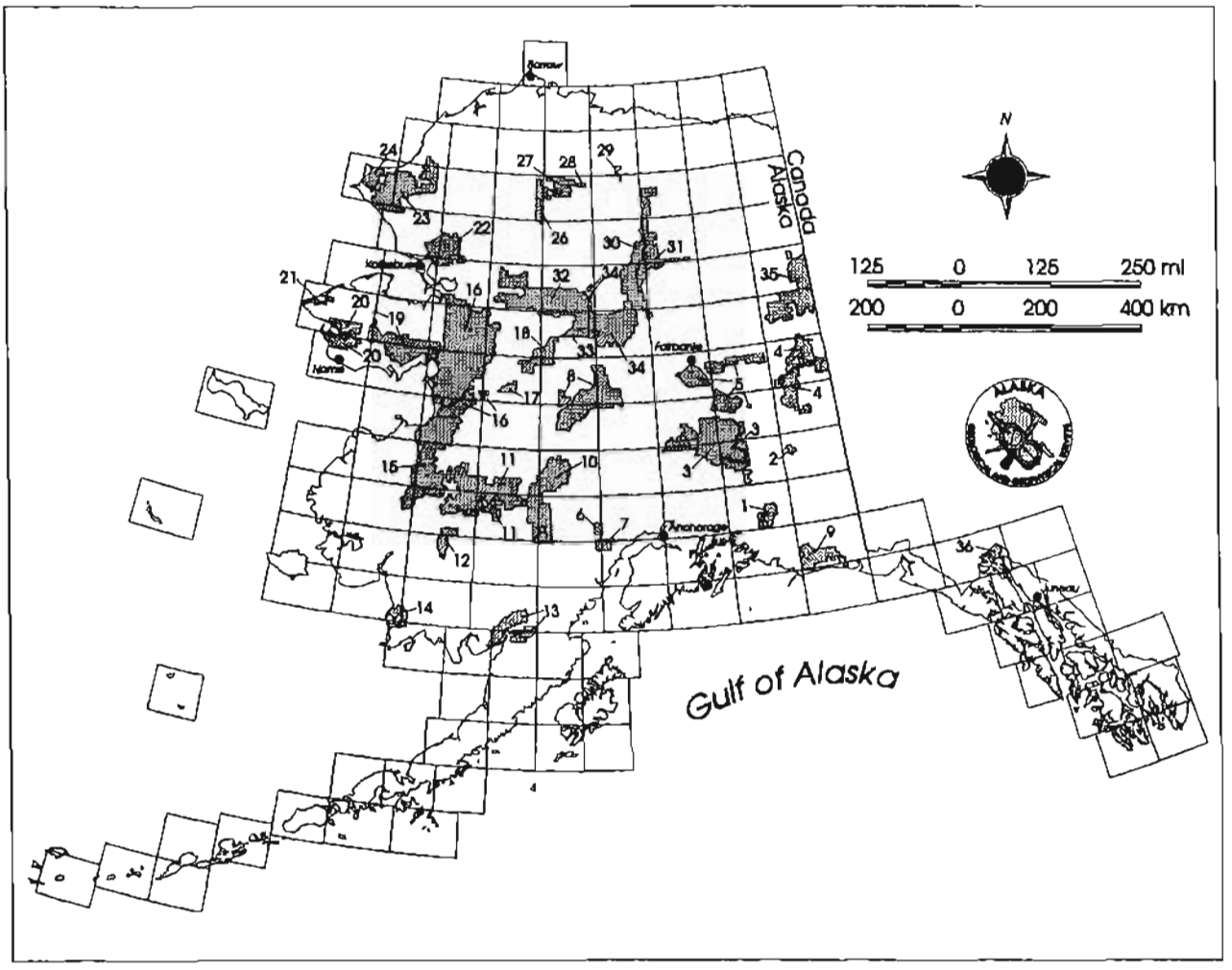


Figure 1. *Index map showing evaluation units assessed for mineral potential during final land selection process.*

Claim information is coordinated through the Alaska Division of Mining and the U.S. Bureau of Mines; a computerized, section-level map of Alaska showing current and most historical claim activity was produced on the DGGS computer system in Fairbanks for the endowment analysis.

Data for geothermal resources, construction materials, and coal were derived mainly from USGS and DGGS geological reports and the Department of Transportation and Public Facilities file reports.

The most critical problem facing the project was the lack of quality information for many selection units in the state, particularly for the large tracts in remote western and northern Alaska where only brief reconnaissance geological surveys have been conducted. We estimate that only about seven percent of Alaska has been geologically mapped at a scale of 1:63,360 or better—an obvious shortcoming for a project like this.

Field work began in 1991 and continued through 1992. Because of the time constraints and the enormous scope of the project, our field investigations concentrated on acquiring data to outline permissive mineral terranes and to define mineral deposit types that occur in each land selection unit. This task proved difficult in areas where little previous geological information was available. However, progress was made in delineating mineral terrane and mineral deposit trends in virtually all land selection areas examined.

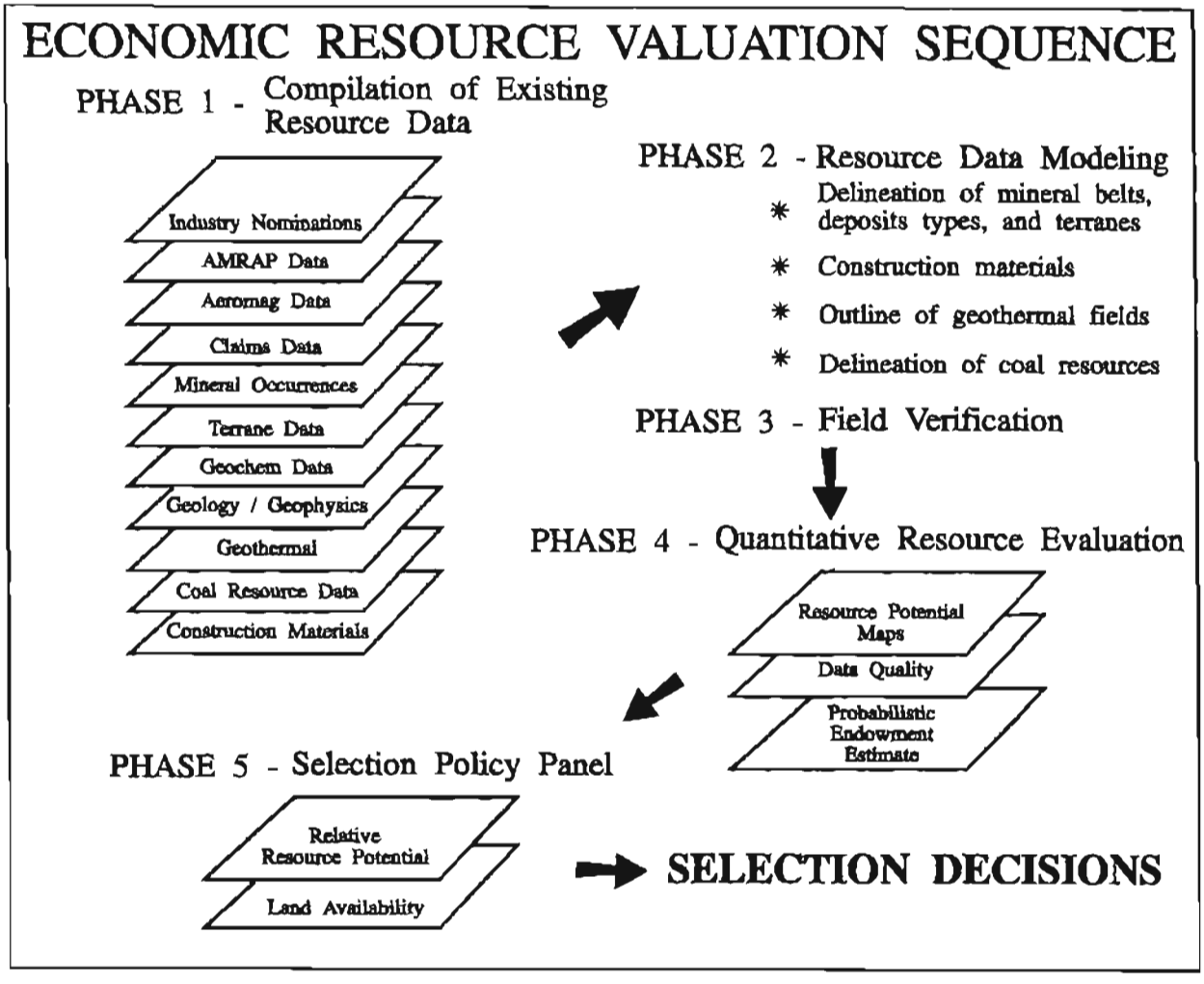


Figure 2. *Methodology used in assessing lands available for state selection.*

PERSONNEL

Most of the DGGS staff were on special assignment to the Land Selection Project during 1991 and 1992. The tasks outlined above occupied about 90 percent of the division effort during that period. The project leaders responsible for each of the evaluation units were:

Unit 1	L.E. Burns	Unit 13	T.K. Bundtzen	Unit 25	NPRA - Not assigned
Unit 2	M.A. Wiltse	Unit 14	L.E. Burns	Unit 26	C.G. Mull
Unit 3	K.H. Clautice	Unit 15	T.K. Bundtzen	Unit 27	C.G. Mull
Unit 4	M.S. Robinson	Unit 16	D.N. Solie	Unit 28	C.G. Mull
Unit 5	L.E. Burns/K.H. Clautice	Unit 17	D.N. Solie	Unit 29	R.R. Reifenstuhl
Unit 6	D.N. Solie	Unit 18	D.N. Solie	Unit 30	L.E. Burns/R.R. Reifenstuhl
Unit 7	D.N. Solie	Unit 19	T.K. Bundtzen	Unit 31	K.H. Clautice
Unit 8	K.H. Clautice	Unit 20	T.K. Bundtzen	Unit 32	S.A. Liss
Unit 9	C.G. Mull	Unit 21	T.K. Bundtzen	Unit 33	D.N. Solie
Unit 10	T.K. Bundtzen	Unit 22	J.G. Clough/M.A. Wiltse	Unit 34	D.N. Solie
Unit 11	T.K. Bundtzen	Unit 23	C.G. Mull	Unit 35	J.G. Clough
Unit 12	T.K. Bundtzen	Unit 24	C.G. Mull	Unit 36	L.E. Burns

J.G. Clough provided coal resource evaluations for all units.

PRIVATE SECTOR INPUT

During the early phases of the project, DGGS sent 124 land-selection mineral questionnaire packets to mining companies, consultants, and Native regional corporations to solicit direct input into the state land selection process. The Alaska Miners Association (AMA) assisted us in formulating the mailing lists and information request. The Division of Mining provided additional land-status information. The packets contained a Series E Alaska Land Status Map (scale 1:2,500,000) showing color-coded land status information. The mineral questionnaire asked for nonconfidential land nominations, mineral deposit type or terrane information, identification of specific mineral commodities in each nominated tract, a relative mineral-potential ranking, and any other comments that might help the state select valuable mineral lands.

As the work progressed, numerous mining companies, consultants and Native corporations provided information on mineralized areas, suggested priorities for access, and helped clarify land status questions in key areas. This information was used along with mineral information from other sources to outline tracts favorable for various deposit models in the evaluation units.

MINERAL DEPOSIT TYPES AND MODELS

The various metallic commodities such as copper, gold, and lead occur in nature within a wide variety of mineral deposit types or models. Most of the deposit types have specific, often unique, geological environments in which they occur and which are recognized worldwide. Moreover, many of the better-known deposit types have a predictable range of size, grade, and associated suite of commodities; the grade-tonnage characteristics of these deposit types form the basis of probabilistic endowment forecasts. In essence, the task of predicting potential for undiscovered mineral resources includes (1) defining the geological environments, (2) predicting which deposit types may occur there, and (3) comparing the likelihood of their in-place endowment or value with similar well-known deposits throughout the world. The last step is accomplished by a computer simulation model. In a few of the evaluation units, published values of estimated resources were used to determine mineral endowment.

The mineral deposit types or models used in the land selection project are listed below. Abbreviated deposit names are used in the tables and maps that follow.

Basalt-hosted copper
Besshi massive sulfide
Copper-silver skarns
Gold-copper skarns
Granite uranium rare-earth
Granitic disseminated gold
Granitic gold veins
Granitic tin greisens
Granitic uranium vein
Hot spring mercury
Iron-gold-copper skarns
Iron-titanium lodes
Iron-titanium alluvial placers
Limestone-hosted lead-zinc
Nickel-copper-cobalt magmatic sulfide
Metamorphic gold veins
Lead-zinc skarns
Buried channel placer gold
Alluvial placer gold-platinum
Platinum group element mafic
Podiform chromite
Polymetallic massive sulfide
Polymetallic veins
Porphyry copper-molybdenum
Porphyry molybdenum
Rift related polymetal massive sulfide
Sedimentary barite
Sediment epithermal gold
Sediment-hosted uranium
Sediment-hosted lead zinc
Sediment-basaltic-hosted copper
Tin skarns
Tin placers
Titanium-iron-rare-earth-beach placer
Tungsten-gold skarns
Volcanic gold silver
Volcanogenic uranium

Some Alaskan examples of the deposit types include (1) granitic disseminated gold at Fort Knox, Fairbanks, (2) iron-titanium placers at Klukwan, (3) granitic tin greisens at Kougarek, Seward Peninsula, (4) buried channel

placer gold at Valdez Creek, (5) sediment-hosted lead-zinc at Red Dog, (6) metamorphic gold veins at the A-J Mine, Juneau.

Pertinent deposit models and the statistical forecast of their contained metal are included in the description of each evaluation unit in this report.

COAL RESOURCE POTENTIAL

Coal resources in land selection units were evaluated and categorized as having high or moderate or low potential for containing minable coal. Areas evaluated for coal potential are referred to in this report as tracts, and discussed individually under each evaluation unit with coal potential. Criteria used to assign high and moderate coal resource potential to tracts are based on the established methods of the U.S. Geological Survey.

Land tracts with high potential for minable coal include the U.S. Geological Survey *identified* and *hypothetical* coal resource classes which are summarized as:

Identified coal resources—estimated more than 90 percent chance of locating minable coal resources. Resources of minable coal are known or almost certain based on drilling, detailed mapping, field observations, and/or outcrop measurements. Identified coal resources are: less than 6,000 ft deep; less than 3 mi from a coal-bearing outcrop or drill hole; anthracite and/or bituminous coal in bed(s) greater than 14 in. thick; and/or subbituminous coal and lignite in bed(s) greater than 30 in. thick.

Hypothetical coal resources—estimated 70-90 percent chance of containing locatable minable coal based on the conservative projection of the continuity of coal-bearing rocks units. Hypothetical coal resources are: less than 6,000 ft deep; greater than 3 mi from a coal-bearing outcrop or drill hole; anthracite and/or bituminous coal in bed(s) greater than 14 in. thick; and/or subbituminous coal and lignite in bed(s) greater than 30 in. thick.

Land tracts assigned a moderate potential for coal resources have an estimated 30-70 percent chance of containing minable deposits of coal. The estimated likelihood is based on the reasonable inference of the continuity of coal-bearing rock units from surrounding areas. Tracts evaluated as moderate in coal potential may include distal hypothetical coal resources (much greater than 3 mi from a coal-bearing outcrop or drill hole) or considerable coal deposits at depths greater than 6,000 ft that may be utilized by future technology.

Tracts were assigned a low potential for having minable coal resources based on the presence of nonmarine sedimentary rocks similar to rocks known to contain coal outside this sedimentary basin.

PROBABILISTIC MODELING

DGGS used probabilistic modeling to estimate mineral endowment in the eligible federal land areas. The DGGS endowment model (which was originally developed with the U.S. Bureau of Mines) is known as ROCKVAL and is one of several such models used by economic geologists at this time. The U.S. Geological Survey independently developed its own probabilistic mineral endowment model, which was used in the evaluation of mineral potential for the Tongass Timber Reform Act and earlier in an evaluation of tin resources of the Seward Peninsula. It should be emphasized that the mineral endowment estimates do not determine economic viability of the mineral resources, but instead define a range of likely tonnages and grades of ore for comparisons between tracts of land.

The strength or weakness of the probabilistic method depends on how well understood the mineral deposit types or mineral terranes are in a given area. To aid in deposit classification, DGGS used new discriminant models developed from worldwide deposits. These models estimate the favorability of gold- or tin-bearing plutonic rocks. When sufficient data is available about the potential mineral deposit types, the deposit and its host terrane is compared with other similar areas worldwide. Assignment of deposits and terranes to specific classifications permits comparisons of size, grade, and overall quality with thousands of ore deposits. The computer simulation provides a range of sizes and grades (mineral endowment) of each deposit or terrane in the land tract is evaluated.

When data is not sufficient the deposit model, the possible ranges for the size, grade, and overall quality are broader because less is known about the tract to be evaluated. Cases where the reserves are estimated by drilling or techniques other than probabilistic modeling are noted as such in the tables.

The actual ROCKVAL model uses a Monte Carlo probabilistic simulation that picks grades and tonnages from typical worldwide deposits, both large and small, and processes them one thousand times in an attempt to estimate what mineral endowment is most likely within the area. The 95th, 50th, and 5th probability levels shown on endowment tables in this report are what is inferred to be there 95, 50, and 5 percent of the time. The moderate and high mineral potential are based on (1) the particular type of mineral deposit that might be present (as some types of mineral deposits tend to be worth more than others), and (2) the likelihood that the particular type of mineral deposit is actually present in the area. Lastly, in using the endowment tables, the size of the area is an important consideration, as a large estimated mineral endowment from a large land area may not be as prospective as a smaller mineral endowment from a small land area.

AVAILABILITY OF DATA

Mineral, energy, and construction material synopses of candidate lands will be provided to the land selection steering committee. Information used to arrive at the play boundaries, deposit types, and mineral endowment estimates in this executive summary will ultimately be released as a set of DGGS Public-Data File reports and made available to the general public. It is anticipated these reports will be available for purchase in late 1993. Inquires may be made to:

Department of Natural Resources
Division of Geological & Geophysical Surveys
794 University Avenue, Suite 200
Fairbanks, Alaska 99709-3645
(907) 474-7147

UNIT 1 - TIEKEL

GEOLOGIC SUMMARY

Unit 1 encompasses 423,000 acres in the central part of the Valdez Quadrangle. The area is composed of three major geologic formations which are, from north to south, the Tonsina ultramafic/mafic complex, the McHugh Complex, and the Valdez Group. The ultramafic/mafic complex is composed of the rock types harzburgite, dunite, websterite, and gabbronorite, and has been interpreted as part of an ancient island arc ophiolite and associated underlying mantle rocks. The island arc rocks are Jurassic in age and are high pressure in origin. The McHugh Complex is a melange or mixed rock package which contains blocks of marble, chert, and pillow lavas in a highly deformed matrix of argillite, graywacke, and tuff. The McHugh Complex ranges in age from Jurassic to Cretaceous and is weakly metamorphosed to the prehnite-pumpellyite facies. The Valdez Group, dominantly Cretaceous in age, is a thick sequence of phyllite, slate, and argillite which is interpreted to have formed in a fore-arc region. The Valdez Group is metamorphosed to the lower greenschist facies. Felsite dikes and small plutons of Eocene age intrude all the units.

Gold-bearing quartz veins are abundant in the Valdez Group and are present, but less abundant, in the McHugh Complex. Two of the prospects within Unit 1 have had minor lode-gold production. About 137,700 oz of gold have been produced from quartz veins in Valdez Group rock in the Prince William Sound area. Some of the quartz veins appear to be genetically associated with the felsite dikes, but the majority are probably formed by metamorphic processes.

No significant gold placer production is known to have occurred within the area. Data suggest that gold placers are widespread in the Valdez Group, but are small and contain very fine gold. The chance for discovery of major new gold placers is considered to be low in this area.

Besshi volcanogenic massive sulfide deposits (VMS) are also potentially present in Unit 1. Copper-bearing deposits of volcanogenic or sedimentary origin and one former mine (the Midas mine) are present in the Valdez Group to the south and southwest of Unit 1; except for the Midas mine, the deposits appear to be large tonnage, low grade prospects. There is little likelihood that a VMS deposit of this type could be present in the Valdez Group within Unit 1.

Platinum group element and chromite deposits are potentially present in the ultramafic and mafic rocks in the northwestern corner of Unit 1. Analyses indicating anomalous levels of platinum and palladium have been produced by two independent studies.

MINERAL DEPOSIT TYPES - UNIT 1

The mineral deposit models chosen to estimate the mineral endowment of Unit 1 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 1-1 through 1-6. The location of the plays and their probabilistic endowment estimates are shown in the map for Unit 1 and table 1.

(1) Metamorphic gold veins: There is moderate mineral potential in plays 1-1 and 1-2.
(2) Podiform chromite: There is moderate mineral potential in play 1-3.
(3) Platinum group elements: There is high mineral potential in play 1-4.
(4) Besshi massive sulfide: There is moderate mineral potential in play 1-5.
(5) Gold placer: There is moderate mineral potential in play 1-6.

Table 1. *Deposit types and estimated mineral endowment of Unit I, Tiekel area*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

METAMORPHIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 1-1	Very large area			
Ore	0.01 million tons	0.25 million tons	1.2 million tons	Moderate
Gold	3 thousand oz	72 thousand oz	360 thousand oz	
Silver	0 thousand oz	2 thousand oz	38 thousand oz	
PLAY 1-2	Large area			
Ore	0	0.11 million tons	0.88 million tons	Moderate
Gold	0	30 thousand oz	250 thousand oz	
Silver	0	0 thousand oz	20 thousand oz	

PODIFORM CHROMITE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 1-3	Small area			
Ore	0	0	0.26 million tons	Moderate
Chromite	0	0	110 thousand tons	

PLATINUM GROUP ELEMENTS

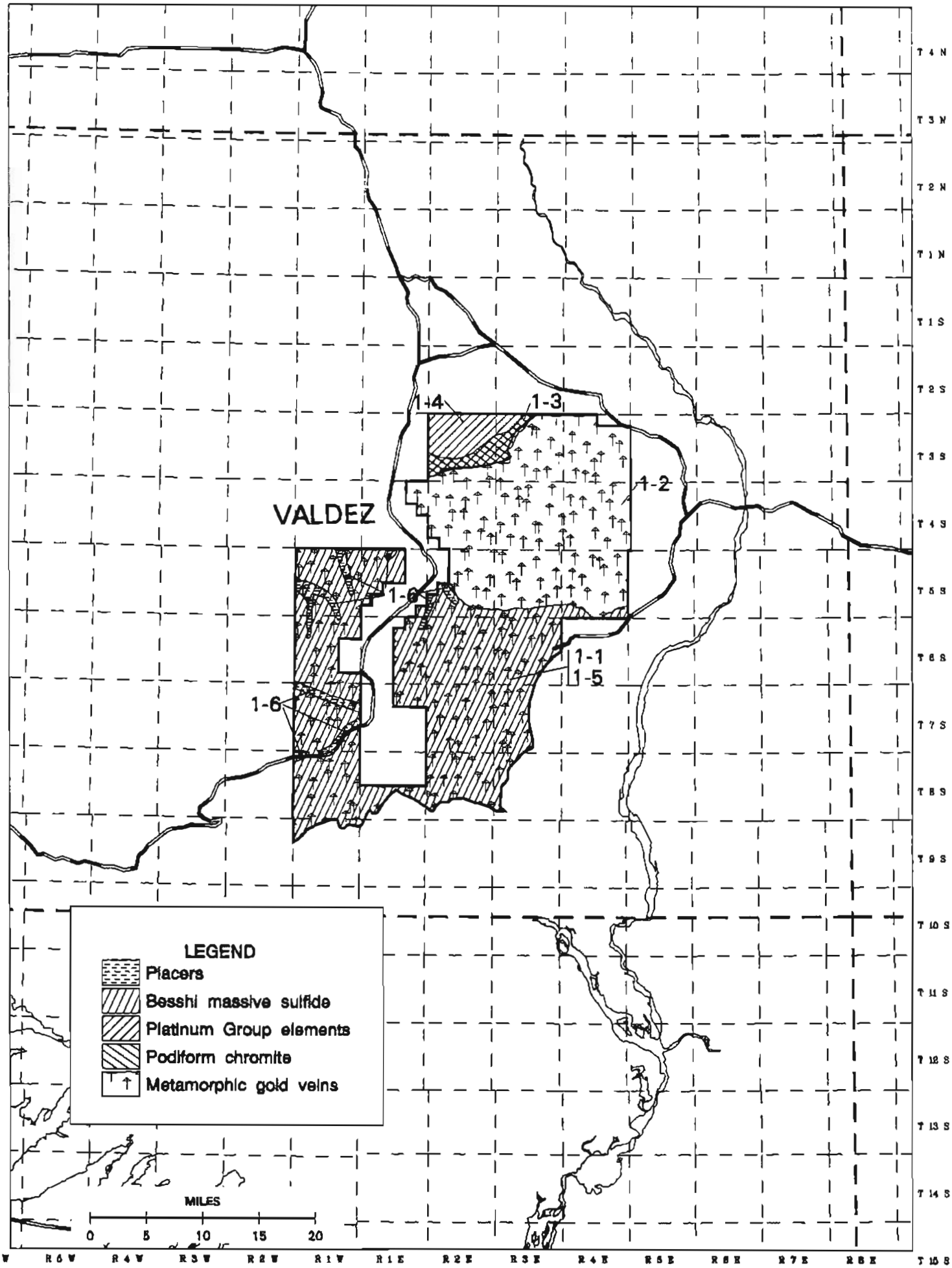
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 1-4	Small area			
Ore	0	0.19 million tons	33 million tons	High
Platinum	0	1 thousand oz	340 thousand oz	
Palladium	0	1 thousand oz	580 thousand oz	

BESSHI MASSIVE SULFIDE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 1-5	Very large area			
Ore	0	0	11 million tons	Moderate
Zinc	0	0	46 thousand tons	
Copper	0	0	190 thousand tons	
Silver	0	0	2,000 thousand oz	
Gold	0	0	150 thousand oz	
Cobalt	0	0	7,700 tons	

GOLD PLACERS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 1-6	Small area			
Ore	0	0	1.2 million tons	Moderate
Gold	0	0	16 thousand oz	
Silver	0	0	0 thousand oz	



Unit 1, Tiekel Unit

UNIT 2 - MENTASTA MOUNTAINS

GEOLOGIC SUMMARY

Unit 2 encompasses 88,000 acres in the northwestern corner of Nabesna Quadrangle. The most predominant bedrock is the Pennsylvanian to Permian (300 million years old) Tetelna volcanic rock unit, which consists of interbedded mafic to intermediate volcanic flows, debris avalanches, tuffs, and other volcanoclastic rocks. These are structurally and stratigraphically juxtaposed against overlying Permian (280-245 million years old) volcanoclastic siltstones, tuffs, breccias, and bioclastic limestones of the Mankomen Formation. A small wedge of Triassic limestone is the youngest of the exposed sedimentary rocks. The stratified rocks are extensively faulted, and intruded by two distinct plutonic igneous suites. The oldest of these, biotite-hornblende syenite-monzonite gneiss, shows little indication of associated metallic mineralization. The younger intrusive series (105-117 million years old) of heterogeneous plutons, varying in composition from mafic diorite to hornblende granodiorite and biotite quartz monzonite, is spatially associated with gold and base-metal geochemical anomalies. Rock samples collected during the land selection survey confirm the presence of low-grade bedrock gold mineralization. A small mafic biotite-hornblende pyroxene diorite in contact with the Triassic limestone has formed a weak skarn zone in the limestone. The entire region encompassing Unit 2 was subjected to alpine glaciation during Wisconsin time (9,600–25,000 years ago). Such glaciation usually scours and disperses placer deposits, however, parts of Unit 2 are thought to have a limited gold placer potential.

Gold and copper anomalies are associated with the diorite and quartz-diorite rocks near and in Unit 2; copper is widely dispersed in the diorites as chalcopyrite associated with pyrite. Extensive hydrothermal alteration in bedrock and polymetallic anomalies in stream sediments are present in some drainages of Unit 2. Visible gold has not been reported; no concentrations of secondary quartz veining were seen during the land selection work, although our reconnaissance traverses were very limited. Previous workers have hypothesized the presence of such veining at higher levels prior to erosion. While previous workers have suggested that gold anomalies are spatially associated with anomalous copper in the diorite complex, we note that gold anomalies in rock samples from the Suslota pluton are closely correlated with a positive magnetic anomaly. This association suggests that gold in the Suslota skarn may be dispersed in magnetite as ultrafine grains and thus may not be readily amenable to extraction by modern mining and milling technology.

MINERAL DEPOSIT TYPES - UNIT 2

The mineral deposit models chosen to estimate the mineral endowment of Unit 2 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 2-1 through 2-4. The location of the plays and their probabilistic endowment estimates are shown in the map for Unit 2 and table 2.

(1) Polymetallic veins: There is moderate mineral potential in plays 2-1 and 2-2.
(2) Gold-copper skarns: There is moderate mineral potential in play 2-3.
(3) Gold placers: There is moderate mineral potential in play 2-4.

Table 2. *Deposit types and estimated mineral endowment of Unit 2, Mentasta Mountains*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

POLYMETALLIC VEINS

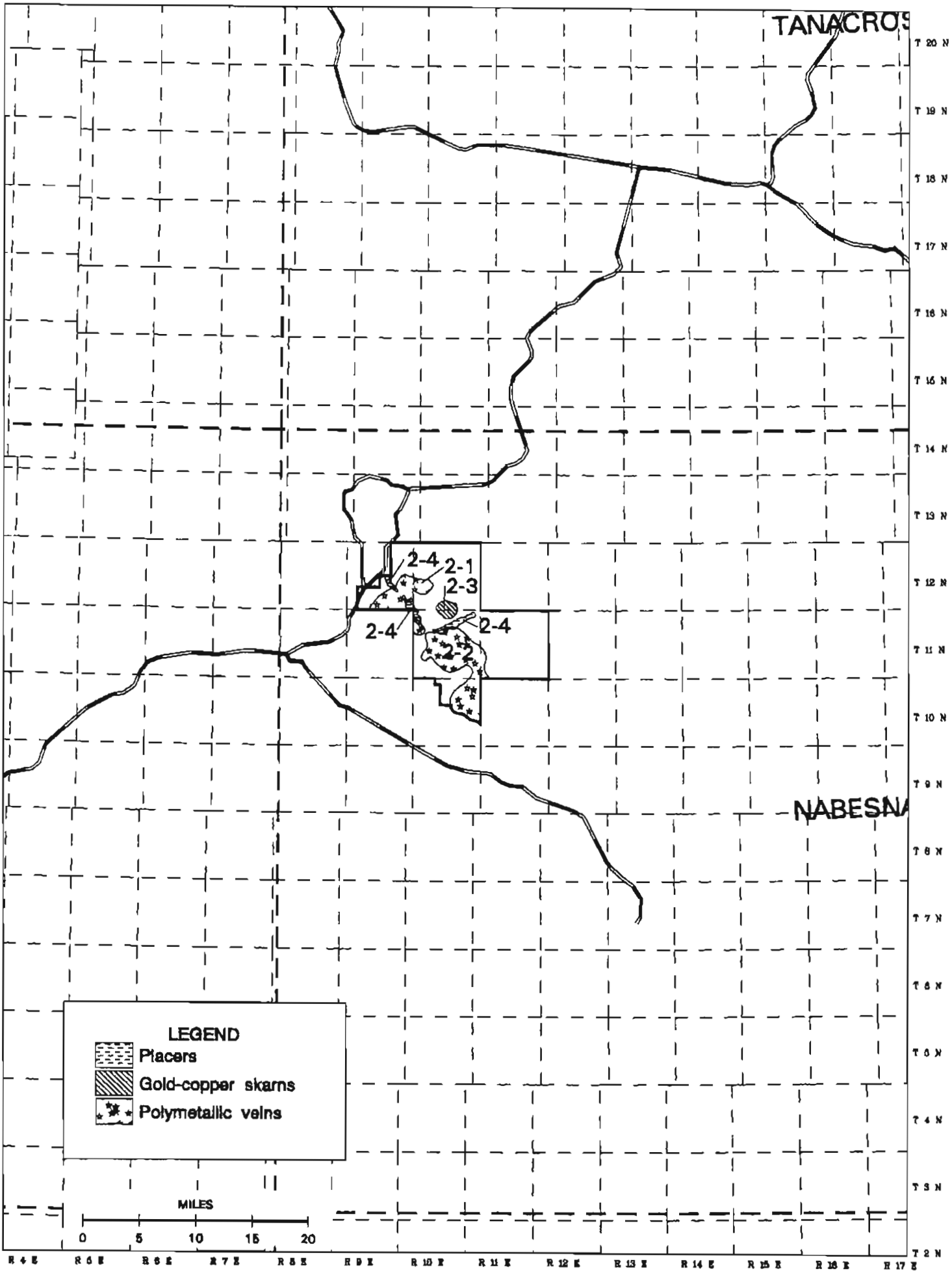
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 2-1	Small area			
Ore	0	0	0.45 million tons	Moderate
Silver	0	0	8,400 thousand oz	
Gold	0	0	15 thousand oz	
Zinc	0	0	8 thousand tons	
Lead	0	0	35 thousand tons	
PLAY 2-2	Large area			
Ore	0	0	0.006 million tons	Moderate
Silver	0	0	200 thousand oz	
Gold	0	0	0 thousand oz	
Zinc	0	0	0 thousand tons	
Lead	0	0	1 thousand tons	

GOLD-COPPER SKARNS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 2-3	Small area			
Ore	0	0	22 million tons	Moderate
Gold	0	0	930 thousand oz	
Silver	0	0	1,300 thousand oz	

GOLD PLACERS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 2-4	Small area			
Ore	0	0	0.24 million tons	Moderate
Gold	0	0	4 thousand oz	
Silver	0	0	2 thousand oz	



Unit 2, Mentasta Mountains Unit

R. Element

Date: 04/07/93

UNIT 3 - DENALI/CLEARWATER

GEOLOGIC SUMMARY

Unit 3 encompasses almost 3.9 million acres in the Healy, Mt Hayes, Talkeetna Mountains, and Gulkana Quadrangles and includes lands along the Denali and Richardson Highways.

The area is composed of three major geologic terranes in fault contact with one another. From north to south these include (1) mid-Paleozoic to Precambrian schist terrane of sedimentary, volcanic, and igneous origin; (2) Jurassic and Cretaceous marine clastic sedimentary rocks of lower greenschist to amphibolite facies metamorphic grade intruded by plutonic rocks 55 to 70 million years ago, and (3) a Permian to Triassic volcanic arc of greenschist metamorphic grade.

The most significant known deposit within Unit 3, the Valdez Creek placer mine, has produced approximately 392,000 oz of gold and contains reserves of about 257,000 oz. Near the Valdez Creek mine, lode gold occurrences, thought to be formed by metamorphic processes, occur in a belt of rocks that extends over 100 mi across Unit 3. Both the Valdez Creek mine and the metamorphic gold belt lie within the Jura-Cretaceous geologic terrane of the western and east-central portion of the area. Other deposit types that may occur within this terrane are associated with intrusive rocks and include gold veins within granitic rocks, tin greisen, and copper-molybdenum porphyry deposits.

Permian to Triassic Tetelna-Ampitheatre volcanic arc deposits along the southern and eastern portions of Unit 3 host numerous mineral occurrences and deposits. The Denali Copper prospect is reported to contain 2 million tons of 5 percent copper and up to 0.44 oz/ton silver. This sediment-hosted, basalt-related copper deposit suggests the potential for similar deposits within the region. Basalt-related deposits are indicated by numerous basalt-hosted copper occurrences, prospects, and limited copper production. Copper-gold skarn potential is shown by the Zackly deposit with estimated inferred reserves of 1.25 million tons grading 2.6 percent copper and 0.2 oz/ton gold. Copper, gold, and platinum occurrences within ultramafic rocks in the region indicate a potential for magmatic sulfide deposits and platinum-gold placers. In addition there is evidence that polymetal massive sulfide veins and porphyry copper deposits may also occur here.

Several polymetal massive sulfide occurrences just north of the unit suggest the potential for this type of deposit within the schist terrane along the northern part of Unit 3.

MINERAL DEPOSIT TYPES - UNIT 3

The mineral deposit models chosen to estimate the mineral endowment of Unit 3 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 3-1 through 3-15. The location of the plays and their probabilistic endowment estimates are shown in the map for Unit 3 and table 3.

(1) Gold-copper skarns: There is high mineral potential in play 3-1 and moderate mineral potential in play 3-2.
(2) Granite tin greisens: There is moderate mineral potential in play 3-3.
(3) Metamorphic gold veins: There is high mineral potential in play 3-4.
(4) Gold placers: There is high mineral potential in play 3-5 and moderate mineral potential in play 3-16. Play 3-17 shows no resources at the 5th percentile.
(5) Magmatic sulfide: There is high mineral potential in play 3-7.
(6) Polymetal massive sulfide: There is moderate mineral potential in play 3-8.
(7) Porphyry copper-molybdenum: There is high mineral potential in play 3-9 and moderate mineral potential in play 3-18.
(8) Sediment-basaltic copper: There is high mineral potential in play 3-10 and moderate mineral potential in play 3-19.

(9) Basalt-hosted copper: There is high mineral potential in play 3-11.
(10) Placer gold platinum: There is moderate mineral potential in play 3-12.
(11) Granitic gold veins: There is moderate mineral potential in plays 3-13, 3-14, and 3-15.

COAL RESOURCE POTENTIAL - UNIT 3

There is a moderate potential within tract 3-20 for a Tertiary lignite deposit similar to that at nearby Jarvis Creek. Tract 3-20 is shown on the Unit 3 map.

Table 3. *Deposit types and estimated mineral endowment of Unit 3, Denali/Clearwater*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

GOLD-COPPER SKARNS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 3-1	Small area			
Ore	1.3 million tons[a]	1.7 million tons	3.9 million tons	High
Gold	240 thousand oz	400 thousand oz	1,200 thousand oz	
Silver	100 thousand oz	1,500 thousand oz	18,000 thousand oz	
Copper	33 thousand tons	64 thousand tons	200 thousand tons	
PLAY 3-2	Small area			
Ore	0	0	1.3 million tons	Moderate
Gold	0	0	240 thousand oz	
Silver	0	0	100 thousand oz	
Copper	0	0	33 thousand tons	

[a]Values for play 3-1 are extrapolated from proven, probable, and inferred resources of the Zackly deposit

GRANITE TIN GREISENS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 3-3	Small area			
Ore	0	0	5 million tons	Moderate
Tin	0	0	7 thousand tons	
Niobium	0	0	0 tons	
Beryllium	0	0	0 tons	
Fluoride	0	0	0 thousand tons	
Silver	0	0	72 thousand oz	
Tungsten	0	0	0 thousand tons	

METAMORPHIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 3-4	Very large area			
Ore	0	0.1 million tons	46 million tons	High
Gold	0	31 thousand oz	10,500 thousand oz	
Silver	0	0 thousand oz	1 thousand oz	

GOLD PLACERS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 3-5	Small area			
Ore	3.7 million tons	5 million tons	12.5 million tons	High
Gold	300 thousand oz[b]	400 thousand oz	1,000 thousand oz	

[b]Values for play 3-5 are extrapolated from proven, probable, and inferred resources at Valdez Creek Mine.

MAGMATIC SULFIDE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 3-7	Small area			
Ore	0	0	47 million tons	High
Copper	0	0	280 thousand tons	
Nickel	0	0	370 thousand tons	

POLYMETAL MASSIVE SULFIDE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 3-8	Very large area			
Ore	0	0	5 million tons	Moderate
Zinc	0	0	280 thousand tons	
Copper	0	0	150 thousand tons	
Lead	0	0	130 thousand tons	
Silver	0	0	7,000 thousand oz	
Gold	0	0	110 thousand oz	

PORPHYRY COPPER-MOLYBDENUM

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 3-9	Small area			
Ore	0	200 million tons	760 million tons	High
Copper	0	880 thousand tons	3,000 thousand tons	
Molybdenum	0	29 thousand tons	120 thousand tons	
Gold	0	0 thousand oz	220 thousand oz	
Silver	0	6,400 thousand oz	49,000 thousand oz	

SEDIMENT-BASALTIC COPPER

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 3-10	Small area			
Ore	2 million tons[c]	4 million tons	6 million tons	High
Copper	100 thousand tons	200 thousand tons	300 thousand tons	

[c]Values extrapolated from proven, probable, and inferred resources of Denali Copper prospect.

BASALT-HOSTED COPPER

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 3-11	Very large area			
Ore	0	0	45 million tons	High
Copper	0	0	1,100 thousand tons	
Silver	0	0	48,000 thousand oz	

PLACER GOLD PLATINUM

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 3-12	Small area			
Ore	0	0	0.05 million tons	Moderate
Platinum	0	0	2 thousand oz	
Gold	0	0	0 thousand oz	

GRANITIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 3-13	Medium area			
Ore	0	0	6.1 million tons	Moderate
Gold	0	0	900 thousand oz	
PLAY 3-14	Medium area			
Ore	0	0	2.8 million tons	Moderate
Gold	0	0	410 thousand oz	
PLAY 3-15	Small area			
Ore	0	0	0.1 million tons	Moderate
Gold	0	0	12 thousand oz	

GOLD PLACERS

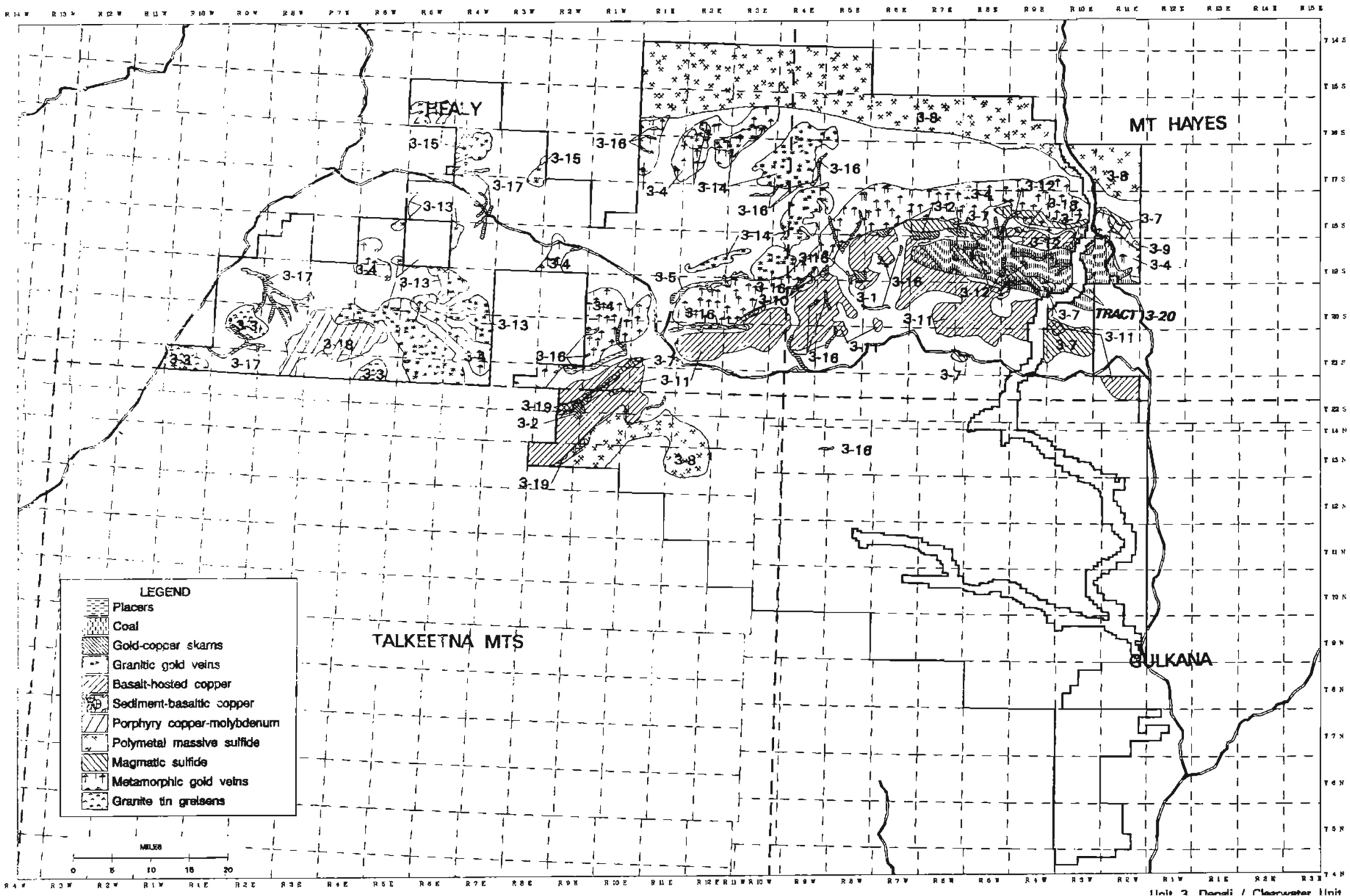
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 3-16	Small area			
Ore	0	0	0.3 million tons	Moderate
Gold	0	0	3 thousand oz	
Silver	0	0	2 thousand oz	
PLAY 3-17	Small area			
Ore	0	0	0 million tons	Moderate
Gold	0	0	0 thousand oz	
Silver	0	0	0 thousand oz	

PORPHYRY COPPER-MOLYBDENUM

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 3-18	Small area			
Ore	0	0	230 million tons	Moderate
Copper	0	0	800 thousand tons	
Molybdenum	0	0	32 thousand tons	
Gold	0	0	0 thousand oz	
Silver	0	0	5,600 thousand oz	

SEDIMENT-BASALTIC COPPER

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 3-19	Small area			
Ore	0	0	6.5 million tons	Moderate
Copper	0	0	377 thousand tons	
Silver	0	0	4,150 thousand oz	



Unit 3 Denali / Clearwater Unit

UNIT 4 - CHICKEN

GEOLOGIC SUMMARY

Unit 4 encompasses almost 2 million acres in the Tanacross, Eagle, and Charley River Quadrangles in east-central Alaska. This Yukon-Tanana Upland area is bounded on the north by the Tintina fault, a major right-lateral strike slip system that juxtaposes relatively unmetamorphosed sedimentary and mafic igneous rocks of the Seventymile terrane against medium- and high-grade metamorphic rocks of the Yukon Crystalline terrane.

Bedrock geology in Unit 4 consists primarily of metamorphic rocks which have been intruded by extensive plutonic bodies and coeval (co-magmatic) volcanic and subvolcanic complexes. The metamorphic rocks include quartzitic and pelitic gneiss and schist, quartzite, marble, and amphibolite. Foliation and compositional layering have been deformed into tight, asymmetric folds that are locally isoclinal.

Regional metamorphism throughout the Yukon-Tanana Upland ranges from very low grade (about equivalent to burial metamorphism) to amphibolite facies. The highest regional metamorphic grade documented in the Tanacross and Eagle quadrangles is within a sillimanite gneiss dome; metamorphic grade probably surpasses the sillimanite isograd, and partial melting may have occurred. The lowest metamorphic grade is found in slightly metamorphosed sedimentary rocks in the eastern part of the Eagle Quadrangle (Seventymile terrane). Contact metamorphism is primarily associated with Tertiary plutons (about 60 million years old), but in a few places may be associated with Cretaceous plutonism (about 100 million years ago).

Several episodes of igneous activity have been recognized in the eastern part of the Yukon-Tanana Uplands. Syenitic intrusions at Taylor Mountain (southcentral Eagle Quadrangle) and at Mount Veta (west-central Eagle Quadrangle) have yielded Jurassic potassium-argon ages (about 145 to 205 million years old). This igneous event was probably synchronous with early metamorphism. Granodiorites of mid-Cretaceous age (about 100 million years old) are the most voluminous plutonic rocks in Unit 4. The boundaries of these intrusions are very irregular and many large xenoliths and roof pendants are included. Other mid-Cretaceous igneous rocks in the region include felsic tuffs and other associated volcanic rocks. The volcanic rocks are related to calderas located in the north-central Tanacross and southwestern Eagle Quadrangles. Tertiary granites and granodiorites are also present in Unit 4, as well as numerous small to intermediate-sized bodies of mafic and ultramafic rocks.

Placer gold mining has been significant in the Eagle and Fortymile mining districts. Gold was discovered in streams of the Eagle (Seventymile) district between 1895 and 1898. The district has produced at least 52,000 oz of gold and byproduct silver, all from stream and bench placers. Gold alloyed with platinum was found at Fourth of July Creek and the mouth of Broken Neck Creek, and a few platinum nuggets were reportedly recovered from a tributary (Lucky Gulch) to the Seventymile River according to earlier U.S. Geological Survey reports. Sources for the gold may be quartz veins and mineralized zones that are genetically related to granitic rocks, paleoplacers, metamorphic rocks, and some dike rocks.

Gold was initially discovered in the Fortymile district in 1886. Gold production of at least 523,154 oz has come mostly from stream and low bench placers; however, a few high bench placers have been worked occasionally. The streams of the Fortymile district drain a diverse group of rocks that include metamorphic and sedimentary rocks, serpentinite, and plutonic rocks such as granodiorite, quartz monzonite, quartz diorite, and diorite.

At least three types of small lode sources of gold are present in the Fortymile district. One type, exemplified by the Purdy, Angle, and Tweeten lodes, is gold-bearing quartz + calcite veins in metasedimentary and metavolcanic rocks of the Seventymile terrane and in intermediate composition plutonic rocks that intruded the terrane. The second type of lode gold occurrence is gold in quartz veins in the southern part of the Yukon Crystalline terrane; U.S. Geological Survey workers reported such an occurrence along Jack Wade Creek and thought that the veins were related to a granite intrusion at depth. A third type of gold occurrence is gold in and adjacent to crushed zones and faults. Such zones are thought to be a source of gold in Dome Creek and Canyon Creeks. The recognition of major thrust faults within the Fortymile region provides other possible sites of lode concentrations of gold.

MINERAL DEPOSIT TYPES - UNIT 4

The mineral deposit models chosen to estimate the mineral endowment of Unit 4 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 4-1 through 4-12. The location of plays and their probabilistic endowment are shown in the map for Unit 4 and table 4.

(1) Polymetallic Veins: There is moderate mineral potential in plays 4-1 and 4-2.
(2) Volcanic Gold-Silver: There is moderate mineral potential in play 4-3.
(3) Granitic Gold Veins: There is high mineral potential in plays 4-4 and 4-5, and moderate mineral potential in play 4-6.
(4) Granitic Disseminated Gold: The large area contained in play 4-4 was evaluated for a possibility of high gold grades. Plays 4-5 and 4-6 were evaluated for low gold grades. There is high mineral potential in play 4-7, and moderate mineral potential in play 4-8.
(5) Sediment Epithermal Gold: There is high mineral potential in play 4-9, and moderate mineral potential in play 4-10.
(6) Rift Polymetal Massive Sulfide: There is high mineral potential in play 4-11.
(7) Porphyry Copper-Molybdenum: There is high mineral potential in play 4-12, and moderate mineral potential in play 4-13.

COAL RESOURCE POTENTIAL - UNIT 4

Tertiary to Cretaceous lignite occurring in sandstone, mudstone, and conglomerate along the Tintina fault indicates a moderate coal potential for tract 4-14 in Unit 4. Tract 4-14 is shown on the Unit 4 map.

Table 4. *Deposit types and estimated mineral endowment of Unit 4, Chicken*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

POLYMETALLIC VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 4-1	Small area			
Ore	0	0	0.9 million tons	Moderate
Silver	0	0	37,000 thousand oz	
Gold	0	0	70 thousand oz	
Zinc	0	0	26 thousand tons	
Lead	0	0	74 thousand tons	
PLAY 4-2	Medium area			
Ore	0	0	0.6 million tons	Moderate
Silver	0	0	12,000 thousand oz	
Gold	0	0	26 thousand oz	
Zinc	0	0	12 thousand tons	
Lead	0	0	50 thousand tons	

VOLCANIC GOLD-SILVER

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 4-3	Medium area			
Ore	0	0	6.7 million tons	Moderate
Gold	0	0	2,000 thousand oz	
Silver	0	0	38,000 thousand oz	

GRANITIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 4-4	Extremely large area			
Ore	0	0	5.5 million tons	High
Gold	0	0	770 thousand oz	
PLAY 4-5	Small area			
Ore	0	0	1.2 million tons	High
Gold	0	0	440 thousand oz	
PLAY 4-6	Small area			
Ore	0	0	0.8 million tons	Moderate
Gold	0	0	250 thousand oz	

GRANITIC DISSEMINATED GOLD

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 4-7	Small area			
Ore	0	0	21 million tons	High
Gold	0	0	700 thousand oz	
PLAY 4-8	Very large area			
Ore	0	0	89 million tons	Moderate
Gold	0	0	3,700 thousand oz	

SEDIMENT EPITHERMAL GOLD

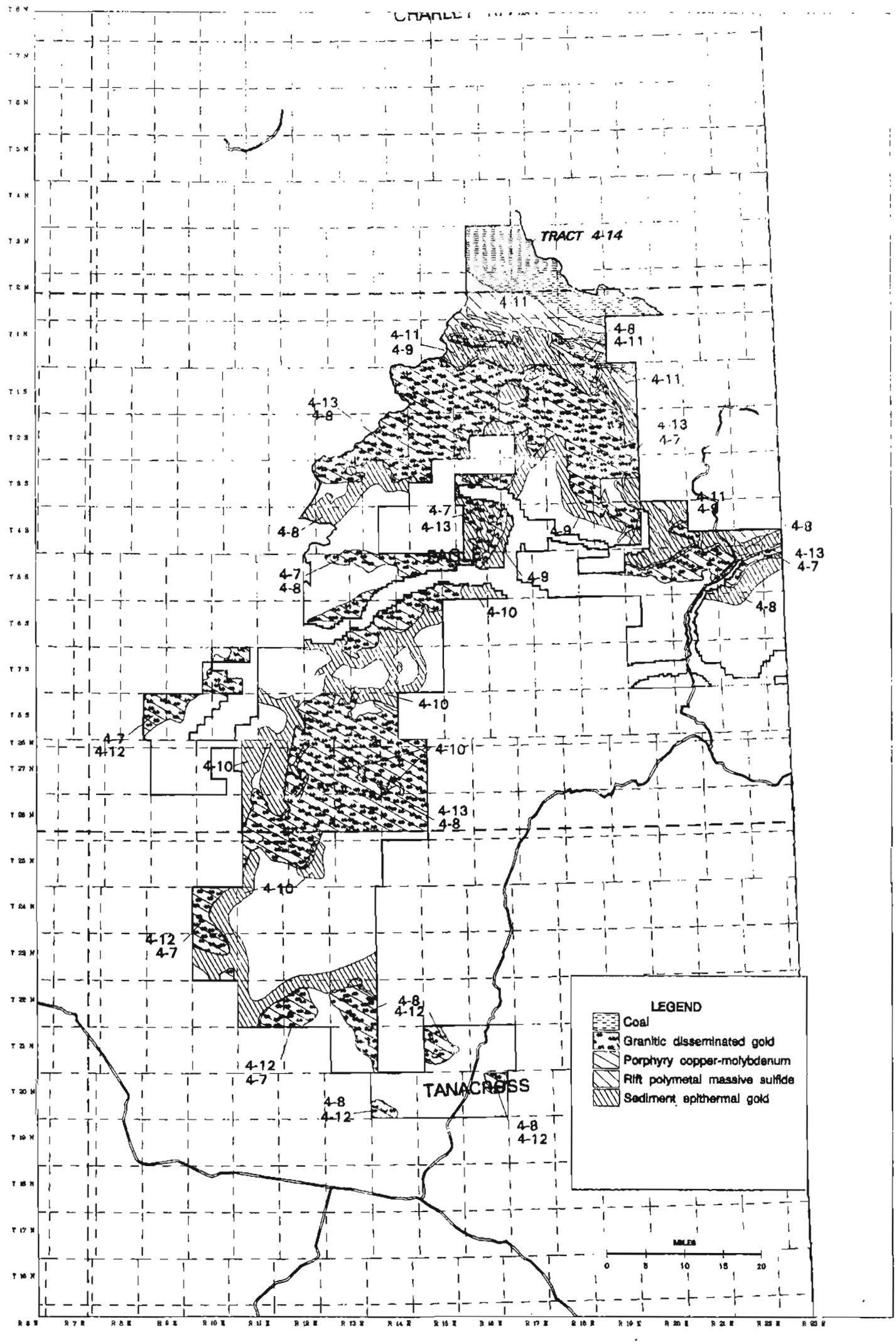
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 4-9	Very large area			
Ore	0	0	140 million tons	High
Gold	0	0	14,000 thousand oz	
Silver	0	0	110,000 thousand oz	
PLAY 4-10	Very large area			
Ore	0	0	95 million tons	Moderate
Gold	0	0	8,800 thousand oz	
Silver	0	0	52,000 thousand oz	

RIFT POLYMETAL MASSIVE SULFIDE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 4-11	Large area			
Ore	0	0	32 million tons	High
Zinc	0	0	1,900 thousand tons	
Copper	0	0	800 thousand tons	
Lead	0	0	820 thousand tons	
Silver	0	0	25,000 thousand oz	
Gold	0	0	520 thousand oz	

PORPHYRY COPPER-MOLYBDENUM

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 4-12	Medium area			
Ore	0	0	600 million tons	High
Copper	0	0	3,500 thousand tons	
Gold	0	0	7,400 thousand oz	
Silver	0	0	31,000 thousand oz	
PLAY 4-13	Extremely large area			
Ore	0	0	2,800 million tons	Moderate
Copper	0	0	17,000 thousand tons	
Gold	0	0	33,000 thousand oz	
Silver	0	0	180,000 thousand oz	


TRACT 4-14
4-11
4-11
4-9
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TANACROSS
4-8
4-12
4-8
4-12
LEGEND
Coal
Granitic disseminated gold
Porphyry copper-molybdenum
Rift polymetal massive sulfide
Sediment epithermal gold
MILES
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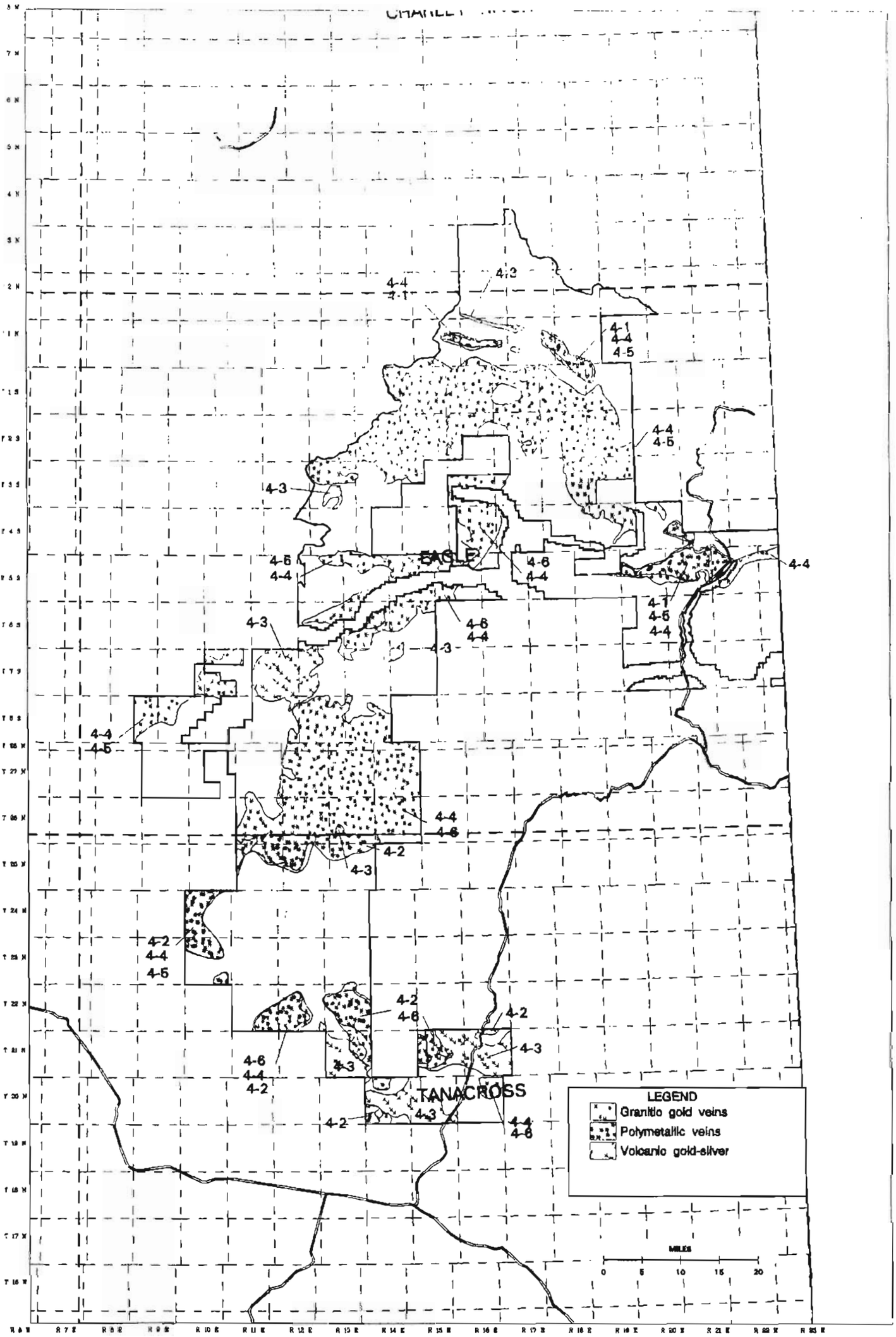

EAGLE
TANACROSS
4-1
4-2
4-3
4-4
4-5
4-6
LEGEND
Granitic gold veins
Polymetallic veins
Volcanic gold-silver
MILES
0
5
10
15
20

UNIT 5 - OLD NIKE RANGE

GEOLOGIC SUMMARY

Unit 5 encompass 2 million acres part of the Big Delta, Mount Hayes, and Fairbanks Quadrangles. Bedrock in the northern areas consists dominantly of greenschist-facies metamorphic rocks, which have been intruded by numerous granitic plutons and are overlain by a thrust klippe of ultramafic rocks. The greenschist unit is thought to be mid-Paleozoic in age (about 320 to 480 million years old); parts of it are interpreted as correlative with volcanogenic massive sulfide-bearing units of the Alaska Range. Two main types of granitic plutons, granodiorite of mainly Late Cretaceous age (about 65 to 98 million years old), and granite of early Tertiary age (about 40 to 65 million years old) are present in the area. The ultramafic rock is thought to be a remnant of an extensive thrust complex; it consists of harzburgite and dunite and is about 1 km thick.

Most of the southern parts of Unit 5 are composed of Quaternary alluvial deposits (Nenana gravels and younger stream sedimentary deposits). Only small areas of bedrock (Cretaceous plutons as discussed above) are exposed.

Unit 5 has numerous gold, arsenic, bismuth, tungsten, and tin anomalies in rocks, stream sediments, and panned concentrates. These anomalies are mostly present around the granitic plutons. Major oxide rock geochemistry has been used to show that several plutons in the region have a strong potential for gold lode associations, and several have a good potential for tin greisen systems. Other geochemical indicators suggest that Unit 5 could potentially contain volcanogenic massive sulfide deposits (VMS) as well.

Although no gold placer production has occurred within Unit 5, gold placers could well be present, since placer gold production has occurred immediately south of and north of the study area; additionally the presence of favorable gold-related plutons indicates possible sources for potential gold placers.

Potential ore deposit types were considered but rejected because of lack of geochemical indicators, critical rock types, and extremely small areas of favorablity areas include volcanogenic-type Cleary Sequence gold, tungsten-gold skarns, lead-zinc-silver skarns, porphyry molybdenum deposits and chromite, nickel, and gold deposits potentially associated with ultramafic rocks. The general lack of carbonate rocks restricts the possible size of skarn deposits. Thus, although some skarn prospects are known, the likelihood of large deposits is small.

MINERAL DEPOSIT TYPES - UNIT 5

The mineral deposit models chosen to estimate the mineral endowment of Unit 5 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 5-1 through 5-20. The location of the plays and their probabilistic endowment estimates are shown in the map for Unit 5 and table 5.

(1) Plutonic gold: There is high mineral potential in plays 5-2, 5-3, and 5-4 and moderate mineral potential in plays 5-1, 5-5, and 5-6.
(2) Granite tin greisen: There is moderate mineral potential in plays 5-9, 5-10, and 5-11; plays 5-7 and 5-8 show no resources at the 5th percentile.
(3) Gold placers: There is high mineral potential in plays 5-13 and 5-14 and moderate mineral potential in plays 5-12, 5-15, and 5-16. Play 5-17 shows no resources at the 5th percentile.
(4) Rift polymetal massive sulfide: There is moderate mineral potential in play 5-18.
(5) Porphyry copper-molybdenum: There is high mineral potential in play 5-19.
(6) Metamorphic gold veins: There is moderate mineral potential in play 5-20.

Table 5. *Deposit types and estimated mineral endowment of Unit 5, Old Nike Range*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

GRANITIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 5-1	Medium area			
Ore	0	0.1 million tons	3.5 million tons	Moderate
Gold	0	10 thousand oz	480 thousand oz	
PLAY 5-2	Medium area			
Ore	0	1.0 million tons	8.8 million tons	High
Gold	0	120 thousand oz	1,200 thousand oz	
PLAY 5-3	Small area			
Ore	0	0.2 million tons	4.3 million tons	High
Gold	0	30 thousand oz	610 thousand oz	
PLAY 5-4	Small area			
Ore	0	0.1 million tons	5.8 million tons	High
Gold	0	9 thousand oz	760 thousand oz	
PLAY 5-5	Medium area			
Ore	0	0	2.2 million tons	Moderate
Gold	0	0	330 thousand oz	
PLAY 5-6	Small area			
Ore	0	0	0 million tons	Moderate
Gold	0	0	0 thousand oz	

GRANITE TIN GREISENS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 5-7	Small area			
Ore	0	0	0 million tons	Moderate
Tin	0	0	0 thousand tons	
Niobium	0	0	0 tons	
Beryllium	0	0	0 tons	
Fluoride	0	0	0 thousand tons	
Silver	0	0	0 thousand oz	
Tungsten	0	0	0 thousand tons	
PLAY 5-8	Small area			
Ore	0	0	0 million tons	Moderate
Tin	0	0	0 thousand tons	
Niobium	0	0	0 tons	
Beryllium	0	0	0 tons	
Fluoride	0	0	0 thousand tons	
Silver	0	0	0 thousand oz	
Tungsten	0	0	0 thousand tons	

GRANITE TIN GREISENS CONTINUED

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 5-9	Small area			
Ore	0	0	8.5 million tons	Moderate
Tin	0	0	14 thousand tons	
Niobium	0	0	100 tons	
Beryllium	0	0	0 tons	
Fluoride	0	0	0 thousand tons	
Silver	0	0	380 thousand oz	
Tungsten	0	0	0 thousand tons	
PLAY 5-10	Small area			
Ore	0	0	5.7 million tons	Moderate
Tin	0	0	8 thousand tons	
Niobium	0	0	0 tons	
Beryllium	0	0	0 tons	
Fluoride	0	0	0 thousand tons	
Silver	0	0	290 thousand oz	
Tungsten	0	0	0 thousand tons	
PLAY 5-11	Small area			
Ore	0	0	11 million tons	Moderate
Tin	0	0	24 thousand tons	
Niobium	0	0	250 tons	
Beryllium	0	0	0 tons	
Fluoride	0	0	0 thousand tons	
Silver	0	0	1,100 thousand oz	
Tungsten	0	0	0 thousand tons	

GOLD PLACERS

Probability level	95	50	5	Mineral Potential
PLAY 5-12	Small area			
Ore	0	0	6.1 million tons	Moderate
Gold	0	0	100 thousand oz	
Silver	0	0	67 thousand oz	
PLAY 5-13	Small area			
Ore	0	0	0.6 million tons	High
Gold	0	0	7 thousand oz	
Silver	0	0	5 thousand oz	
PLAY 5-14	Small area			
Ore	0	0	0.7 million tons	High
Gold	0	0	8 thousand oz	
Silver	0	0	8 thousand oz	

GOLD PLACERS CONTINUED

Probability level	95	50	5	Mineral Potential
PLAY 5-15	Small area			
Ore	0	0	6.3 million tons	Moderate
Gold	0	0	92 thousand oz	
Silver	0	0	66 thousand oz	
PLAY 5-16	Small area			
Ore	0	0	52 million tons	Moderate
Gold	0	0	680 thousand oz	
Silver	0	0	440 thousand oz	
PLAY 5-17	Small area			
Ore	0	0	0 million tons	Moderate
Gold	0	0	0 thousand oz	
Silver	0	0	0 thousand oz	

RIFT POLYMETAL MASSIVE SULFIDE

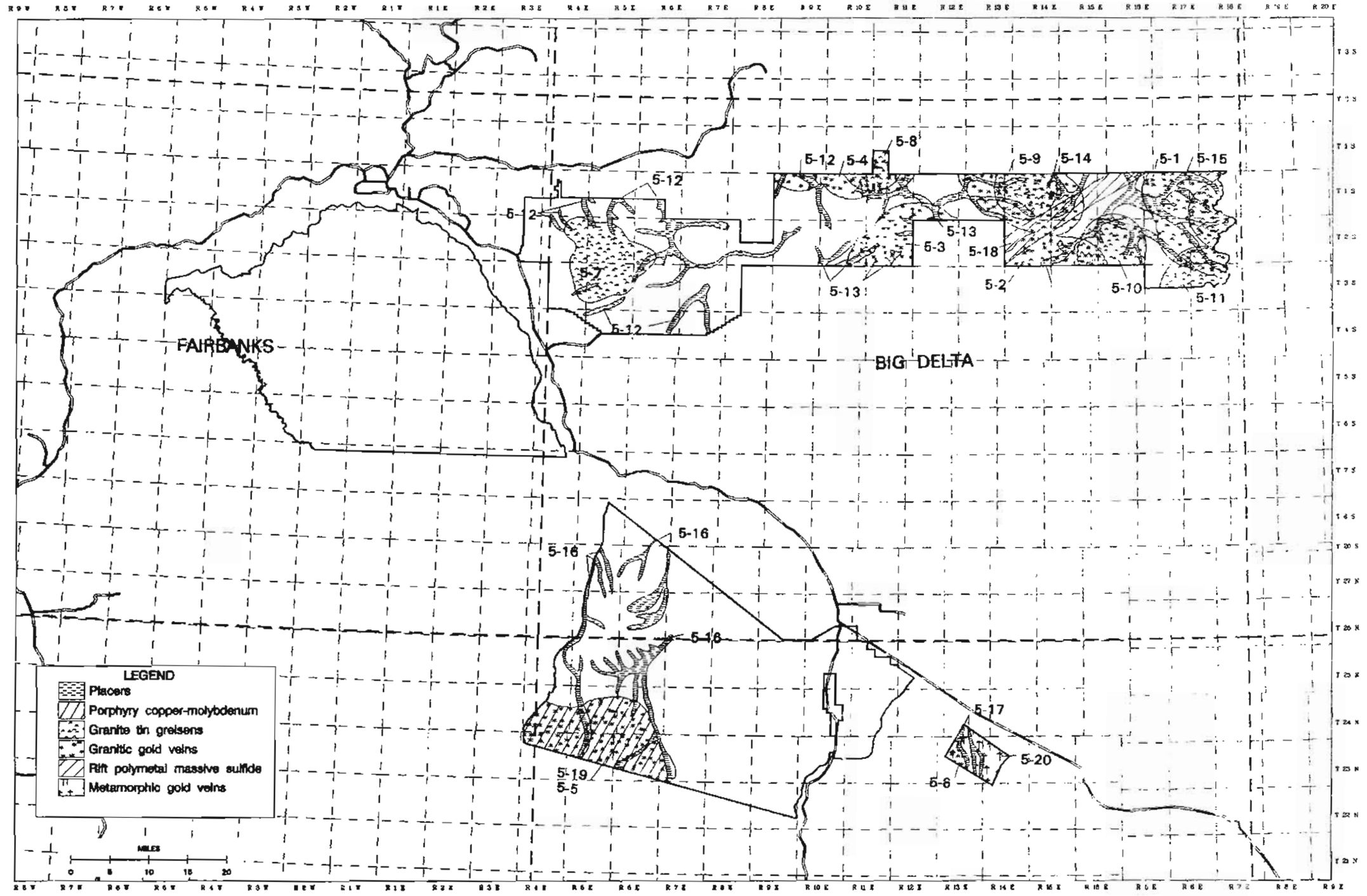
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 5-18	Small area			
Ore	0	0	3.6 million tons	Moderate
Zinc	0	0	160 thousand tons	
Copper	0	0	58 thousand tons	
Lead	0	0	92 thousand tons	
Silver	0	0	0 thousand oz	
Gold	0	0	36 thousand oz	

PORPHYRY COPPER-MOLYBDENUM

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 5-19	Medium area			
Ore	0	0	420 million tons	High
Copper	0	0	1,500 thousand tons	
Molybdenum	0	0	68 thousand tons	
Gold	0	0	29 thousand oz	
Silver	0	0	19,000 thousand oz	

METAMORPHIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 5-20	Small area			
Ore	0	0	0.04 million tons	Moderate
Gold	0	0	9 thousand oz	
Silver	0	0	0 thousand oz	



Unit 5, Old Nike Range Unit

UNIT 6 - WEST TORDRILLO FOOTHILLS

GEOLOGIC SUMMARY

The West Tordrillo Foothills Unit 6 encompasses about 140,000 acres in the Tyonek Quadrangle. The area is underlain by Cretaceous and Tertiary plutonic rocks, with Mesozoic metasedimentary roof pendants, screens, and inclusions. The plutonic rocks are generally felsic to intermediate in composition, and include rocks of the Styx River batholith, the Nagishlamina River granodiorite, minor Mesozoic diorite and gabbro, and areas of undifferentiated plutonic rock.

There is no known history of mining activity in Unit 6. DGGS collected rock samples anomalous in copper, molybdenum, gold, bismuth, and manganese from the eastern portion of the unit in rocks that appear similar to Nagishlamina River granodiorite. National Uranium Research Evaluation (NURE) lead and zinc geochemical anomalies in the northwest portion of the area, and a nearby lead-zinc prospect suggest the possibility of polymetallic vein deposits in the unit. In addition to mineral resource potential, this area holds a low to moderate potential for a building stone resource.

MINERAL DEPOSIT TYPES - UNIT 6

The mineral deposit models chosen to estimate the mineral endowment of Unit 6 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 6-1 through 6-3. The location of the plays and their probabilistic endowment estimates are shown in the map for Units 6 and 7 and table 6.

(1) Porphyry copper-molybdenum: There is high mineral potential in play 6-1. Play 6-2 shows no resources at the 5th percentile.
(2) Polymetallic veins: There is moderate mineral potential in play 6-3.

Table 6. *Deposit types and estimated mineral endowment of Unit 6, West Tordrillo Foothills*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

PORPHYRY COPPER-MOLYBDENUM

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 6-1	Small area			
Ore	0	0	200 million tons	High
Copper	0	0	670 thousand tons	
Molybdenum	0	0	22 thousand tons	
Gold	0	0	0 thousand oz	
Silver	0	0	5,800 thousand oz	
PLAY 6-2	Small area			
Ore	0	0	0 million tons	Moderate
Copper	0	0	0 thousand tons	
Molybdenum	0	0	0 thousand tons	
Gold	0	0	0 thousand oz	
Silver	0	0	0 thousand oz	

POLYMETALLIC VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 6-3	Medium area			
Ore	0	0	2 thousand tons	Moderate
Silver	0	0	67 thousand oz	
Gold	0	0	0 thousand oz	
Zinc	0	0	54 tons	
Lead	0	0	0 thousand tons	

UNIT 7 - NEACOLA MOUNTAINS

GEOLOGIC SUMMARY

The Neacola Mountains Unit 7 encompasses almost 300,000 acres in the Tyonek and Kenai Quadrangles. The area is underlain by Mesozoic and Tertiary plutonic rocks, with a small area of Tertiary Tyonek Formation sedimentary rocks in the northeast part of the unit. The plutonic rocks are generally intermediate in composition, but include more felsic and mafic variants as well. The northeast-trending Lake Clark fault transects the unit.

There is no history of mining activity in Unit 7, and available geologic mapping is of a reconnaissance nature. DGGS collected rock samples anomalous in gold, tin, copper, bismuth, and barium in zones of potassic alteration. In addition to mineral resource potential, this area holds a low to moderate potential for a building stone resource.

MINERAL DEPOSIT TYPES - UNIT 7

The mineral deposit models chosen to estimate the mineral endowment of Unit 7 are listed below. The permissive areas for each mineral deposit type are referred to as "plays." The location of the plays and their probabilistic endowment estimates are shown in the map for Units 6 and 7 and table 7.

(1) Granite tin greisen: There is moderate mineral potential in play 7-1.

COAL RESOURCE POTENTIAL - UNIT 7

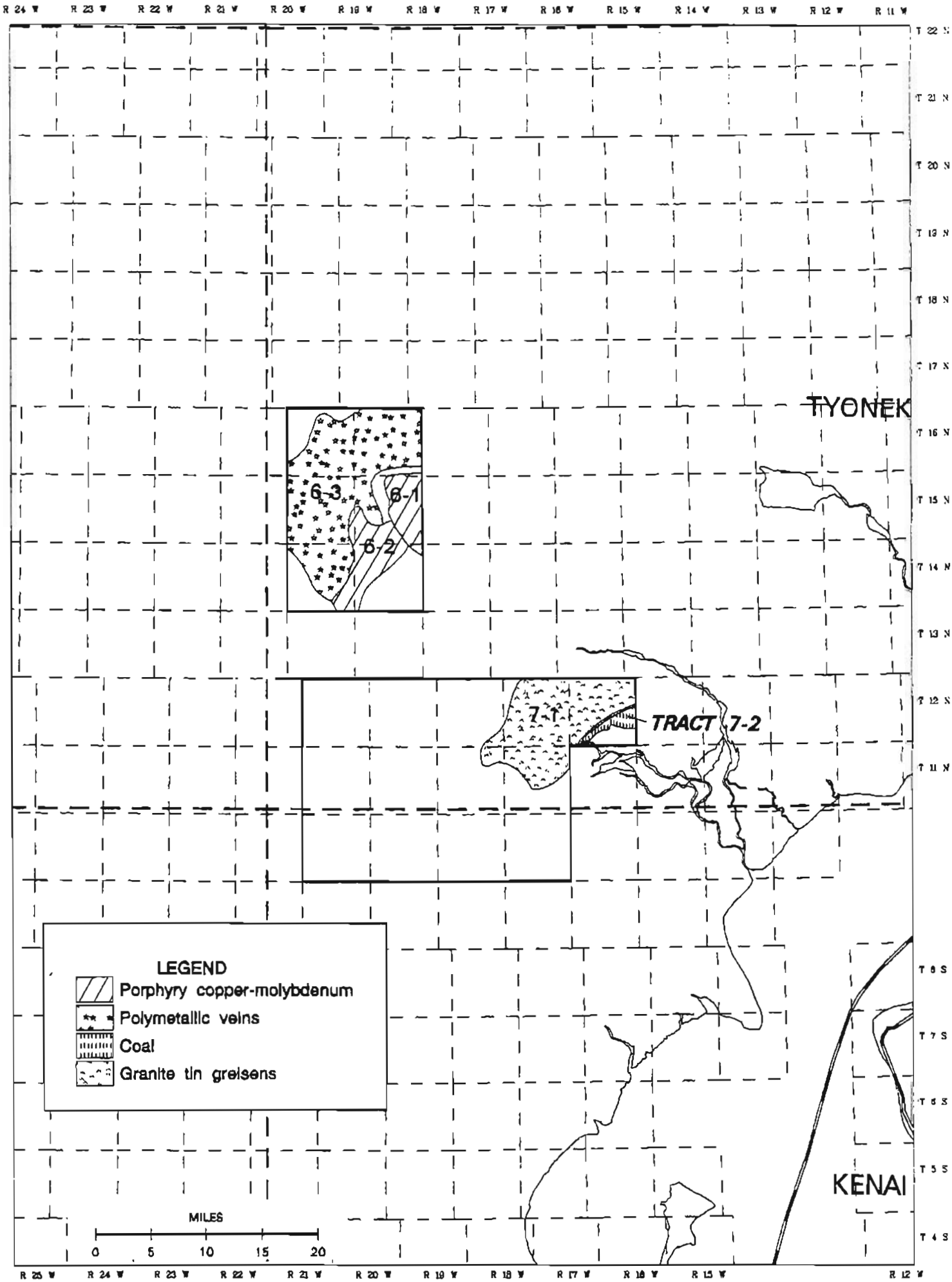
Tract 7-2 has a high potential for containing coal resources because it is mapped as Tyonek Formation and is on trend with subbituminous coal in the Capps-Chuitna coal field located 9 mi east. Tract 7-2 is shown on the Unit 7 map.

Table 7. *Deposit types and estimated mineral endowment of Unit 7, Neacola Mountains*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

GRANITE TIN GREISENS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 7-1	Small area			
Ore	0	0	1.9 million tons	Moderate
Tin	0	0	2 thousand tons	
Niobium	0	0	0 tons	
Beryllium	0	0	0 tons	
Flouride	0	0	0 thousand tons	
Silver	0	0	0 thousand oz	
Tungsten	0	0	0 thousand tons	



Units 6 and 7, West Tordrillo Foothills and Neacola Mtns. Units

UNIT 8 - MINCHUMINA

GEOLOGIC SUMMARY

Unit 8 encompasses about 2.6 million acres within the Kantishna River, Ruby, and Medfra Quadrangles. The bedrock units of Unit 8 strike roughly northeast-southwest and represent diverse lithologies brought into juxtaposition by a system of northeast-trending strike slip faults and subsequent cross faults. From east to west the bedrock units include (1) a chert and black phyllite unit with some interbedded tuffaceous sedimentary rocks of Ordovician to Silurian age, (2) limestone units of Ordovician through Devonian age of both reefal, shallow water, and deep basin origin, and (3) to the northwest, a variety of Precambrian to lower Paleozoic metasedimentary and metaigneous rocks including quartzite, quartz mica schist, calc-schist, and greenstone. Volcanic and plutonic rocks intruded these units along the northeast-trending fault system about 60 to 70 million years ago.

Major and trace element geochemical analyses of samples collected during the 1991 field season indicate there is a potential for gold deposits associated with plutonic rocks, which trend northeast-southwest across Unit 8. The region is very similar and on trend with recently recognized gold deposits outside Unit 8 in southwestern Alaska.

Several lead-zinc-cadmium occurrences near Unit 8 and favorable stream sediment geochemistry within Unit 8 suggest a potential for carbonate-hosted deposits of lead, zinc, and cadmium within the unit. The proximity of the lead occurrences to plutonic rocks indicate that they might be hydrothermal vein occurrences or small skarns rather than a carbonate-hosted deposit. However, lead-isotope analyses done as part of the evaluation process suggest that the lead does not have an igneous source, but rather it is similar isotopically to lead from carbonate-hosted deposits, which have a greater potential for significant tonnage.

Chert and black phyllite, which commonly host lead-zinc sedex deposits, underlie much of the eastern and central portions of Unit 8. There are no known occurrences of lead and zinc within the region, but because the area underlain by these rocks is so large and poorly explored and because rocks of similar age and lithology host significant deposits of lead and zinc in Canada, the area is considered to have a moderate to low favorability for lead zinc sedex deposits.

Extensive areas of hornfelsed rock and quartz-tourmaline veining, typically associated with tin greisen deposits, are abundant in the Bitzshtini and Haystack Mountain areas. Analyses of both intrusive rock and bedrock collected during this evaluation indicate a favorability for tin greisen deposits in this region of Unit 8.

Radiometric surveys conducted as part of the National Uranium Research Evaluation (NURE) in the 1970s identified the region as having potential for uranium and rare earth deposits. Although no occurrences have been identified, trace element chemistry from rock samples collected during the land selection field work suggest a significant favorability for deposits of uranium and rare earths associated with the Sischu volcanics, which trend through the center of Unit 8.

Data suggest a low potential for the discovery of gold veins associated with metamorphic rocks in the northern and western portions of Unit 8. No significant gold placer production is known to have occurred within the area, and the chance for the discovery of major new gold placers is considered to be low.

MINERAL DEPOSIT TYPES - UNIT 8

The mineral deposit models chosen to estimate the mineral endowment of Unit 8 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 8-1 through 8-11. The location of plays and their probabilistic endowment are shown in the map for Unit 8 and table 8.

(1) Granitic gold veins: There is high mineral potential in play 8-1.
(2) Granitic disseminated gold: There is high mineral potential in plays 8-2 and 8-3.

(3) Sediment lead-zinc: There is moderate mineral potential in play 8-4. Play 8-5 shows no resources at the 5th percentile.
(4) Metamorphic gold veins: There is a moderate mineral potential in play 8-6.
(5) Limestone lead-zinc: There is high mineral potential in play 8-8 and moderate mineral potential in play 8-7.
(6) Granite tin greisens: There is high mineral potential in play 8-9.
(7) Granite uranium-rare earth: There is high mineral potential in play 8-10.
(8) Gold placers: There is moderate mineral potential in play 8-11.

Table 8. *Deposit types and estimated mineral endowment of Unit 8, Minchumina*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

GRANITIC GOLD VEINS				
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 8-1	Medium area			
Ore	0	0	62 million tons	High
Gold	0	0	2,200 thousand oz	
GRANITIC DISSEMINATED GOLD				
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 8-2	Small area			
Ore	0	0	7.6 million tons	High
Gold	0	0	1,100 thousand oz	
PLAY 8-3	Small area			
Ore	0	0	5.2 million tons	High
Gold	0	0	690 thousand oz	
SEDIMENT LEAD-ZINC				
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 8-4	Small area			
Ore	0	0	4.8 million tons	Moderate
Zinc	0	0	360 thousand tons	
Lead	0	0	190 thousand tons	
Silver	0	0	5,100 thousand oz	
PLAY 8-5	Very large area			
Ore	0	0	0 million tons	Moderate
Zinc	0	0	0 thousand tons	
Lead	0	0	0 thousand tons	
Silver	0	0	0 thousand oz	
METAMORPHIC GOLD VEINS				
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 8-6	Extremely large area			
Ore	0	0	0.4 million tons	Moderate
Gold	0	0	280 thousand oz	
Silver	0	0	0 thousand oz	
LIMESTONE LEAD-ZINC				
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 8-7	Very large area			
Ore	0	0	23 million tons	Moderate
Lead	0	0	540 thousand tons	
Zinc	0	0	1,100 thousand tons	
Copper	0	0	0 thousand tons	
Silver	0	0	20,000 thousand oz	

LIMESTONE LEAD-ZINC CONTINUED

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 8-8	Small area			
Ore	0	0	9.1 million tons	High
Lead	0	0	110 thousand tons	
Zinc	0	0	340 thousand tons	
Copper	0	0	0 thousand tons	
Silver	0	0	7,000 thousand oz	

GRANITE TIN GREISENS

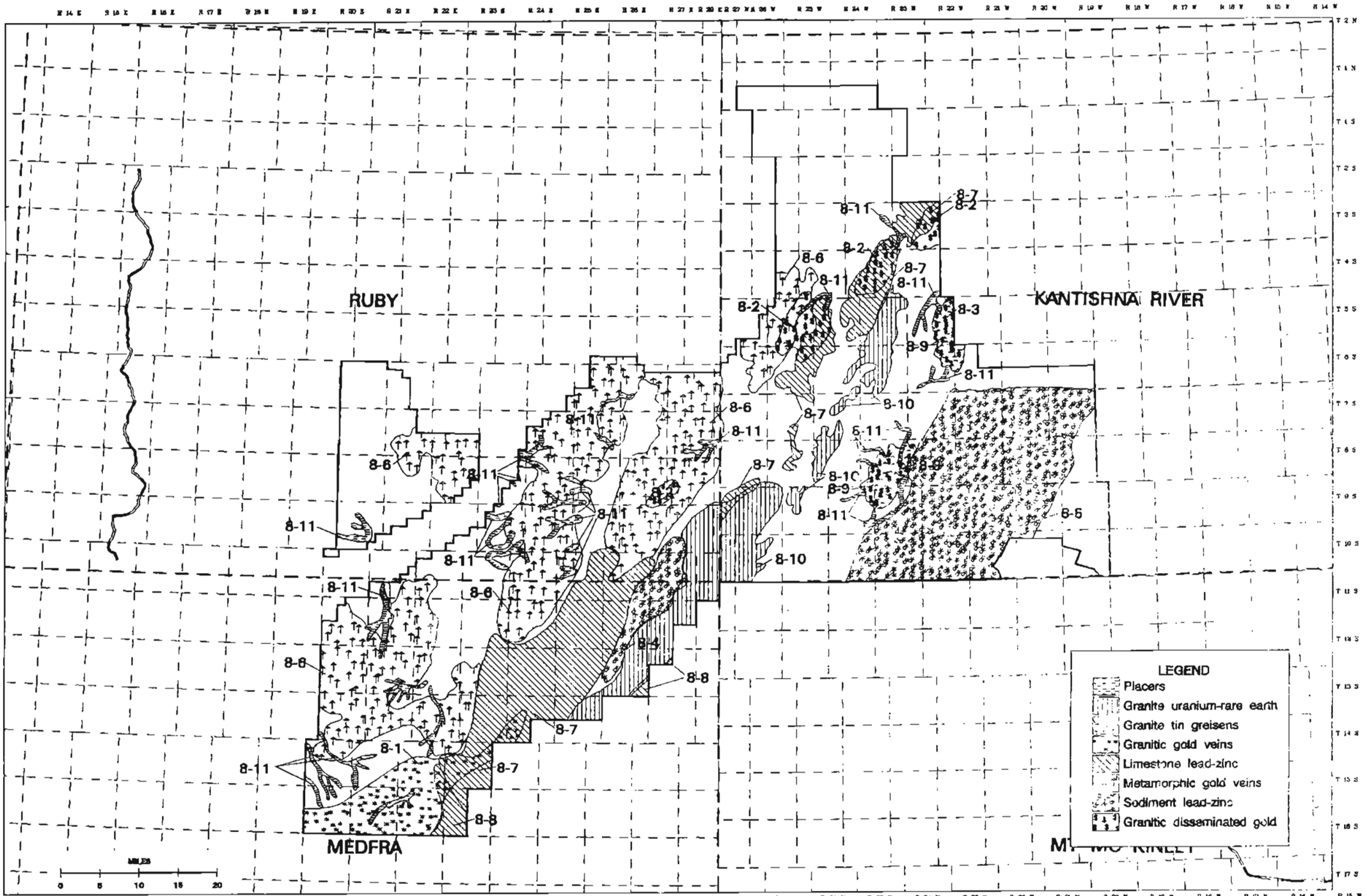
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 8-9	Small area			
Ore	0	0	4.9 million tons	High
Tin	0	0	9 thousand tons	
Niobium	0	0	0 tons	
Beryllium	0	0	0 tons	
Fluoride	0	0	0 thousand tons	
Silver	0	0	0 thousand oz	
Tungsten	0	0	0 thousand tons	

GRANITE URANIUM-RARE EARTH

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 8-10	Small area			
Ore	0	0	0 million tons	Moderate
Uranium	0	0	1,500 tons	
Ree	0	0	5,300 tons	

GOLD PLACERS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 8-11	Medium area			
Ore	0	0	3.8 million tons	Moderate
Gold	0	0	51 thousand oz	
Silver	0	0	35 thousand oz	



Unit 8, Minchumina Unit

UNIT 9 - BERING GLACIER

GEOLOGIC SUMMARY

Unit 9 contains approximately 1 million acres in the Chugach-St. Elias Mountains, entirely within the Bering Glacier Quadrangle. Some of the more accessible lands in the unit have previously been selected but not conveyed to the State. Large parts of the unit are glacier covered; significant parts are at elevations above 6,000 ft and reach to over 11,000 ft.

Unit 9 is underlain by four major groups of rocks separated by major faults. On the north, a small area north of the Martin River Glacier is underlain by a belt of quartz-mica schist, gneiss, and amphibolite at elevations of 5,000 to 11,000 ft; these rocks form the peaks of Mt. Hawkins (10,295 ft) and Mt. Tom White (11,210 ft). These rocks appear to be on trend with and may be more highly metamorphosed correlatives of some parts of the Yakutat Group, which has abundant gold-bearing quartz veins in more accessible and more extensively explored areas to the west.

The belt of metamorphic rocks is bounded on the south by the Contact fault, a long linear probable strike-slip fault that underlies the Bagley Icefield and separates the metamorphic rocks from a belt of interbedded pillow basalt and thick sandstone-shale turbidites probably deposited as deep-sea submarine fans. These rocks form isolated mountain massifs and peaks that are generally above 4,000 ft and are entirely surrounded by the Bagley Icefield, Bering Glacier, Steller Glacier, and Martin River Glacier. They culminate in Waxell Ridge, Barkley Ridge, and Mount Steller (10,617 ft). In Prince William Sound and the Copper River area to the west, similar rocks are considered part of the early Tertiary Orca Group, which contains significant massive sulfide deposits that were mined in the early 20th century. In the central Bering Glacier Quadrangle, an intensely deformed part of this belt of rocks is referred to as the Yakutat Group of Jurassic and Cretaceous age, although it is lithologically similar to the less deformed roks to the west. This belt of the Orca (or Yakutat) Group is bounded on the south by the Chugach-St. Elias fault, a major thrust fault that is one of the fundamental structural features of the Chugach-St. Elias Range.

Rocks south of the Chugach-St. Elias fault consist dominantly of an extremely thick sequence of unmetamorphosed sedimentary rocks of Eocene to Pliocene age. These rocks range from nonmarine sandstone, conglomerate, shale, and coal of the Kushtaka and Kulthieth Formations at the base, to thick marine sandstone and glaciofluviatile sediments of the Poul Creek and Yakataga Formations at the top.

In addition to the lithified sedimentary section, placer gold is known on the beaches and in some of the stream drainages in the Yakataga area. These subcommercial placers have yielded small amounts of gold to a succession of prospectors since the turn of the century.

MINERAL DEPOSIT TYPES - UNIT 9

The mineral deposit models chosen to estimate the mineral endowment of Unit 9 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 9-1 through 9-3. The location of plays and their probabilistic endowment are shown in the map for Units 9 and 9A and table 9.

(1) Besshi massive sulfide: There is moderate mineral potential in plays 9-1.
(2) Metamorphic gold veins: There is moderate mineral potential in play 9-2.
(3) Gold placers: Play 9-3 shows no resources at the 5th percentile.

COAL RESOURCE POTENTIAL - UNIT 9

Tracts shown as 9-4 have moderate potential for containing coal resources because they are mapped as Tertiary Kushtaka Formation. This formation contains semi-anthracite to bituminous coal in the adjacent Carbon Mountain area where past coal mining has occurred. Tract 9-4 is shown on the Unit 9 map.

Table 9. *Deposit types and estimated mineral endowment of Unit 9, Bering Glacier*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

BESSHI MASSIVE SULFIDE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 9-1	Large area			
Ore	0	0	6.7 million tons	Moderate
Copper	0	0	120 thousand tons	
Zinc	0	0	27 thousand tons	
Silver	0	0	1,100 thousand oz	
Gold	0	0	73 thousand oz	
Cobalt	0	0	5,200 tons	

METAMORPHIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 9-2	Small area			
Ore	0	0	0.11 million tons	Moderate
Gold	0	0	31 thousand oz	
Silver	0	0	0 thousand oz	

GOLD PLACERS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 9-3	Small area			
Ore	0	0	0 million tons	Moderate
Gold	0	0	0 thousand oz	
Silver	0	0	0 thousand oz	

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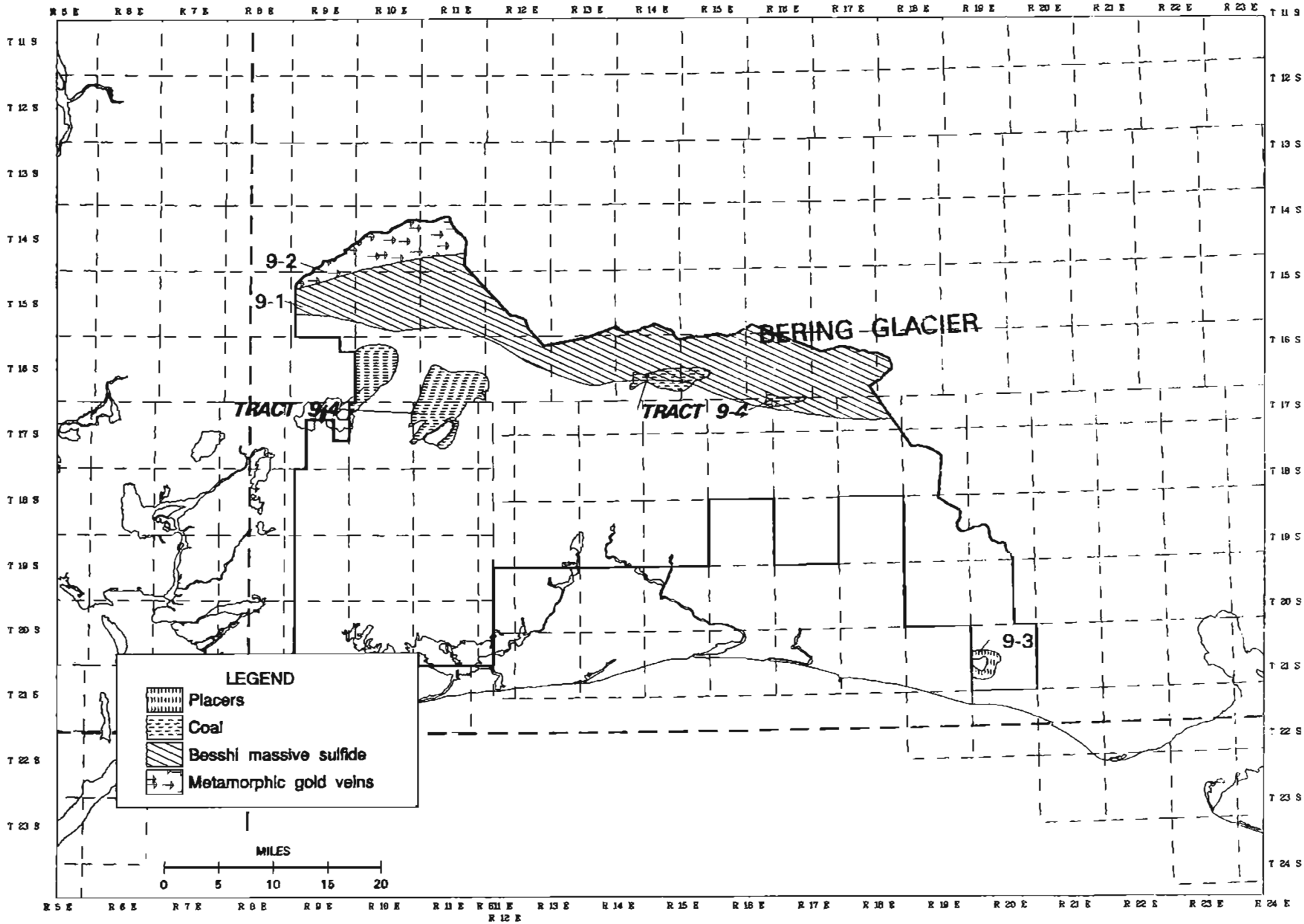

UNIT 10 - KUSKOKWIM/STONY RIVER

GEOLOGIC SUMMARY

Unit 10 encompasses over 2.8 million acres of western Lime Hills and McGrath Quadrangles in the Upper Kuskokwim River drainage of western Alaska. Most of the study area is below timberline and composed of flat-topped, carbonate-sandstone cored ridgelines averaging 350 ft in elevation. Major glacial deposits obscure lowlands in the southern third of Unit 10.

The oldest rock units are limestone dominated, platform-continental margin deposits of the Dillinger and Nixon Fork terranes, which range in age from Late Cambrian to Middle Devonian (about 530 to 380 million years old). Overlying both terranes are carbonate clastic deposits of the Mystic terrane, which ranges in age from Late Devonian to Triassic (about 530 to 210 million years old) This Paleozoic-Lower Mesozoic package of rocks shows many similarities to continental margin sequences in Yukon Territory, Canada, where major resources of lead, zinc, and silver have been found and exploited. Although the entire Paleozoic carbonate-clastic sedimentary rock section has some potential for sedex type lead-zinc-silver deposits, we have restricted our mineral tract or plays only to those portions of the section where mineral occurrences have been recognized in western Alaska.

Turbidite-dominated deposits of the Kuskokwim Group and Kahiltna terrane, both of Cretaceous age (about 145 to 65 million years old)--overlie or are in fault contact with the older bedded sequences; the Kuskokwim Group is the dominant rock lithology in the northern part of Unit 10.

Small intermediate-to-felsic plutons and dike swarms of Late Cretaceous and early Tertiary age intrude all lithologies and are part of the Kuskokwim plutonic belt, a major source of gold and other metallic resources of southwest Alaska. Gold anomalies near VABM Tough and Tatlawiksuk River are associated with this plutonic suite.

The Denali-Farewell fault system bifurcates the area into two geologic provinces: the Kuskokwim Group and platform rocks of the Nixon Fork terrane on the north versus the Dillinger and Kahiltna terranes and offset Nixon Fork stratigraphy on the south. This fault forms the mountain front of the Alaska Range and Cheeneetnuk River Valley.

Youthful northeast and north-south high-angle faults have formed grabens where Tertiary coal bearing basins have been localized. DGGS discovered a new hot springs system near Tatlaniksuk River along one of these youthful high-angle faults.

There has been no recorded mineral production in Area 10. A small mercury mine produced about 1,400 tons of cinnabar concentrates from 1963-1974 at White Mountain immediately east of Unit 10 at the head of Cheeneetnuk River.

MINERAL DEPOSIT TYPES - UNIT 10

The mineral deposit models chosen to estimate the mineral endowment of Unit 10 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 10-1 through 10-10. The location of plays and their probabilistic endowment are shown in the map for Units 10 and table 10.

(1) Granitic disseminated gold: There is high mineral potential in play 10-1, and moderate mineral potential in plays 10-2 and 10-3.
(2) Gold-copper skarns: There is moderate mineral potential in play 10-4.
(3) Sediment lead-zinc: There is high mineral potential in plays 10-5 and 10-6 and moderate mineral potential in play 10-7.

(4) Hot spring mercury: There is moderate mineral potential in play 10-8.
(5) Polymetallic veins: There is moderate mineral potential in plays 10-9 and 10-10.

COAL RESOURCE POTENTIAL - UNIT 10

These tracts have moderate potential for containing coal resources because they delineate an area of Tertiary sediments which are similar to and on trend with the Tonzona coal deposit to the northeast along the Farewell fault. The tracts are shown, but not numbered, on the Unit 10 map.

Table 10. *Deposit types and estimated mineral endowment of Unit 10, Kuskokwim River*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

GRANITIC DISSEMINATED GOLD				
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 10-1	Small area			
Ore	0	0	34 million tons	High
Gold	0	0	1,300 thousand oz	
PLAY 10-2	Small area			
Ore	0	0	0 million tons	Moderate
Gold	0	0	0 thousand oz	
PLAY 10-3	Small area			
Ore	0	0	13 million tons	Moderate
Gold	0	0	380 thousand oz	
GOLD-COPPER SKARNS				
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 10-4	Small area			
Ore	0	0	2 million tons	Moderate
Gold	0	0	190 thousand oz	
Silver	0	0	2,300 thousand oz	
Copper	0	0	23 thousand tons	
SEDIMENT LEAD-ZINC				
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 10-5	Small area			
Ore	0	0	14 million tons	High
Zinc	0	0	1,200 thousand tons	
Lead	0	0	720 thousand tons	
Silver	0	0	14,000 thousand oz	
PLAY 10-6	Small area			
Ore	0	0	28 million tons	High
Zinc	0	0	1,800 thousand tons	
Lead	0	0	990 thousand tons	
Silver	0	0	23,000 thousand oz	
PLAY 10-7	Small area			
Ore	0	0	2.3 million tons	Moderate
Lead	0	0	120 thousand tons	
Zinc	0	0	260 thousand tons	
Silver	0	0	340 thousand oz	
HOT SPRING MERCURY				
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 10-8	Small area			
Ore	0	0	24 thousand tons	Moderate
Mercury	0	0	180 tons	
Antimony	0	0	930 tons	
Gold	0	0	2 thousand oz	

POLYMETALLIC VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 10-9	Small area			
Ore	0	0	560 tons	Moderate
Silver	0	0	9 thousand oz	
Gold	0	0	0 thousand oz	
Zinc	0	0	7 tons	
Lead	0	0	49 thousand tons	
PLAY 10-10	Small area			
Ore	0	0	500 tons	Moderate
Silver	0	0	6 thousand oz	
Gold	0	0	0 thousand oz	
Zinc	0	0	13 tons	
Lead	0	0	32 tons	

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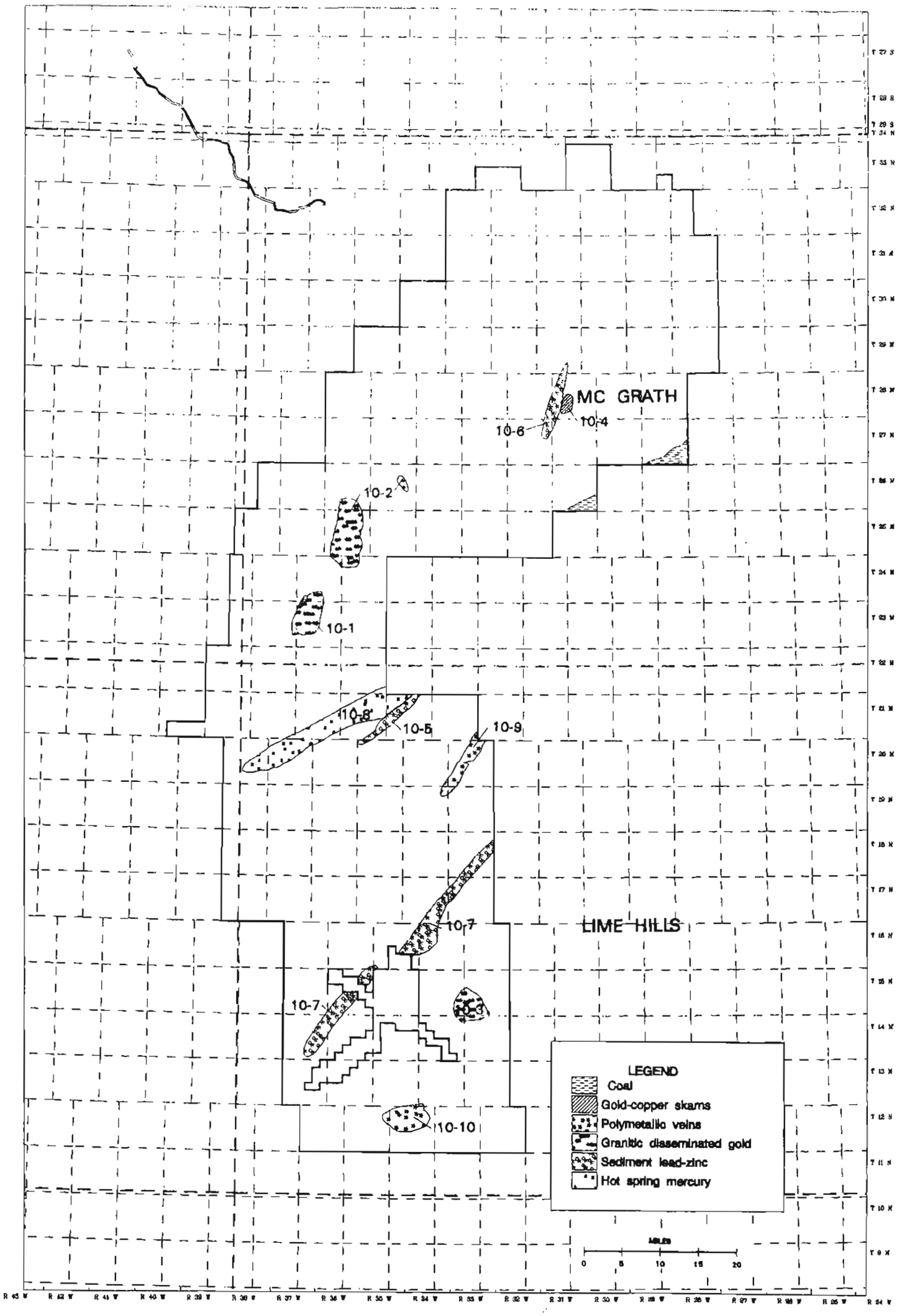


UNIT 11 - IDITAROD/GEORGE

GEOLOGIC SUMMARY

The Iditarod-George River Unit 11 covers about 3.6 million acres in the central Kuskokwim Mountains of southwestern Alaska and includes lands in the Iditarod, Sleetmute, Russian Mission, and Holy Cross Quadrangles. The region is dominated by accordant, rounded, vegetated ridges that average 1,398 ft in elevation and by steeper plutonic cored, isolated mountain ranges that average about 3,000 ft in elevation. The Kuskokwim River, Alaska's second largest river system, parallels much of the southern boundary of the unit.

The oldest rocks in Unit 11 are schist, quartzite, and gneiss of the early Proterozoic Idono sequence and are probably the oldest rocks in Alaska. Mafic metavolcanic and siliciclastic metasedimentary rocks of the Gemuk Group occur in structural slivers along the western margin of the unit.

Nearly 90 percent of Unit 11 is underlain by the Late Cretaceous Kuskokwim Group, which contains contrasting shallow water and turbidite-dominated sections along the western margin of the study area.

Plutons and associated volcanic rocks ranging in age from 55-75 million years intrude all older lithologies and occur in distinctive northeast-trending belts. Young basalt flows and Quaternary units blanket much of the study area.

Unit 11 comprises portions of the Iditarod and Aniak mining districts, where some 2,500,000 million oz of placer gold, about 41,000 flasks of mercury, and by-products of tungsten, silver, and antimony have been recovered since the early 20th century. Drill-indicated lode reserves contained in auriferous plutons of the Iditarod-Flat district are currently estimated at 415,000 oz gold. The Iditarod district is Alaska's third-largest producer of placer gold. Commercial recovery of placer gold and modern mineral exploration is currently taking place in the study area.

All known metallic mineral resources are associated with Late Cretaceous-early Tertiary (55-75 million-year-old) plutonic and volcanic rocks of the Kuskokwim Igneous Belt and are therefore metallogenically-related. This belt of rocks has become a focus of hard rock gold exploration throughout western Alaska. Erosion of the mineralized igneous complexes has produced the well-known placer gold deposits of the area. An elongate belt of true granites appears to host several molybdenum porphyry deposits from Molybdenum Mountain northward to the Fox Hills.

MINERAL DEPOSIT TYPES - UNIT 11

The mineral deposit models chosen to estimate the mineral endowment of Unit 11 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 11-1 through 11-16. The location of plays and their probabilistic endowment are shown in the map for Unit 11 and table 11.

(1) Granitic disseminated gold: There is high mineral potential in play 11-1.
(2) Granitic gold veins: There is high mineral potential in plays 11-2 and 11-3 and moderate mineral potential in play 11-4.
(3) Granite tin greisens: There is high mineral potential in play 11-5 and moderate mineral potential in play 11-6.
(4) Gold placers: There is high mineral potential in play 11-7 and moderate mineral potential in play 11-8.
(5) Porphyry copper-molybdenum: There is high mineral potential in play 11-9.
(6) Hot spring mercury: There is high mineral potential in play 11-10 and moderate mineral potential in plays 11-11, 11-12, and 11-13.
(7) Volcanic gold-silver: There is moderate mineral potential in play 11-14.
(8) Granite uranium-rare earth: There is moderate mineral potential in plays 11-15 and 11-16.

Table 11. *Deposit types and estimated mineral endowment of Unit 11, Iditarod/George*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

GRANITIC DISSEMINATED GOLD

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 11-1	Small area			
Ore	0	16 million tons	98 million tons	High
Gold	0	480 thousand oz	5,000 thousand oz	

GRANITIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 11-2	Small area			
Ore	0	1.8 million tons	16 million tons	High
Gold	0	240 thousand oz	2,000 thousand oz	
PLAY 11-3	Small area			
Ore	0	0	3.2 million tons	High
Gold	0	0	440 thousand oz	
PLAY 11-4	Extremely large area			
Ore	0	0	9.8 million tons	Moderate
Gold	0	0	1,500 thousand oz	

GRANITE TIN GREISENS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 11-5	Small area			
Ore	0	0.92 million tons	180 million tons	High
Tin	0	0 thousand tons	350 thousand tons	
Niobium	0	0 tons	7,100 tons	
Beryllium	0	0 tons	8,100 tons	
Fluoride	0	0 thousand tons	1,100 thousand tons	
Silver	0	0 thousand oz	20,000 thousand oz	
Tungsten	0	0 thousand tons	2 thousand tons	
PLAY 11-6	Small area			
Ore	0	0	4.5 million tons	Moderate
Tin	0	0	11 thousand tons	
Niobium	0	0	0 tons	
Beryllium	0	0	0 tons	
Fluoride	0	0	0 thousand tons	
Silver	0	0	170 thousand oz	
Tungsten	0	0	0 thousand tons	

GOLD PLACERS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 11-7	Small area			
Ore	0	6 million tons	27 million tons	High
Gold	0	67 thousand oz	420 thousand oz	
Silver	0	31 thousand oz	320 thousand oz	

Mercury	0	0 tons	2,700 tons	

GOLD PLACERS CONTINUED

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 11-8	Small area			
Ore	0	0	11 million tons	Moderate
Gold	0	0	190 thousand oz	
Silver	0	0	120 thousand oz	
Mercury	0	0	42,000 thousand tons	

PORPHYRY COPPER-MOLYBDENUM

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 11-9	Small area			
Ore	0	0	260 million tons	High
Copper	0	0	930 thousand tons	
Moly	0	0	38 thousand tons	
Gold	0	0	0 thousand oz	
Silver	0	0	8,700 thousand oz	

HOT SPRING MERCURY

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 11-10	Small area			
Ore	0	9.9 thousand tons	740 thousand tons	High
Mercury	0	44 tons	5,400 tons	
Antimony	0	0 thousand tons	32 thousand tons	
Silver	0	1 thousand oz	120 thousand oz	
PLAY 11-11	Small area			
Ore	0	0	17 thousand tons	Moderate
Mercury	0	0	120 tons	
Antimony	0	0	0 thousand tons	
Silver	0	0	3 thousand oz	
PLAY 11-12	Small area			
Ore	0	0	11 thousand tons	Moderate
Mercury	0	0	56 tons	
Antimony	0	0	0 thousand tons	
Silver	0	0	1 thousand oz	
PLAY 11-13	Large area			
Ore	0	0	11 thousand tons	Moderate
Mercury	0	0	41 tons	
Antimony	0	0	0 thousand tons	
Silver	0	0	1 thousand oz	

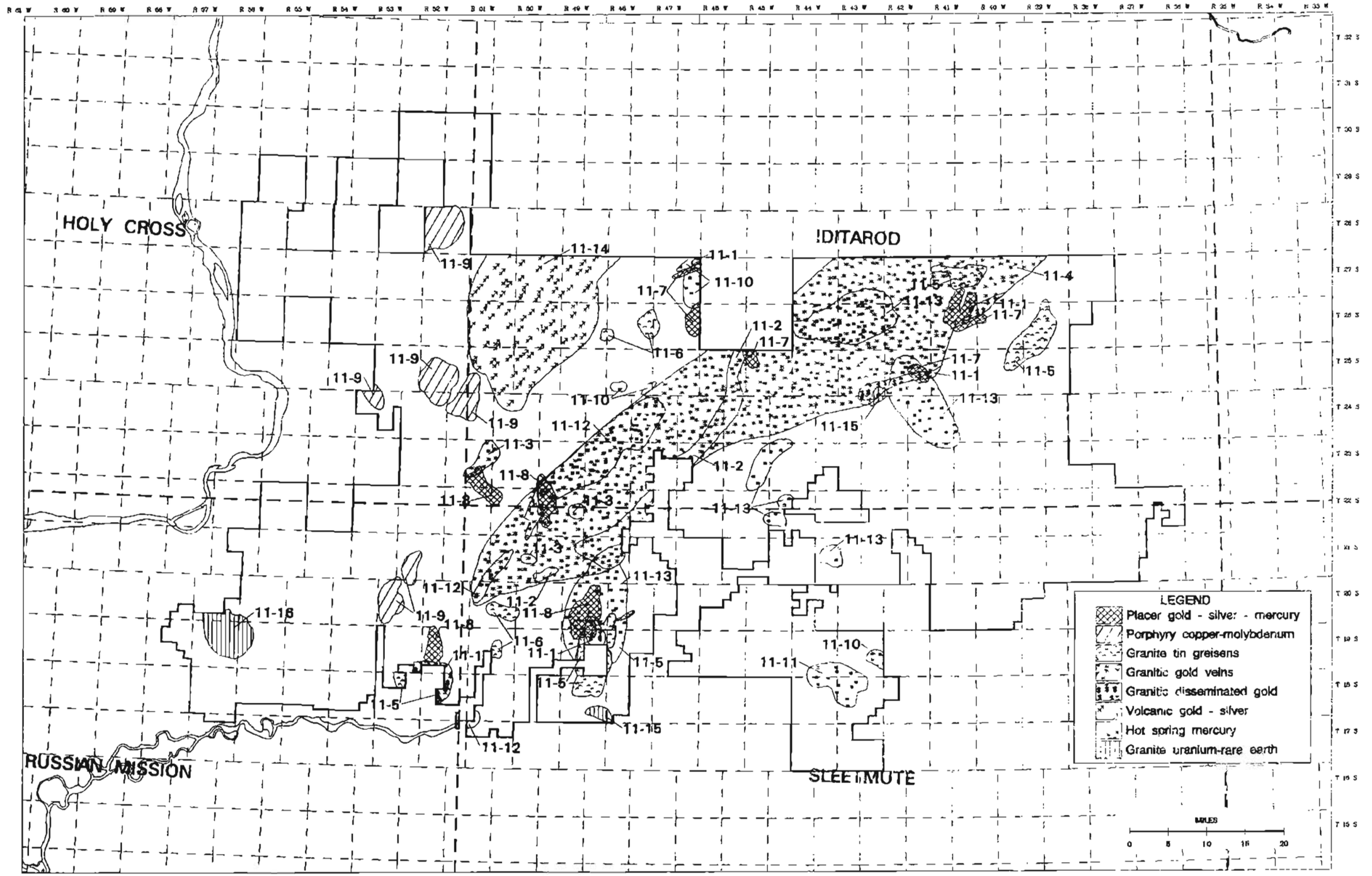
VOLCANIC GOLD-SILVER

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 11-14	Large area			
Ore	0	0	2.8 million tons	Moderate
Gold	0	0	520 thousand oz	

Silver	0	0	13,000 thousand oz	

GRANITE URANIUM-RARE EARTH

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 11-15	Small area			
Ore	0	0.25 million tons	0.83 million tons	Moderate
Uranium	0	290 tons	1,900 tons	
Rare Earth	0	660 tons	11,000 tons	
PLAY 11-16	Small area			
Ore	0	0	0.43 million tons	Moderate
Uranium	0	0	610 tons	
Rare Earths	0	0	1,300 tons	



Unit 11, Iditarod / George Unit

UNIT 12 - NYAC

GEOLOGIC SUMMARY

Unit 12 is situated in the northern Kilbuck Mountains, the last major mountainous region of southwest Alaska that merges with the broad Yukon-Kuskokwim Delta. Most of the 439,000 acre area is drained by the Tuluksak River, a major tributary of the Kuskokwim River drainage. The Tulgksak River flows south and northwest 90 mi to the Kuskokwim River.

The oldest rocks outcrop in a small structural sliver in the southernmost limit of the unit and are composed of tholeiitic pillow basalt and chert of the Paleozoic-Mesozoic Goodnews terrane. Extensive andesite flows and tuff and marine sandstone of the Jurassic Nyac terrane underlie about a third of the central and northern portions, mainly north of Tuluksak River. Although the volcanic-sedimentary rocks of the Nyac terrane might contain volcanogenic massive sulfide deposits, on the basis of geochemisty, geology, and geophysics, we judge this potential as low.

The Late Cretaceous Kuskokwim Group, which is largely composed of marine turbidites and shallow water shoreline facies sedimentary rocks, flanks the Nyac terrane on the south and trends southwest making up most of the southern half of Unit 12.

Two ages of mineralized, gold-molybdenum-bearing stocks occur: (1) 110-million-year old Nyac and Sawmill Creek plutons mainly north of Tuluksak River; and (2) 65-70-million-year-old plutons and small plugs that occur in the Mt. Plummer and Marvel Dome area and as a linear belt of dikes oblique to the drainage of Bear Creek.

Subaerial volcanic flows and tuffs, probably coeval with the younger plutons described above, cover the northern foothills flanking the Whitefish Lake lowlands. Glacial fluvial deposits have infilled upper Bear Creek and other tributaries flanking Mt. Plummer.

The Nyac mining district is centered in the study area and has been an important producer of placer gold since 1908. Recorded gold production within Unit 12 is estimated at 525,900 oz of gold. Most production has taken place in Bear and California Creek and tributaries of Tuluksak River. Minor gold production has also taken place on Marvel Creek. Mineralized plutonic bodies and epithermal zones in volcanic rocks appear to be the lode source of the placer gold. Overall, the Cretaceous plutonic bodies comprise the southwestern extension of the Kuskokwim mineral belt, which is a major source of gold, antimony, tin, and mercury in western Alaska.

MINERAL DEPOSIT TYPES - UNIT 12

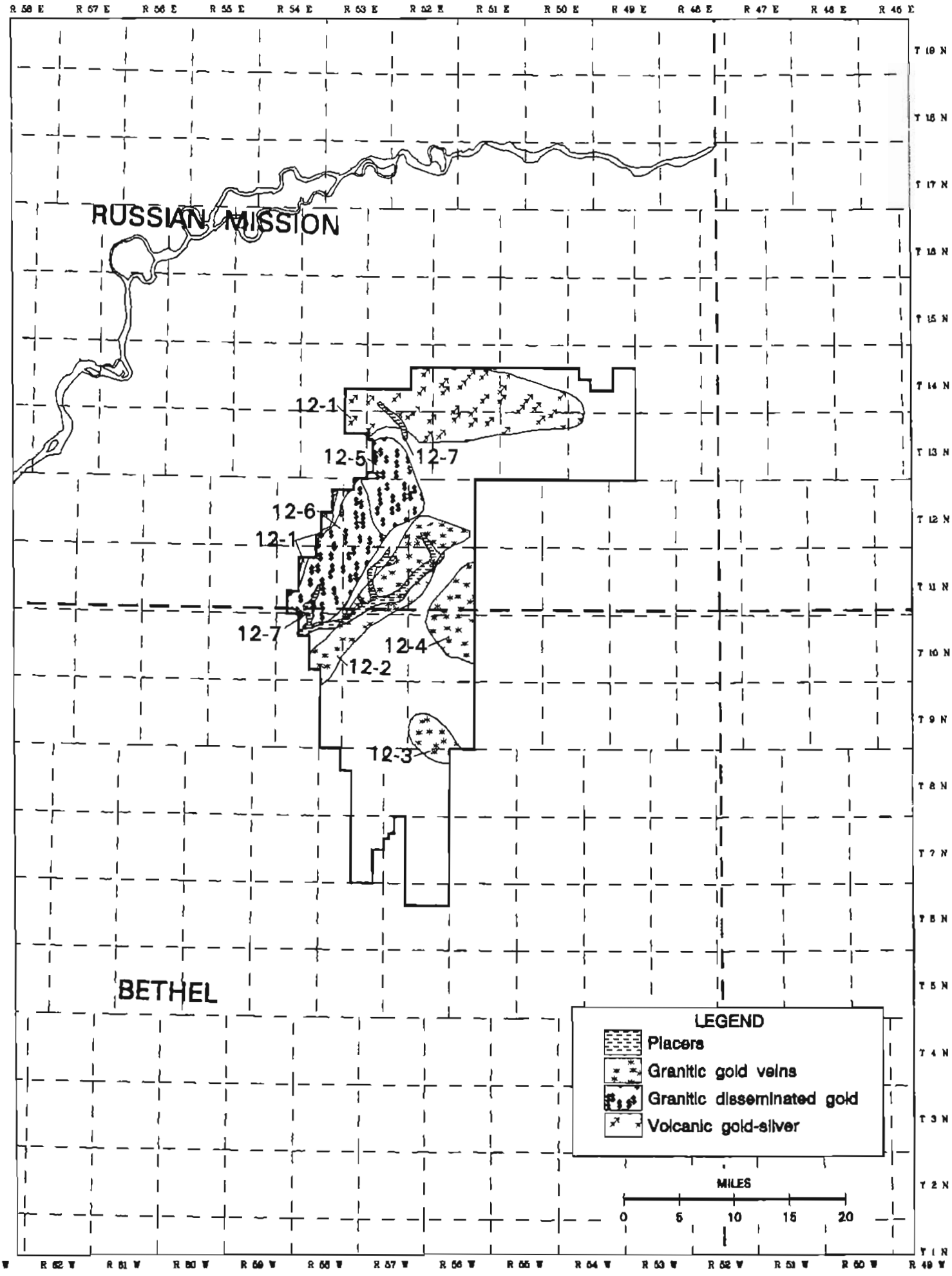
The mineral deposit models chosen to estimate the mineral endowment of Unit 12 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 12-1 through 12-7. The location of plays and their probabilistic endowment are shown in the map of Unit 12 and table 12.

(1) Volcanic gold-silver: There is high mineral potential in play 12-1.
(2) Granitic gold veins: There is high mineral potential in plays 12-2 and 12-4 and moderate mineral potential in play 12-3.
(3) Granitic disseminated gold: There is a high mineral potential in play 12-5 and moderate mineral potential in play 12-6.
(4) Gold placers: There is high mineral potential in play 12-7.

Table 12. *Deposit types and estimated mineral endowment of Unit 12, Nyac*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

VOLCANIC GOLD-SILVER				
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 12-1	Medium area			
Ore	0	0	11 million tons	High
Gold	0	0	3,400 thousand oz	
Silver	0	0	96,000 thousand oz	
GRANITIC GOLD VEINS				
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 12-2	Small area			
Ore	0	0.93 million tons	6.9 million tons	High
Gold	0	110 thousand oz	1,100 thousand oz	
PLAY 12-3	Small area			
Ore	0	0	1.0 million tons	Moderate
Gold	0	0	110 thousand oz	
PLAY 12-4	Small area			
Ore	0	0.066 million tons	3.4 million tons	High
Gold	0	8 thousand oz	430 thousand oz	
GRANITIC DISSEMINATED GOLD				
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 12-5	Small area			
Ore	0	0	19 million tons	High
Gold	0	0	820 thousand oz	
PLAY 12-6	Small area			
Ore	0	0	3.4 million tons	Moderate
Gold	0	0	110 thousand oz	
GOLD PLACERS				
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 12-7	Small area			
Ore	0	9.5 million tons	46 million tons	High
Gold	0	110 thousand oz	670 thousand oz	
Silver	0	55 thousand oz	480 thousand oz	



Unit 12, Nyak Unit

UNIT 13 - SOUTHEAST KVICHAK RIVER

GEOLOGIC SUMMARY

Unit 13 encompasses almost 1.2 million acres of land immediately west and southwest of Lake Iliamna, Alaska's largest body of fresh water. More than 90 percent of the tract lies in the Nushagak lowland province; low foothills flanking Katmai National Park occur in the southeast portion of the study area.

The oldest rock units are Mesozoic clastic and volcanic rocks that have been intruded by Cretaceous - Tertiary intermediate plutons. The major oxide chemistry of two small outcrop areas of plutonic rock in the study area is similar to that reported near the Pebble Copper prospect near Non Dalton.

Almost all of the area is covered with a Wisconsin-age extensive till and glaciofluvial outwash which was deposited about 30,000 to 70,000 years ago.

MINERAL DEPOSIT TYPES - UNIT 13

The mineral deposit model chosen to estimate the mineral endowment of Unit 13 is listed below. The permissive areas for each mineral deposit type are referred to as "plays." The location of the play for Unit 13 and its probabilistic endowment is shown in the map for Unit 13 and table 13.

(1) Porphyry copper-molybdenum: There is moderate mineral potential in play 13-1. The play shows no resources at the 5th percentile.

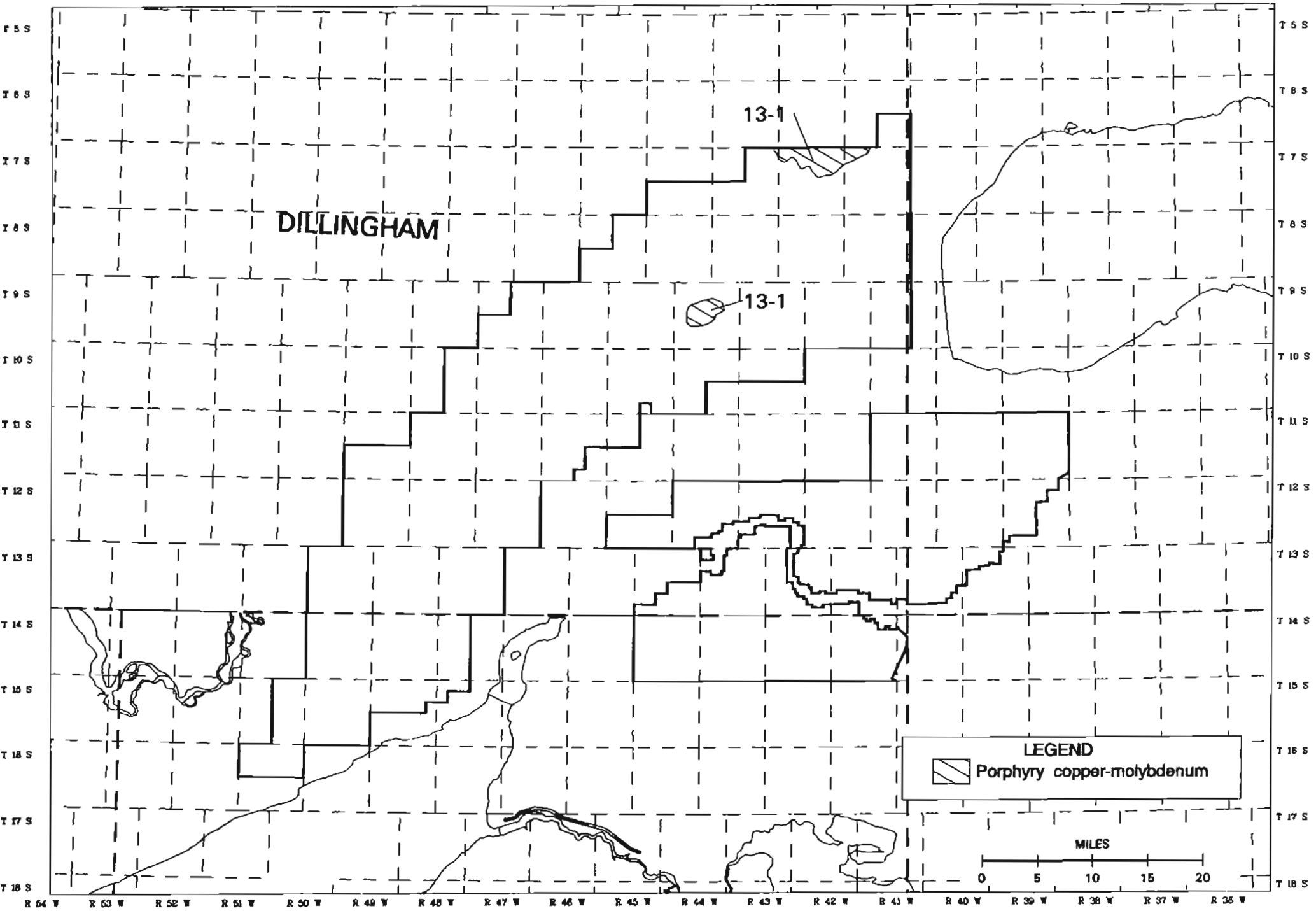
Table 13. *Deposit types and estimated mineral endowment of Unit 13, Southeast Kvichak River*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

PORPHYRY COPPER-MOLYBDENUM

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 13-1	Small area			
Ore	0	0	0 million tons	Moderate
Copper	0	0	0 thousand tons	
Molybdenum	0	0	0 thousand tons	
Gold	0	0	0 thousand oz	
Silver	0	0	0 thousand oz	

Date: 04/07/93 R. Clement



UNIT 14 - GOODNEWS BAY

GEOLOGIC SUMMARY

Unit 14 encompasses 327,000 acres in the southwestern part of the Goodnews Bay Quadrangle. The area is composed largely of sedimentary and mafic volcanic rocks of the Goodnews terrane, interspersed with mountains composed of ultramafic and mafic plutonic rocks. Three granitic plutons intrude the volcanic and sedimentary rocks. A small portion near the northern area contains older, foliated metamorphic rocks of the Kilbuck terrane.

The Kilbuck terrane consists of very foliated metamorphic rocks of pre-Cambrian age that are thought to be the oldest rocks in Alaska (2.1 billion years old). The Kilbuck terrane exhibits an Early Proterozoic amphibolite-facies metamorphic and an Early Cretaceous greenschist-facies retrograde metamorphic event. The rocks include biotite-hornblende gneiss, garnetiferous amphibolite, quartz-mica schist, and marble.

The Goodnews terrane (largely consisting of rocks of the Gemuk Group) is composed of metabasalt, meta-andesite, schist, and lesser graywacke, slate, marble, chert, and limestone, and covers most of Unit 14. The rocks in this unit range from Early Ordovician(?) to Early Cretaceous (about 500 to 115 million years old). Metamorphism is generally in the greenschist facies.

The ultramafic and mafic bodies are composed of dunite, clinopyroxenite, and gabbroic rocks. All visible contacts of the bodies are faults. These rocks are probably ophiolitic and, hence, represent either oceanic crust of some form or accumulations of material beneath an island arc. These rocks are correlated with mafic and ultramafic rocks of Jurassic age of southeast Alaska near Goodnews Bay and in the Ophir district.

The granitic plutonic rocks range from diorite to granodiorite in composition and are all thought to be Cretaceous or early Tertiary in age (about 135 to 40 million years old).

Significant gold placer production is known to have occurred in several areas within Unit 14—notably at Snow Gulch, and Wattamuse, Butte, and KowKow Creeks. A small bucketline dredge, now in a state of disrepair, is present in Wattamuse Creek. Total production from the study area from 1916 to 1941 has been estimated at 29,700 oz of gold and about 3,400 oz of silver. Also, about 150 oz of platinum were recovered from Snow Gulch. The chance for discovery of new placer gold resources is considered to be moderate in this area.

The potential for plutonic-related gold lode deposits is moderate to good. Two bodies, the Wattamuse and the Ikuktlitlig plutons, are dioritic to monzodioritic in composition, and are very similar to plutonic rocks associated with gold in the Iditarod-Flat, Innoko, and Vinasale district to the northeast of the area. Gold-bearing quartz veins were found to have up to 0.45 oz/ton gold in parts of the Wattamuse pluton, and are thought to be the source of placer gold in Wattamuse Creek.

Platinum group element and chromite deposits are potentially present in the ultramafic and mafic rocks in Unit 14. Platinum groups elements have been found associated with gold placers in the north-central part of Unit 14. However, no anomalous values of platinum or palladium were found in the rock samples taken in this survey, and no significant chromite concentrations were found anywhere.

Rift-related polymetallic volcanogenic massive sulfide deposits (VMS) may be present in Unit 14. However, the likelihood is low that a VMS deposit of this type could be present in the Goodnews Bay terrane of Unit 14.

MINERAL DEPOSIT TYPES - UNIT 14

The mineral deposit models chosen to estimate the mineral endowment of Unit 14 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 14-1 through 14-11. The location of the plays and their probabilistic endowment estimates are shown in the map for Unit 14 and table 14.

(1) Granitic gold veins: There is high mineral potential in plays 14-1, 2, and 3.
(2) Gold placers: There is high mineral potential in play 14-4.
(3) Placer gold platinum: There is high mineral potential in play 14-5.
(4) Rift polymetal massive sulfide: There is high mineral potential in play 14-6 and moderate mineral potential in play 14-7.
(5) Podiform chromite: There is moderate mineral potential in play 14-8.
(6) Magmatic sulfide: There is moderate mineral potential in plays 14-9.
(7) Platinum group elements: There is moderate mineral potential in plays 14-10 and 14-11.

Table 14. *Deposit types and estimated mineral endowment of Unit 14, Goodnews Bay*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

GRANITIC GOLD VEINS				
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 14-1	Small area			
Ore	0	0	2.9 million tons	High
Gold	0	0	360 thousand oz	
PLAY 14-2	Small area			
Ore	0	0.8 million tons	6.3 million tons	High
Gold	0	37 thousand oz	980 thousand oz	
PLAY 14-3	Small area			
Ore	0	0.5 million tons	6.8 million tons	High
Gold	0	65 thousand oz	960 thousand oz	
GOLD PLACERS				
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 14-4	Small area			
Ore	0	0.2 million tons	2.7 million tons	High
Gold	0	2 thousand oz	41 thousand oz	
Silver	0	1 thousand oz	29 thousand oz	
PLACER GOLD PLATINUM				
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 14-5	Small area			
Ore	0	0	4.4 million tons	High
Platinum	0	0	250 thousand oz	
Gold	0	0	2 thousand oz	
RIFT POLYMETAL MASSIVE SULFIDE				
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 14-6	Small area			
Ore	0	0	1.8 million tons	High
Zinc	0	0	87 thousand tons	
Copper	0	0	21 thousand tons	
Lead	0	0	21 thousand tons	
Silver	0	0	0 thousand oz	
Gold	0	0	0 thousand oz	
PLAY 14-7	Very large area			
Ore	0	0	0.8 million tons	Moderate
Zinc	0	0	45 thousand tons	
Copper	0	0	21 thousand tons	
Lead	0	0	22 thousand tons	
Silver	0	0	0 thousand oz	
Gold	0	0	0 thousand oz	

PODIFORM CHROMITE

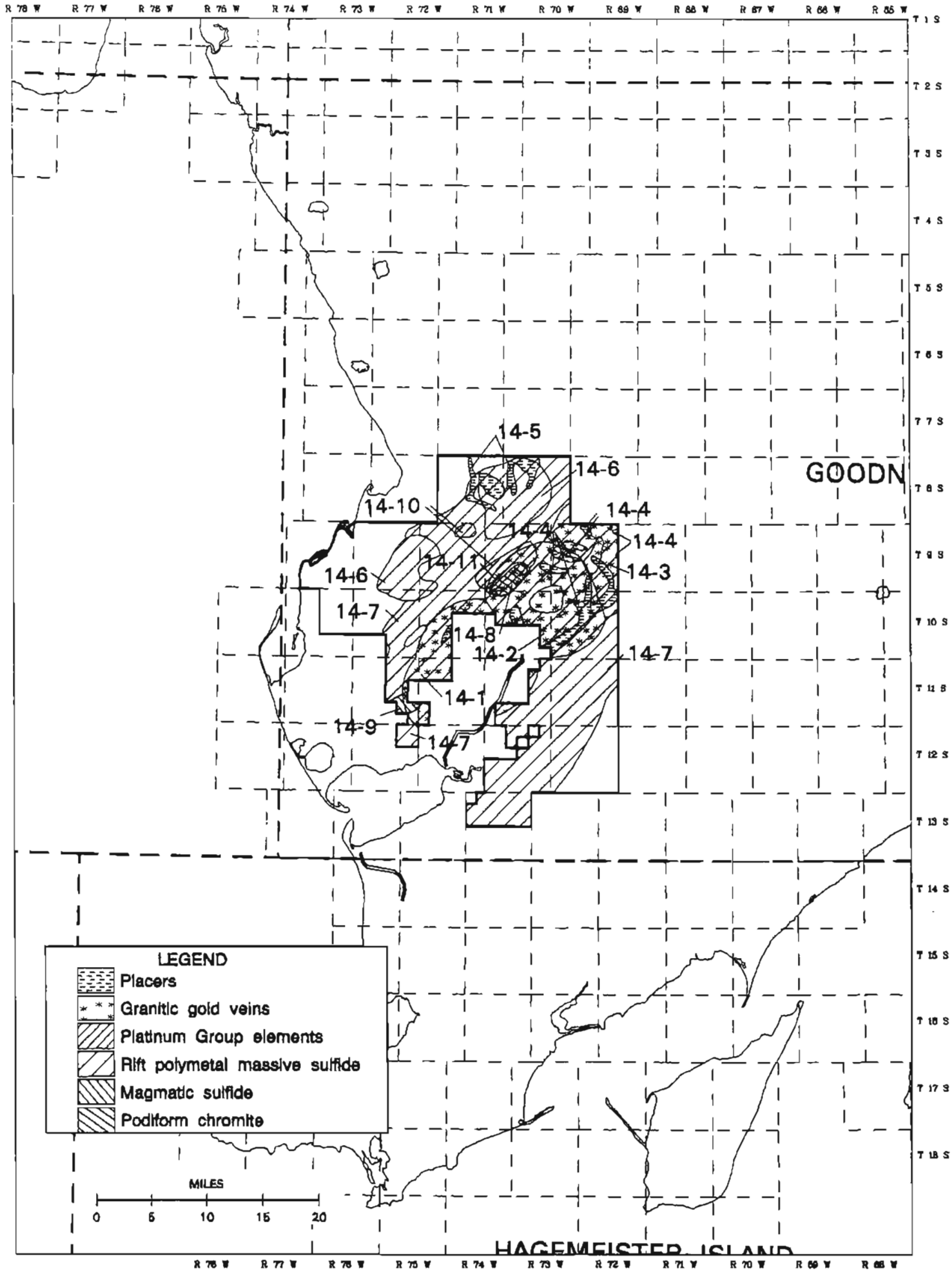
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 14-8	Small area			
Ore	0	0	0 million tons	Moderate
Chromium	0	0	0 thousand tons	

MAGMATIC SULFIDE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 14-9	Small area			
Ore	0	0	0.5 million tons	Moderate
Copper	0	0	1 thousand tons	
Nickel	0	0	3 thousand tons	

PLATINUM GROUP ELEMENTS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 14-10	Small area			
Ore	0	0	3.8 million tons	Moderate
Nickel	0	0	1.8 thousand tons	
Copper	0	0	0.1 thousand tons	
Platinum	0	0	3.6 thousand oz	
Palladium	0	0	7.6 thousand oz	
PLAY 14-11	Small area			
Ore	0	0	0.6 million tons	Moderate
Nickel	0	0	0.2 thousand tons	
Copper	0	0	0.0 thousand tons	
Platinum	0	0	0.1 thousand oz	
Palladium	0	0	0.4 thousand oz	



Unit 14, Goodnews Bay Unit

UNIT 15 - UNALAKLEET/NULATO HILLS

GEOLOGIC SUMMARY

The Unalakleet/Nulato Hills Unit 15 covers about 3.5 million acres in the lower Yukon drainage basin of western Alaska. The unit forms an irregular, elongate, north trending block that is bounded on the south and east by the Yukon River, on the north by Norton Sound and the Chirusky River, and on the west by the Andreafsky Hills. The region is dominated by accordant rounded summits that average 985 ft in height and alluvial-filled lowlands that average 150 ft in elevation. About 95 percent of the study area is below timberline and heavily vegetated.

The regional geological framework has been summarized in previous U.S. Geological Survey reconnaissance studies. Because much of Unit 15 was largely unmapped, DGGS heavily incorporated its own geological studies in this analysis. Units range in age from mid-Paleozoic to Quaternary. The oldest rocks, mafic schist and metagranite of Mississippian(?) age (about 330 million years old), are near Marshall.

A heterogeneous package of carbonate, pillow basalt, chert, and clastic sedimentary rocks of the Koyukuk terrane underlies about 50 percent of Unit 15. Part of the Koyukuk terrane includes an elongate belt of ophiolites offset right laterally along the Chirosky Fault, a splay of the Kaltag Fault. Two belts of Cretaceous flysch overlie the Koyukuk terrane. Although some volcanogenic massive sulfide mineralization exists in the Koyukuk terrane, we judged this potential to be low and did not model it in this analysis.

The area of the Koyakuk terrane is intruded and overlain with Late Cretaceous volcanic-plutonic complexes at Wolf Mountain and Blackburn Hills and with dike swarms and small intrusions. Late Tertiary-to-Quaternary alkaline basaltic volcanic rocks form conspicuous plateaus west of Wolf Mountain and along the entire southern margin of Norton Sound. The Wolf Creek complex contains elevated levels of rare earth elements, arsenic, thorium, uranium, mercury, and molybdenum, particularly near its intrusive core. Wolf Mountain is a classic caldera complex that exhibits geologic features similar to Cripple Creek and Summitville in Colorado, McDermott in Nevada, and Emperor in Fiji.

The southern portion of Unit 15 includes the Marshall mining district which has produced approximately 121,600 ozs of gold from 1913 to the present. Principal producing streams are confined to three small, geographically isolated areas: (1) the Wilson-Willow Creeks area just east of Marshall; (2) the Kako-Buster Creeks area north of Russian Mission; and (3) the Stuyahok River area west-northwest of Holy Cross. Commercial gold is being produced in the latter two areas.

Known metallic mineral resources in Unit 15 include post-accretionary, plutonic-associated precious metal and pre-accretionary, metamorphic gold types. On the basis of geochemical and geologic characteristics, we speculate that metamorphogenic gold deposits are the source rocks for gold in the Wilson-Willow Creek areas of the Marshall mining district.

MINERAL DEPOSIT TYPES - UNIT 15

The mineral deposit models chosen to estimate the mineral endowment of Unit 15 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 15-1 through 15-14. The location of plays and their probabilistic endowment are shown in the map for Unit 15 and table 15.

(1) Metamorphic gold veins: There is high mineral potential in play 15-1.
(2) Granitic disseminated gold: There is high mineral potential in play 15-2 and moderate mineral potential in plays 15-3 and 15-4.
(3) Gold placers: There is high mineral potential in play 15-5 and moderate mineral potential in play 15-6.
(4) Podiform chromite: There is moderate mineral potential in plays 15-7 and 15-8.
(5) Magmatic sulfide: There is moderate mineral potential in plays 15-9 and 15-10.

(6) Platinum group elements: There is moderate mineral potential in plays 15-11 and 15-12.
(7) Titanium beach placer: There is high mineral potential in play 15-13.
(8) Volcanogenic uranium: There is moderate mineral potential in play 15-14.

Table 15. *Deposit types and estimated mineral endowment of Unit 15. Unalakleet/Nulato Hills*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

METAMORPHIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 15-1	Small area			
Ore	0	0.2 million tons	13 million tons	High
Gold	0	51 thousand oz	3,500 thousand oz	
Silver	0	0 thousand oz	92 thousand oz	

GRANITIC DISSEMINATED GOLD

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 15-2	Small area			
Ore	0	0	30 million tons	High
Gold	0	0	1,200 thousand oz	
PLAY 15-3	Small area			
Ore	0	0	23 million tons	Moderate
Gold	0	0	1,000 thousand oz	
PLAY 15-4	Small area			
Ore	0	0	23 million tons	Moderate
Gold	0	0	680 thousand oz	

GOLD PLACERS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 15-5	Small area			
Ore	0	0.1 million tons	1.7 million tons	High
Gold	0	1 thousand oz	26 thousand oz	
Silver	0	1 thousand oz	19 thousand oz	
PLAY 15-6	Small area			
Ore	0	0	2.4 million tons	Moderate
Gold	0	0	33 thousand oz	
Silver	0	0	26 thousand oz	

PODIFORM CHROMITE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 15-7	Medium area			
Ore	0	0	0.3 million tons	Moderate
Chromium	0	0	130 thousand tons	
PLAY 15-8	Small area			
Ore	0	0	1.3 million tons	Moderate
Chromium	0	0	570 thousand tons	

MAGMATIC SULFIDE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 15-9	Medium area			
Ore	0	0	92 million tons	Moderate
Copper	0	0	660 thousand tons	
Nickel	0	0	860 thousand tons	
PLAY 15-10	Small area			
Ore	0	0	13 million tons	Moderate
Nickel	0	0	22 thousand tons	
Copper	0	0	3 thousand oz	
Platinum	0	0	38 thousand oz	
Palladium	0	0	120 thousand oz	

PLATINUM GROUP ELEMENTS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 15-11	Medium area			
Ore	0	0	0 million tons	Moderate
Nickel	0	0	0 thousand tons	
Copper	0	0	0 tons	
Platinum	0	0	0 thousand oz	
Palladium	0	0	0 thousand oz	
PLAY 15-12	Small area			
Ore	0	0	0 million tons	Moderate
Copper	0	0	0 tons	
Nickel	0	0	0 thousand tons	

TITANIUM BEACH PLACER[a]

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 15-13	High area			
Ore	10 million tons	50 million tons	75 million tons	High
Ilmenite	130 thousand tons	650 thousand tons	975 thousand tons	
Zircon	30 thousand tons	150 thousand tons	225 thousand tons	
Rutile	87 thousand tons	445 thousand tons	658 thousand tons	

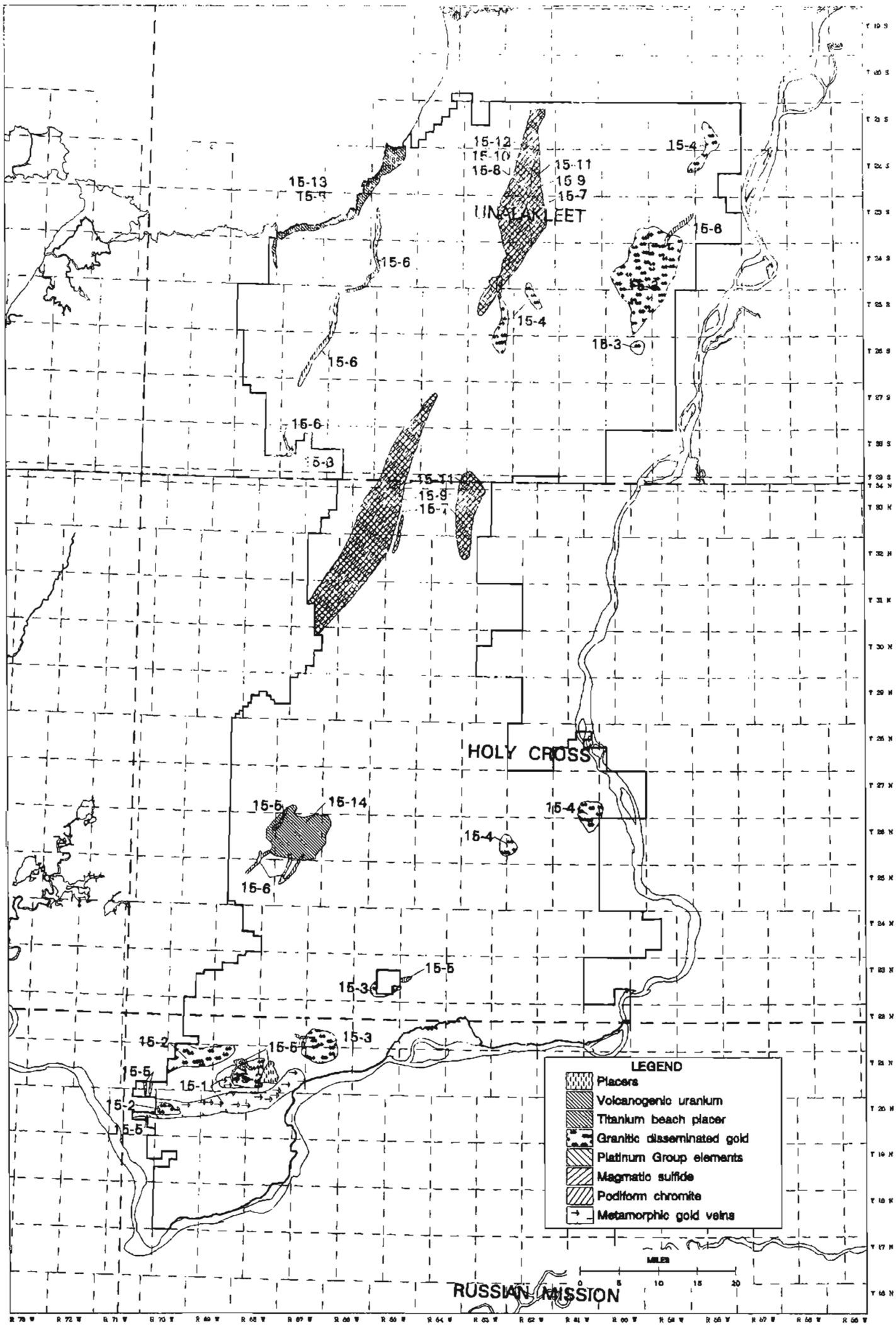
[a]Estimates based on unpublished grade/tonnage data supplied by Dennis Cox and Emil Aterasi (USGS) and from Laznika (1985).

Source:

Laznicka, P., 1985, Empirical Metallogeny, v. 1: Elsevier, Amsterdam, 1758 p.

VOLCANOGENIC URANIUM

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 15-14	Small area			
Ore	0	1.1 million tons	4.6 million tons	Moderate
Uranium	0	1,000 tons	6,500 tons	


15-13
15-12
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UNALAKLEET
15-6
15-3
15-14
HOLY CROSS
15-5
15-2
15-1
RUSSIAN MISSION
LEGEND
Placers
Volcanogenic uranium
Titanium beach placer
Granitic disseminated gold
Platinum Group elements
Magmatic sulfide
Podiform chromite
Metamorphic gold veins
MILES
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20

UNIT 16 - BUCKLAND

GEOLOGIC SUMMARY

The Buckland Unit 16 encompasses 7.1 million acres in the Unalakleet, Norton Bay, Candle, Selawik, Shungnak, Kateel River, and Nulato Quadrangles. The area is underlain by Jurassic to Cretaceous volcanic rocks of the Koyukuk terrane and onlapping mid-Cretaceous clastic rocks of the Yukon-Koyukuk basin. Both are intruded and overlain by Cretaceous and Tertiary plutonic and volcanic rocks. Locally, Quaternary basalt overlies the older units.

Mineralization deposit models are primarily associated with the Cretaceous and Tertiary plutonic and volcanic rocks and their derivative deposits. In the northern portion of Unit 16, the Selawik Hills plutonic complex contains a potassic series of syenite, monzonite, quartz monzonite and granite, and an ultrapotassic series of feldspathoid-bearing syenites. The ultrapotassic series is favorable for uranium and rare earth element mineralization, as are altered zones with high radiogenic anomalies in the potassic series. The potassic series is compositionally favorable for hosting gold, though no anomalies are known. However it is thought likely that gold and heavy mineral placer deposits are present around the plutonic complex, both in recent alluvium and in underlying Tertiary sediments. The Tertiary sediments, north of the Selawik Hills, are also favorable for sediment-hosted uranium deposits.

In the Jurassic and Cretaceous volcanic and clastic rocks in the middle portion of Unit 16, there is low to moderate potential for gold placer deposits. Unexposed plutons have been hypothesized for the area, and these could also be related to gold deposits.

In the Ungalik River area, there is present and historic gold placer activity. This area is considered highly favorable for continued production, not only along the present Ungalik River channel, but in a broader region where air-photo interpretation indicates the presence of paleochannels due to ancient sea level changes. Strandline placers may have formed along the ancestral beachlines where the Ungalik River entered Norton Sound. Mineralization related to felsic intrusive activity in the ridge west of the Ungalik River is considered highly favorable at the southern end of the ridge and less favorable further north. The potential for deposits around Christmas Mountain is moderate to high.

A previously unreported occurrence of stockwork vein mineralization related to the Poison Creek volcanic field is considered to have good potential for a gold- and silver-bearing epithermal mineral deposit.

Coal is known to occur locally in the Cretaceous clastic rock unit. However, no extensive deposits are known within Unit 16, and potential is considered low. There is also coal reported in Tertiary sedimentary rocks underlying the basin north of Selawik Hills. The coal is probably not high rank, no thick beds are known.

MINERAL DEPOSIT TYPES - UNIT 16

The mineral deposit models chosen to estimate the mineral endowment of Unit 16 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 16-1 through 16-17. The location of plays and their probabilistic endowment are shown in the map for Unit 16 and table 16.

(1) Granitic gold veins: There is high mineral potential in plays 16-3 and 16-4 and moderate mineral potential in plays 16-1, 16-2, and 16-5.
(2) Granitic disseminated gold: There is moderate mineral potential in play 16-6.
(3) Gold placers: There is high mineral potential in plays 16-7, 16-8, and 16-9 and moderate mineral potential in plays 16-10, 16-11, 16-12, and 16-13.
(4) Volcanic gold-silver: There is high mineral potential in play 16-14.
(5) Polymetallic veins: There is moderate mineral potential in play 16-15.

(6) Sediment-hosted uranium: There is high mineral potential in play 16-16.
(7) Granite uranium-rare earth: There is high mineral potential but small area in plays 16-18, 16-19, and 16-20, and moderate mineral potential in play 16-17.

COAL RESOURCE POTENTIAL - UNIT 16

Tract 16-21 has moderate potential for containing coal resources because it delineates an area of rocks similar to bituminous coal-bearing rocks along the Yukon River between Kaltag and Nulato. Tract 16-21 is shown on the Unit 16 map.

Table 16. *Deposit types and estimated mineral endowment of Unit 16, Buckland*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

GRANITIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 16-1	Medium area			
Ore	0	0	0.6 million tons	Moderate
Gold	0	0	70 thousand oz	
PLAY 16-2	Small area			
Ore	0	0	0.1 million tons	Moderate
Gold	0	0	7 thousand oz	
PLAY 16-3	Small area			
Ore	0	0	1.1 million tons	High
Gold	0	0	160 thousand oz	
PLAY 16-4	Small area			
Ore	0	0	1.5 million tons	High
Gold	0	0	220 thousand oz	
PLAY 16-5	Small area			
Ore	0	0	1.1 million tons	Moderate
Gold	0	0	150 thousand oz	

GRANITIC DISSEMINATED GOLD

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 16-6	Medium area			
Ore	0	0	2.9 million tons	Moderate
Gold	0	0	70 thousand oz	

GOLD PLACERS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 16-7	Small area			
Ore	0	2.2 million tons	12 million tons	High
Gold	0	2 thousand oz	250 thousand oz	
Silver	0	7 thousand oz	220 thousand oz	
PLAY 16-8	Small area			
Ore	0	0	15 million tons	High
Gold	0	0	210 thousand oz	
Silver	0	0	130 thousand oz	
PLAY 16-9	Small area			
Ore	0	0	0.4 million tons	High
Gold	0	0	5 thousand oz	
Silver	0	0	3 thousand oz	
PLAY 16-10	Small area			
Ore	0	0	6.9 million tons	Moderate
Gold	0	0	86 thousand oz	
Silver	0	0	44 thousand oz	

GOLD PLACERS CONTINUED

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 16-11	Small area			
Ore	0	0	0.6 million tons	Moderate
Gold	0	0	8 thousand oz	
Silver	0	0	4 thousand oz	
PLAY 16-12	Medium area			
Ore	0	0	16 million tons	Moderate
Gold	0	0	210 thousand oz	
Silver	0	0	130 thousand oz	
PLAY 16-13	Small area			
Ore	0	0	0.2 million tons	Moderate
Gold	0	0	2 thousand oz	
Silver	0	0	1 thousand oz	

VOLCANIC GOLD-SILVER

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 16-14	Large area			
Ore	0	0	17 million tons	High
Gold	0	0	5,700 thousand oz	
Silver	0	0	170,000 thousand oz	

POLYMETALLIC VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 16-15	Small area			
Ore	0	0	0 million tons	Moderate
Silver	0	0	12 thousand oz	
Gold	0	0	0 thousand oz	
Zinc	0	0	0 thousand tons	
Lead	0	0	0 thousand tons	

SEDIMENT-HOSTED URANIUM

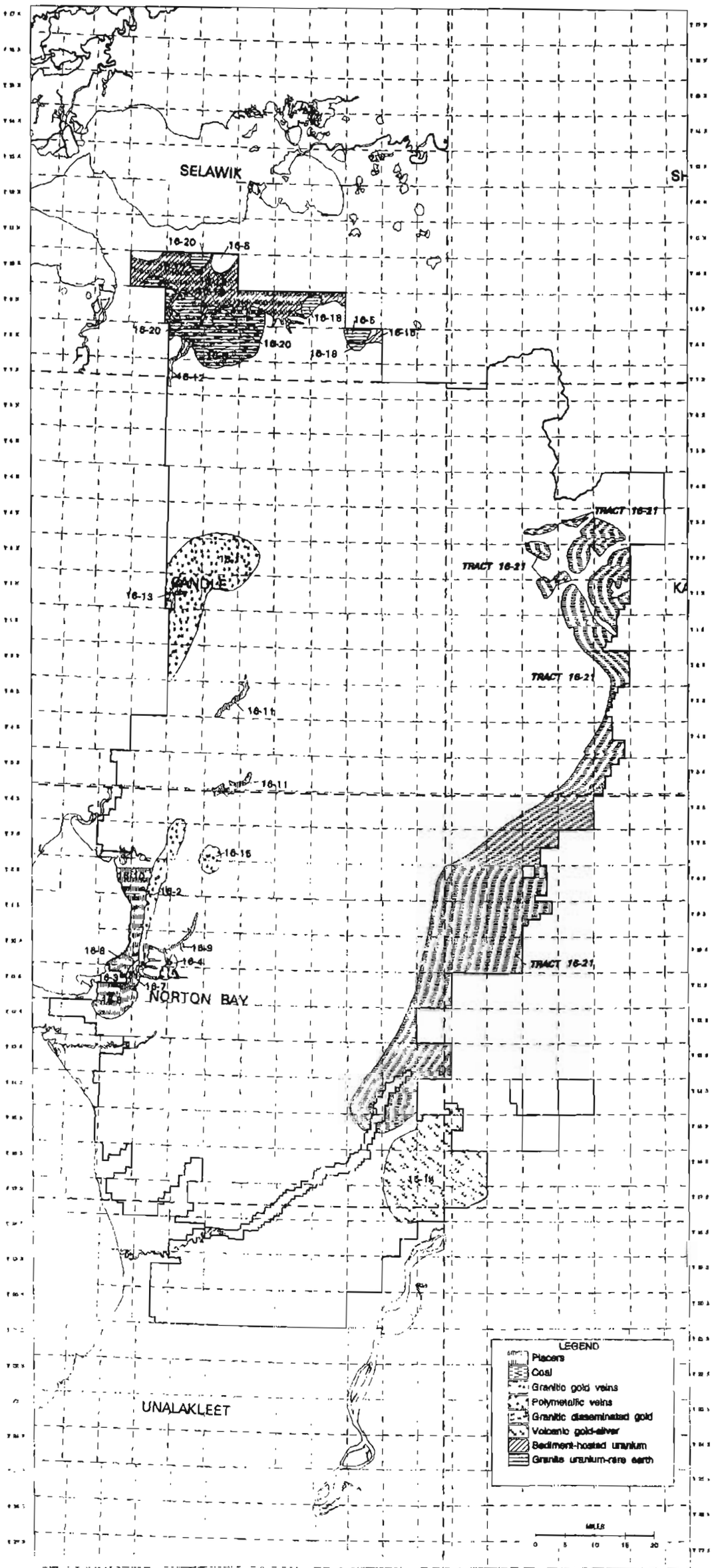
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 16-16	Medium area			
Ore	0	0.01 million tons	14 million tons	High
Uranium	0	10 tons	23,000 tons	

GRANITE URANIUM-RARE EARTH

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 16-17	Medium area			
Ore	0	0	0.95 million tons	Moderate
Uranium	0	0	1,800 tons	
Rare Earth	0	0	7,100 tons	
PLAY 16-18	Small area			
Ore	0	0	0 million tons	High
Uranium	0	0	0 tons	
Rare Earth	0	0	0 tons	

GRANITE URANIUM-RARE EARTH CONTINUED

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 16-19	Small area			
Ore	0	0	0 million tons	High
Uranium	0	0	0 tons	
Rare Earth	0	0	0 tons	
PLAY 16-20	Small area			
Ore	0	0.2 million tons	0.7 million tons	High
Uranium	0	160 tons	140 tons	
Rare Earth	0	230 tons	7,700 tons	



Unit 16, Buckland Unit

UNIT 17 - KAIYUH HILLS

GEOLOGIC SUMMARY

Unit 17, Kaiyuh Hills, encompasses 198,000 acres in the Nulato Quadrangle, south of the Yukon River. The northwestern part of the area is underlain by lower Paleozoic and/or Precambrian metamorphic rocks, in fault contact with Triassic basalt and chert to the southeast.

The Perseverance polymetallic vein deposit is just outside Unit 17, in the metamorphic sequence. The area adjacent to the deposit is considered to have high favorability for polymetallic vein resources, with a broadly distributed moderate favorability throughout the metamorphic sequence for additional resources. The metamorphic sequence is also generally favorable for volcanogenic massive sulfide and copper-molybdenum porphyry deposits, but is rated lower due to the lack of specific known deposits in the area.

The gold placer deposit in Camp Creek is derived from the metamorphic rock sequence; however, specific lode source of the gold has not been identified. Placer favorability ranges from moderate to high. Platinum group metals, derived from ultramafic rocks discovered in the metamorphic sequence, locally add potential endowment to placer deposits. We consider the ultramafic rocks themselves to have only low potential for platinum group metal or chromium lode deposits.

The basalt and chert sequence was considered for basalt-hosted copper deposit potential, and no evidence was found to indicate more than a background favorability for copper.

MINERAL DEPOSIT TYPES - UNIT 17

The mineral deposit models chosen to estimate the mineral endowment of Unit 17 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 17-1 through 17-18. The location of plays and their probabilistic endowment are shown in the map for Unit 17 and table 17.

(1) Polymetallic veins: There is high mineral potential in play 17-1.
(2) Gold placers: There is high mineral potential in plays 17-3 and 17-4 and moderate mineral potential in plays 17-2 and 17-5.
(3) Podiform chromite: Play 17-6 has moderate mineral potential, but shows no resources at the 5th percentile.
(4) Polymetal massive sulfide: There is moderate mineral potential in play 17-7.
(5) Porphyry copper-molybdenum: There is moderate mineral potential in play 17-8.

Table 17. *Deposit types and estimated mineral endowment of Unit 17, Kaiyuh Hills*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

POLYMETALLIC VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 17-1	Medium area			
Ore	0	0	0.9 million tons	High
Silver	0	0	31,000 thousand oz	
Gold	0	0	66 thousand oz	
Zinc	0	0	23 thousand oz	
Lead	0	0	86 thousand oz	

GOLD PLACERS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 17-2	Small area			
Ore	0	0	0.3 million tons	Moderate
Gold	0	0	3 thousand oz	
Silver	0	0	1 thousand oz	
PLAY 17-3	Small area			
Ore-Gold	0	0.2 million tons	1.0 million tons	High
Ore-Plat	0	0.0 million tons	0.3 million tons	
Gold	0	2 thousand oz	17 thousand oz	
Silver	0	1 thousand oz	15 thousand oz	
Platinum	0	0 thousand oz	14 thousand oz	
PLAY 17-4	Small area			
Ore	0	0	0.6 million tons	High
Gold	0	0	6 thousand oz	
Silver	0	0	4 thousand oz	
PLAY 17-5	Small area			
Ore	0	0	0.8 million tons	Moderate
Gold	0	0	10 thousand oz	
Silver	0	0	7 thousand oz	

PODIFORM CHROMITE

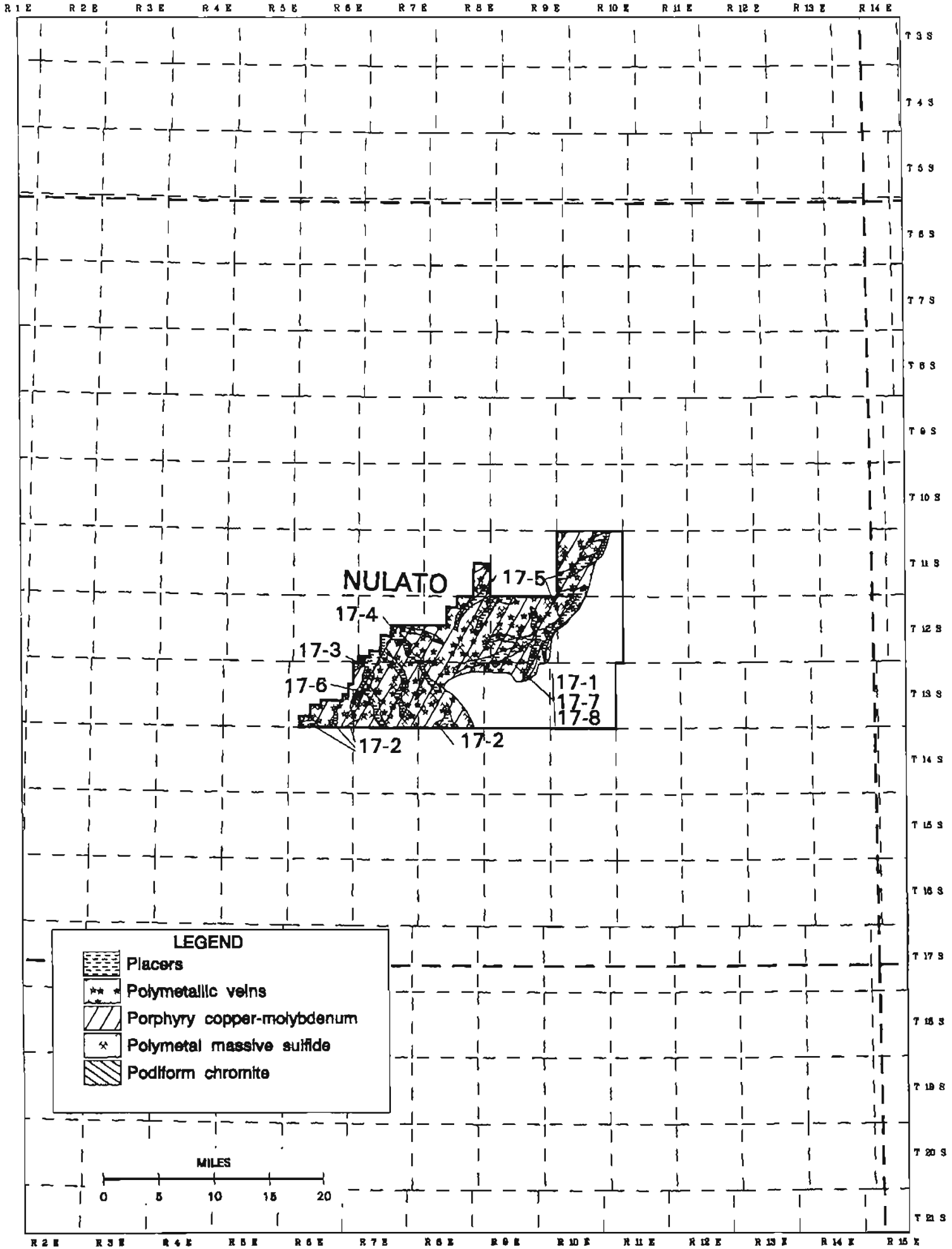
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 17-6	Small area			
Ore	0	0	0 million tons	Moderate
Chromium	0	0	0 thousand tons	

POLYMETAL MASSIVE SULFIDE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 17-7	Medium area			
Ore	0	0	0.2 million tons	Moderate
Zinc	0	0	6 thousand tons	
Copper	0	0	0 thousand tons	
Lead	0	0	870 tons	
Silver	0	0	0 thousand oz	
Gold	0	0	0 thousand oz	

PORPHYRY COPPER-MOLYBDENUM

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 17-8	Medium area			
Ore	0	0	330 million tons	Moderate
Copper	0	0	1,500 thousand tons	
Molybdenum	0	0	45 thousand tons	
Gold	0	0	0 thousand oz	
Silver	0	0	14,000 thousand oz	



Unit 17, Kaiyuh Hills Unit

UNIT 18 - DULBI RIVER

GEOLOGIC SUMMARY

The Dulbi River Unit 18 encompasses more than 900,000 acres in the Melozitna, Ruby, Kateel River, and Nulato Quadrangles. The area is underlain predominantly by Cretaceous sedimentary rocks, many of which were derived at least in part from volcanic rocks. Structurally placed in the package of sedimentary rocks are three northeast-southwest-trending belts of Jurassic basalt and greenstone, which include small areas of ultramafic intrusive rocks. In the southeast corner of the unit, an area of older pelitic schist crops out in structural contact with one of the Jurassic mafic igneous lithologies. In the northern part of Unit 18, Cretaceous volcanic rocks crop out. These are comprised of andesite and basalt flows, andesitic tuffs, and interlayered chert and limestone. All of the above bedrock types have been intruded by Tertiary or Cretaceous intrusive rocks which are generally intermediate to felsic in composition. A circular-shaped volcanic center crops out on the Dulbi River.

In the area of Shovel Creek, near the contact between pelitic schist and Jurassic basalt, rock samples from several gossanous alteration zones, stream sediments samples, and pan concentrate samples contain elevated concentrations of gold, silver, bismuth, tungsten, molybdenum, arsenic, and antimony. We believe these anomalies suggest moderate favorability for structurally controlled metamorphic gold vein deposits (play 18-1). Near VABM Bald, intrusive rocks are compositionally favorable for association with gold. Sulfide-rich rock grab samples collected by DGGS yielded up to 51 ppb gold. We have assigned a moderately high favorability to this area for a plutonic-related gold deposit (play 18-2). At a sharp bend in the Dulbi River, a gossanous outcrop yielded anomalous arsenic and antimony concentrations, that indicate a low to moderate favorability for polymetallic vein deposits (play 18-6). The Jurassic basalt belts contain ultramafic bodies which have yielded anomalous values of chromium, nickel, cobalt, platinum, and palladium in rock and pan concentrate samples. These areas have been assigned moderate favorability for podiform chromite deposits and platinum-group element deposits (plays 18-4 and 18-5). The volcanic center transected by the Dulbi River is a geologic feature favorable for volcanic-hosted gold-silver epithermal deposits. However, no anomalous concentrations of metals were found during DGGS field work, and, therefore, the play has been assigned a low favorability for mineralization (play 18-7).

Dulbi Hot Springs, on the north side of the Dulbi River, did not yield anomalous metal values in pan concentrate samples. However, based on geologic setting, it has been assigned a low favorability for a gold-mercury deposit that is related to a hot springs (Play 18-3). The site is also a moderately favorable geothermal resource.

MINERAL DEPOSIT TYPES - UNIT 18

The mineral deposit models chosen to estimate the mineral endowment of Unit 18 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 18-1 through 18-7. The location of the plays and their probabilistic endowment estimates are shown in the map for Unit 18 and table 18.

(1) Metamorphic gold veins: There is high mineral potential in play 18-1.
(2) Granitic gold veins: There is high mineral potential in play 18-2.
(3) Hot springs mercury: There is moderate mineral potential in play 18-3.
(4) Podiform chromite: There is moderate mineral potential in play 18-4.
(5) Platinum group elements: There is moderate mineral potential in play 18-5.
(6) Polymetallic veins: There is a low favorability for polymetallic veins in play 18-6.
(7) Volcanic gold-silver: There is moderate mineral potential in play 18-7.

Table 18. *Deposit types and estimated mineral endowment of Unit 18, Dulbi River*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

METAMORPHIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 18-1	Small area			
Ore	0	0	0.3 million tons	High
Gold	0	0	91 thousand oz	
Silver	0	0	7 thousand oz	

GRANITIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 18-2	Small area			
Ore	0	0.2 million tons	4.8 million tons	High
Gold	0	24 thousand oz	680 thousand oz	

HOT SPRING MERCURY

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 18-3	Small area			
Ore	0	0	0 million tons	Moderate
Mercury	0	0	0 tons	
Antimony	0	0	0 thousand tons	
Gold	0	0	0 thousand oz	

PODIFORM CHROMITE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 18-4	Small area			
Ore	0	0	0.1 million tons	Moderate
Chromium	0	0	50 thousand tons	

PLATINUM GROUP ELEMENTS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 18-5	Small area			
Ore	0	0	1.1 million tons	Moderate
Nickel	0	0	170 tons	
Copper	0	0	9 tons	
Platinum	0	0	220 oz	
Paladium	0	0	1 thousand oz	

POLYMETALLIC VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 18-6	Small area			
Ore	0	0	0 million tons	Moderate
Silver	0	0	0 thousand oz	
Gold	0	0	0 thousand oz	
Zinc	0	0	0 thousand tons	
Lead	0	0	0 thousand tons	

VOLCANIC GOLD-SILVER

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 18-7	Small area			
Ore	0	0	0 million tons	Moderate
Gold	0	0	0 thousand oz	
Silver	0	0	0 thousand oz	

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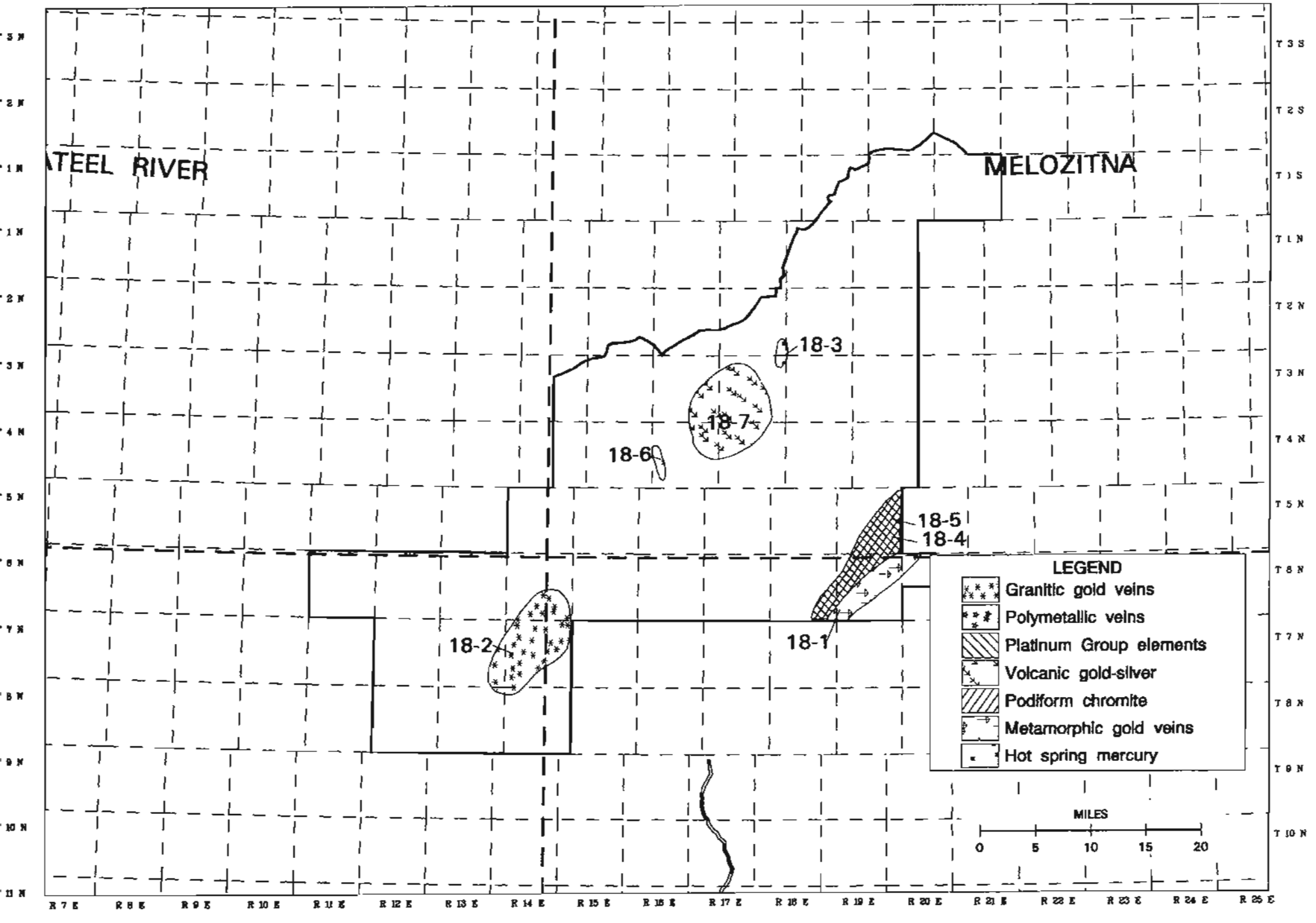


Unit 18 - Dalki River Unit

UNIT 19 - BENDELEBEN MOUNTAINS

GEOLOGIC SUMMARY

Unit 19 comprises 1.9 million acres of land in the Bendeleben and Darby Mountains of central Seward Peninsula. These small mountain ranges form a broad curvilinear arc of highlands nearly 125 m long that is flanked by distinctive lowlands or basins on the east, south, and north.

A wide variety of rock types occur throughout Unit 19. Most of the bedrock lithologies belong to the Seward terrane, which is mainly composed of blueschist-, greenschist-, and amphibolite-facies metasedimentary and meta-igneous rocks of Paleozoic and Precambrian(?) age (more than 250 million years old). To the east, this major rock package is juxtaposed by Jurassic-Cretaceous (about 205 to 65 million years old) pillow basalt, andesite, tuff, and ophiolitic rocks of the Yukon-Koyukuk terrane along the Kugruk Fault Zone.

Metamorphic and sedimentary-volcanic sections contain significant Ordovician, Devonian, and Jurassic submarine volcanic rocks, which include at least two types of volcanogenic massive sulfide base metal occurrences and deposits.

Carbonate-clastic sequences of Paleozoic age in the Seward terrane contain numerous sedimentary exhalative lead-zinc-silver-barium deposits and occurrences near the Omalik mine. Private company diamond drill programs have outlined at least three subeconomic deposits of this type in the last ten years in the study area.

A heterogeneous suite of Mesozoic plutonic rocks intrudes older crystalline-layered rock units in the central Bendeleben and Darby Mountains. These include alkalic-subalkalic complexes of monzonite and syenite that contain radioactive and rare earth element mineral concentrations. An 80 million-year-old molybdenum porphyry system occurs in central Darby Mountains. Pegmatite dikes and small plutons contain elevated rare earth element, uranium, and thorium values in the western portion of Unit 19 near Libby River; however their specific mode of occurrence was not modeled here.

Tertiary, nonmarine, continentally-derived seimentary basins have infilled structural troughs adjacent to upland areas. Some contain coal-bearing strata, and in Death Valley, erosion of uranium-bearing intrusive rocks has created a series of small, but moderate grade, 'roll-front' uranium deposits.

Jurassic-to-Cretaceous tectonism resulted in several styles of regional metamorphism, at least two episodes of thrust faulting, and a major strike-slip translocation. Metamorphogenic gold deposits in the Taylor, Kougorak, and Solomon districts formed during one or more of the regional metamorphic events. The youthful strike-slip faulting along the Kugruk Fault Zone is probably responsible for the present geographic position of the Seward Peninsula relative to the rest of Alaska.

Unit 19 flanks and incorporates a small portion of the Council-Solomon mining district, which has had a cummulative past production of 641,553 oz gold. Placer miners in the Kougarok and Koyuk districts, which flank and include the eastern-most and northwest corner of Unit 29 have produced a combined total of 246,402 oz of gold and 300 oz of platinum. Prior to the turn of the century, nearly 440 tons of high grade antimony-lead-silver ores were shipped from the Omalik mine in the west-central Darby Mts.

MINERAL DEPOSIT TYPES - UNIT 19

The mineral deposit models chosen to estimate the mineral endowment of Unit 19 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 19-1 through 19-16. The location of plays and their probabilistic endowment are shown in the map for Unit 19 and table 19.

(1) Sediment lead-zinc: There is high mineral potential in play 19-1 and moderate mineral potential in plays 19-2 and 19-3.
(2) Rift polymetal massive sulfide: There is high mineral potential in play 19-4.
(3) Sediment-hosted uranium: There is high mineral potential in play 19-5 and moderate mineral potential in play 19-6.
(4) Granite uranium-rare earth: There is moderate mineral potential in plays 19-7, 19-8, and 19-9.
(5) Porphyry molybdenum: There is high mineral potential in play 19-10.
(6) Metamorphic gold veins: There is moderate mineral potential in play 19-11.
(7) Polymetallic veins: There is moderate mineral potential in play 19-12.
(8) Besshi massive sulfide: There is moderate mineral potential in play 19-13.
(9) Platinum group elements: There is high mineral potential in play 19-14.
(10) Gold placers: There is moderate mineral potential in play 19-15.
(11) Placer gold platinum: There is high mineral potential in play 19-16.

COAL RESOURCE POTENTIAL - UNIT 19

Tract 19-17 is an area of high potential which contains a 175-ft-thick bed of lignite deposited in a Tertiary basin in the Grouse Creek/Death Valley region.

The other coal tracts 19-18 and 19-19 have moderate potential due to lignite shows which suggest a Tertiary basin similar to the Grouse Creek/Death Valley region and therefore may have undiscovered thick coal (lignite) deposits.

Table 19. *Deposit types and estimated mineral endowment of Unit 19, Bendeleben*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

SEDIMENT LEAD-ZINC

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 19-1	Small area			
Ore	0	0	73 million tons	High
Zinc	0	0	6,100 thousand tons	
Lead	0	0	4,000 thousand tons	
Silver	0	0	130,000 thousand oz	
PLAY 19-2	Small area			
Ore	0	0	2.8 million tons	Moderate
Zinc	0	0	210 thousand tons	
Lead	0	0	110 thousand tons	
Silver	0	0	340 thousand oz	
PLAY 19-3	Small area			
Ore	0	0	0 million tons	Moderate
Zinc	0	0	0 thousand tons	
Lead	0	0	0 thousand tons	
Silver	0	0	0 thousand oz	

RIFT POLYMETAL MASSIVE SULFIDE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 19-4	Medium area			
Ore	0	0	6.2 million tons	High
Zinc	0	0	370 thousand tons	
Copper	0	0	150 thousand tons	
Lead	0	0	150 thousand tons	
Silver	0	0	3,100 thousand oz	
Gold	0	0	49 thousand oz	

SEDIMENT-HOSTED URANIUM

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 19-5	Small area			
Ore	0	0.04 million tons	9.5 million tons	High
Uranium	0	53 tons	17,000 tons	
PLAY 19-6	Small area			
Ore	0	0	0.03 million tons	Moderate
Uranium	0	0	23 tons	

GRANITE URANIUM-RARE EARTH

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 19-7	Small area			
Ore	0	0.2 million tons	1.4 million tons	Moderate
Uranium	0	170 tons	2,600 tons	
Rare Earths	0	290 tons	13,000 tons	

GRANITE URANIUM-RARE EARTH CONTINUED

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 19-8	Small area			
Ore	0	0.7 million tons	2.1 million tons	Moderate
Uranium	0	1,000 tons	4,200 tons	
Rare Earths	0	2,600 tons	21,000 tons	
PLAY 19-9	Small area			
Ore	0	0	0.4 million tons	Moderate
Uranium	0	0	730 tons	
Rare Earths	0	0	1,700 tons	

PORPHYRY MOLYBDENUM

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 19-10	Small area			
Ore	0	0	430 million tons	High
Molybdenum	0	0	320 thousand tons	

METAMORPHIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 19-11	Small area			
Ore	0	0	0.9 million tons	High
Gold	0	0	270 thousand oz	
Silver	0	0	15 thousand oz	

POLYMETALLIC VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 19-12	Small area			
Ore	0	0	0.1 million tons	Moderate
Silver	0	0	3,200 thousand oz	
Gold	0	0	9 thousand oz	
Zinc	0	0	3 thousand tons	
Lead	0	0	12 thousand tons	

BESSHI MASSIVE SULFIDE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 19-13	Small area			
Ore	0	0	0.5 million tons	Moderate
Copper	0	0	7 thousand tons	
Zinc	0	0	1 thousand tons	
Silver	0	0	20 thousand oz	
Gold	0	0	4 thousand oz	
Cobalt	0	0	140 tons	

PLATINUM GROUP ELEMENTS

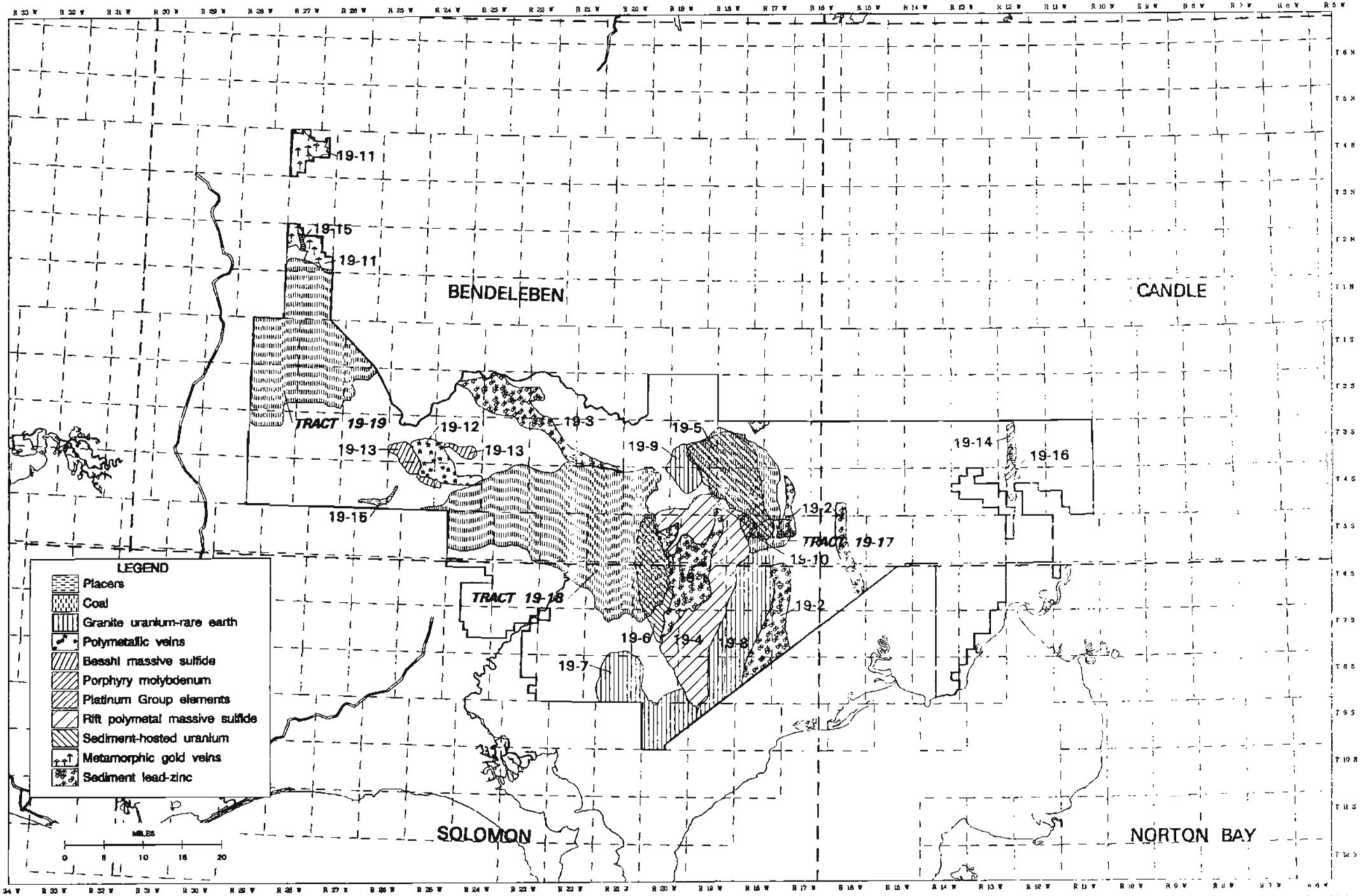
Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 19-14	Small area			
Ore	0	0	2.9 million tons	High
Nickel	0	0	2 thousand tons	
Copper	0	0	99 tons	
Platinum	0	0	3 thousand oz	
Paladium	0	0	7 thousand oz	

GOLD PLACERS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 19-15	Small area			
Ore	0	0.01 million tons	0.45 million tons	Moderate
Gold	0	0.10 thousand oz	9 thousand oz	
Silver	0	0.05 thousand oz	7 thousand oz	

PLACER GOLD PLATINUM

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 19-16	Small area			
Ore	0 million tons	0.1 million tons	4.3 million tons	High
Gold	0 thousand oz	5 thousand oz	320 thousand oz	
Platinum	0 thousand oz	0 thousand oz	5 thousand oz	



Unit 19, Bendeleben Mountains Unit

UNIT 20 - WEST SEWARD PENINSULA

GEOLOGIC SUMMARY

Unit 20 comprises about 860,000 acres of land in west-central Seward Peninsula north of Nome. The unit includes the rugged, glacially carved Kigluaik Mountains, the rolling hills of the Port Clarence mining district, and the Kougarok-Imurok Basin lowlands.

Crystalline rocks of the Precambrian to Paleozoic Seward terrane and shallow water platform deposits of the Ordovician to Mississippian York terrane form the major lithologic packages in Unit 20. The boundary between the Seward and York terranes is poorly exposed, but is thought to be a thrust fault because of its sinuous map trace, a sharp discontinuity in metamorphic grade, and differences in stratigraphy across the terrane boundary.

The Seward terrane lithologies in Unit 20 include the greenschist-blueschist facies Nome Group and the amphibolite to granulite facies Kigluaik Group. The Nome Group contains a large component of mafic and calcareous schists near Sinuk River and in the Port Clarence region that contain Besshi massive sulfide zinc-lead-copper potential; carbonate rocks in the same areas may host base metal deposits of the Mississippi Valley type.

Graphite-bearing amphibolite facies rocks of the Kigluaik Group form the north boundary of the Kigluaik Mountains. Massive and flake graphite deposits occur nearly continuously for a distance of 6 mi, and exhibit physical properties similar to Madagascar grades mined worldwide.

A large granitic orthogneiss intruded the Kigluaik Group 380 million years ago. During that event, an 8-mi-long belt of basemetal-tungsten-gold skarn occurrences formed in calcareous schist and marble.

During Jura-Cretaceous time, the Nome and Kigluaik Groups underwent several periods of regional metamorphism. During retrograde greenschist facies metamorphism, a hydraulic fracturing event formed metamorphogenic gold-tungsten-bismuth deposits in the Nome Group near Nome, near Charley Creek, and in the Port Clarence areas.

Late Cretaceous tin granites intrude strata of both the Kigluaik and York terranes. In the Kigluaik terrane, replacement basemetal occurrences associated with these intrusions formed in carbonate rocks.

High heat flow associated with recent extensional tectonics formed mercury-antimony occurrences in a linear belt extending southwest from Pilgrim Hot Springs, along the eastern boundary of Unit 20.

Unit 20 flanks the northern edge of the Nome mining district, the southwestern portion of the Kougarok mining district, and includes about half of the Port Clarence mining district. The Nome and Kougarok districts have produced 4,934,819 oz of gold, all derived from placer sources. The Port Clarence district has produced 40,402 oz of gold through 1991, all derived from placer sources. Most of the gold in all three districts is believed to have been ultimately derived from metamorphogenic gold deposits.

Approximately 2,755 tons of flake graphite were mined from several deposits on Uncle Sam's Mountain along the northern edge of the Kigluaik Mountains, mostly prior to World War II.

MINERAL DEPOSIT TYPES - UNIT 20

The mineral deposit models chosen to estimate the mineral endowment of Unit 20 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 20-1 through 20-9. The location of plays and their probabilistic endowment are shown in the map for Units 20 and 21 and table 20.

(1) Metamorphic gold veins: There is high mineral potential in plays 20-1, 20-2, and 20-3.
(2) Besshi massive sulfide: There is moderate mineral potential in play 20-4.
(3) Graphite: There is high mineral potential for the discovery of commercial grade graphite deposits in play 20-5.
(4) Tin skarns: There is moderate mineral potential in play 20-6.
(5) Hot spring mercury: There is moderate mineral potential in play 20-7.
(6) Gold placers: There is high mineral potential in play 20-8.
(7) Tungsten-gold skarns: There is moderate mineral potential in play 20-9.

Table 20. *Deposit types and estimated mineral endowment of Unit 20, West Seward Peninsula*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

METAMORPHIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 20-1	Small area			
Ore	0	0.2 million tons	7.1 million tons	High
Gold	0	51 thousand oz	1,900 thousand oz	
Silver	0	0 thousand oz	75 thousand oz	
PLAY 20-2	Small area			
Ore	0	0.6 million tons	20 million tons	High
Gold	0	190 thousand oz	5,700 thousand oz	
Silver	0	1 thousand oz	150 thousand oz	
PLAY 20-3	Small area			
Ore	0	0.5 million tons	15 million tons	High
Gold	0	130 thousand oz	4,300 thousand oz	
Silver	0	0 thousand oz	100 thousand oz	

BESSHI MASSIVE SULFIDE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 20-4	Small area			
Ore	0	0	0.02 million tons	Moderate
Copper	0	0	0.29 thousand tons	
Zinc	0	0	0.03 thousand tons	
Silver	0	0	0.00 thousand oz	
Gold	0	0	0.07 thousand oz	
Cobalt	0	0	0.00 tons	

GRAPHITE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 20-5[a]	Small area			
Ore	0.35 million tons	0.7 million tons	3 million tons	High
Graphite	157.5 thousand tons	450 thousand tons	1,350 thousand tons	

[a]Estimates based on known in-place resources.

TIN SKARNS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 20-6	Small area			
Ore	0	0	1.6 million tons	Moderate
Tin	0	0	0 thousand tons	
Silver	0	0	0 thousand oz	
Tungsten	0	0	0 thousand tons	
Lead	0	0	0 thousand tons	
Zinc	0	0	0 thousand tons	

HOT SPRING MERCURY

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 20-7	Small area			
Ore	0	0	0 million tons	Moderate
Mercury	0	0	0 tons	
Antimony	0	0	0 thousand tons	
Gold	0	0	0 thousand oz	

GOLD PLACERS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 20-8	Small area			
Ore	0	0.03 million tons	0.9 million tons	High
Gold	0	0.3 thousand oz	13 thousand oz	
Silver	0	0.1 thousand oz	12 thousand oz	

TUNGSTEN-GOLD SKARNS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 20-9	Small area			
Ore	0	0	1.2 million tons	Moderate
Tungsten	0	0	9 thousand tons	
Gold	0	0	20 thousand oz	

UNIT 21 - NORTHWEST SEWARD PENINSULA

GEOLOGIC SUMMARY

Unit 21 comprises about 108,000 acres of low tundra-covered hills north of the York Mountains of the northwestern Seward Peninsula. The Mint, Pinguk, and Nuluk Rivers flow north from the York Mountains through Unit 21 into Ikpek and Lopp lagoons and the Bering Sea.

The entire tract is underlain by shale, siltstone, and limestone of the Paleozoic York terrane. The central portion of Unit 21 contains base metal bearing replacement zones and veins probably related to a tin granite system.

The entire area is covered by a thin veneer of glacial till derived from an extensive ice sheet to the south and east in Illinoian(?) time (7.1 million years ago).

No gold production has been documented in the study area; however, minor amounts of placer tin were developed and exploited prior to 1950.

MINERAL DEPOSIT TYPES - UNIT 21

The mineral deposit models chosen to estimate the mineral endowment of Unit 21 are listed below. The permissive areas for each mineral deposit type are referred to as "plays." The location of the one play in Unit 21 and its probabilistic endowment are shown in the map for Units 20 and 21 and table 21.

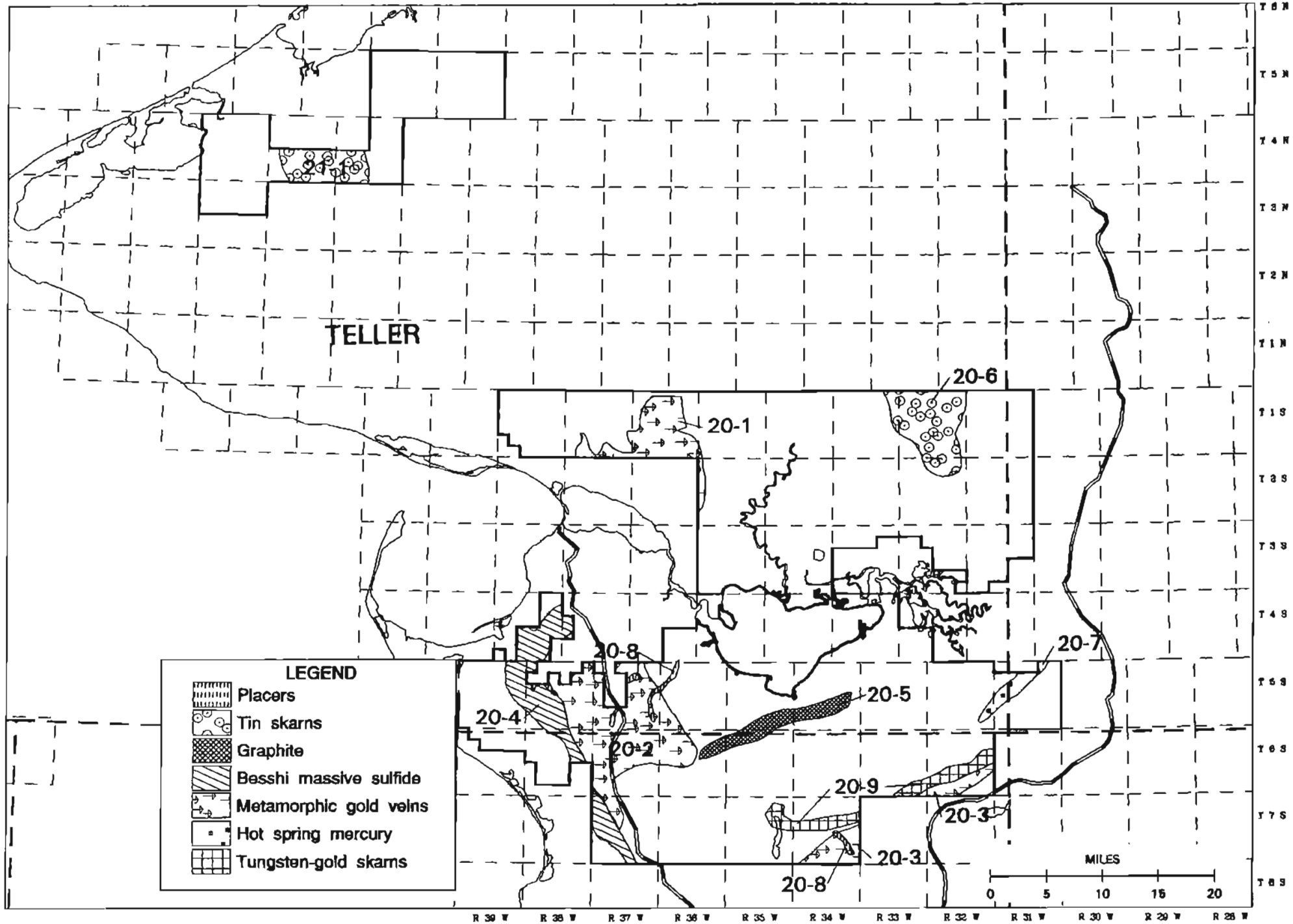
(1) Tin skarns: There is moderate mineral potential in play 21-1.

Table 21. *Deposit types and estimated mineral endowment of Unit 21, Northwest Seward Peninsula*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

TIN SKARNS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 21-1	Small area			
Ore	0	0	1.6 million tons	Moderate
Tin	0	0	0 thousand tons	
Silver	0	0	0 thousand oz	
Tungsten	0	0	0 thousand tons	
Lead	0	0	0 thousand tons	
Zinc	0	0	0 thousand tons	



Units 20 and 21, West Seward Peninsula and Northwest Seward Peninsula Units

UNIT 22 - SQUIRREL RIVER

GEOLOGIC SUMMARY

Unit 22 encompasses almost 1.3 million acres, mainly in the Baird Mountains Quadrangle with its southern and western edges in the Selawik and Noatak Quadrangles, respectively. The unit is within the southern edge of the Brooks Range fold and thrust belt and is largely underlain by slightly metamorphosed to greenschist facies, lower Paleozoic marine carbonate, clastic and pelitic rocks. There are three separate stratigraphic successions in Unit 22: the Nakolik sequence, the Tukpahlearik Creek sequence, and the Kallarichuk Hills sequence. The Nakolik sequence consists of undivided Devonian to Ordovician Baird Group and Devonian limestone, phyllite, and clastic rocks of the Nakolik River. The Tukpahlearik Creek sequence contains Ordovician to Devonian metamorphic sedimentary and possibly Mesozoic intrusive rocks in thrust-bounded belts trending northeast-southwest. Rock types include: chlorite quartz schist and siliceous chlorite schists; pelitic schist with intercalated masses of dark green metabasite, mafic dikes, mafic extrusives, and metachert; micaceous marble with chlorite partings and relict cross-lamination structures along with meter-scale lenses of black carbonaceous calcareous or siliceous semischist; massive to thick-bedded marble in lenses tens of meters thick, intercalated with chloritic schist, calcareous quartz schist, and black carbonaceous schist. The Kallarichuk Hills sequence includes Paleozoic and/or Proterozoic garnet-mica-quartz schist; calcareous quartz-mica schist and marble; massive to gneissic, granitic to dioritic meta-intrusive rocks in mile-scale or smaller bodies that have crosscutting relationships with other rocks of the Kallarichuk Hills; and intrusive dikes of gabbro, leucogabbro, granite and granodiorite of Mount Angayukaqsraq.

The Nakolik sequence hosts three known deposits: Omar, Frost, and Powdermilk. The Omar prospect currently is the largest known deposit in Unit 22 and is characterized by a mineralized breccia zone about 2 mi long and up to 100 ft wide consisting of dolomite clasts and chalcopyrite, bornite, covellite, malachite, and hydrous oxide minerals. Nearby prospects also contain lead and zinc mineralization. The mineralization at Omar resembles that at Ruby Creek, Alaska, and is tentatively classified as a Kipushi-type deposit (shown below under "Limestone lead-zinc").

The Tukpahlearik Creek sequence in Unit 22 currently does not have any known prospects. However, the area does have widespread low-level regional geochemical anomalies of barium, zinc, copper, gold, and lead, suggesting a potential for bedded barite-dominant mineralization in the black carbonaceous calcareous schists or marbles.

The rocks of the Kallarichuk Hills in the southern part of Unit 22 provide a source for placer gold in Klery Creek and exhibit a regional geochemical anomaly of barium, cobalt, copper, and tin, with weaker elevated values of lead, zinc, and gold. A definitive source for the placer gold is unknown, but quartz and graphitic schist attached to some placer gold grains suggests moderate potential for lode deposits of mineralized quartz veins in the schist sequence. The mineral potential of metamorphic lode gold and placer gold in the southwestern part of Unit 22 are probably low to moderate and were not modeled in this study.

The stratigraphy of the Kallarichuk Hills sequence and its associated geochemical anomaly suggest the sequence also has potential for volcanogenic massive sulfide deposits.

MINERAL DEPOSIT TYPES - UNIT 22

The mineral deposit models chosen to estimate the mineral endowment of Unit 22 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively for Units 22-1 and 22-2. The location of plays and their probabilistic endowment are shown in the map for Unit 22 and table 22.

(1) Limestone lead-zinc: There is high mineral potential in play 22-1.
(2) Rift polymetal massive sulfide: There is moderate mineral potential in play 22-2.

COAL RESOURCE POTENTIAL - UNIT 22

Tract 22-3 has moderate potential for containing coal resources because it delineates an area of Cretaceous rocks known to contain bituminous coal in beds up to 3 ft thick to the east along the Kallarichuk River. Tract 22-3 is shown on the Unit 22 map.

Table 22. *Deposit types and estimated mineral endowment of Unit 22, Squirrel River*

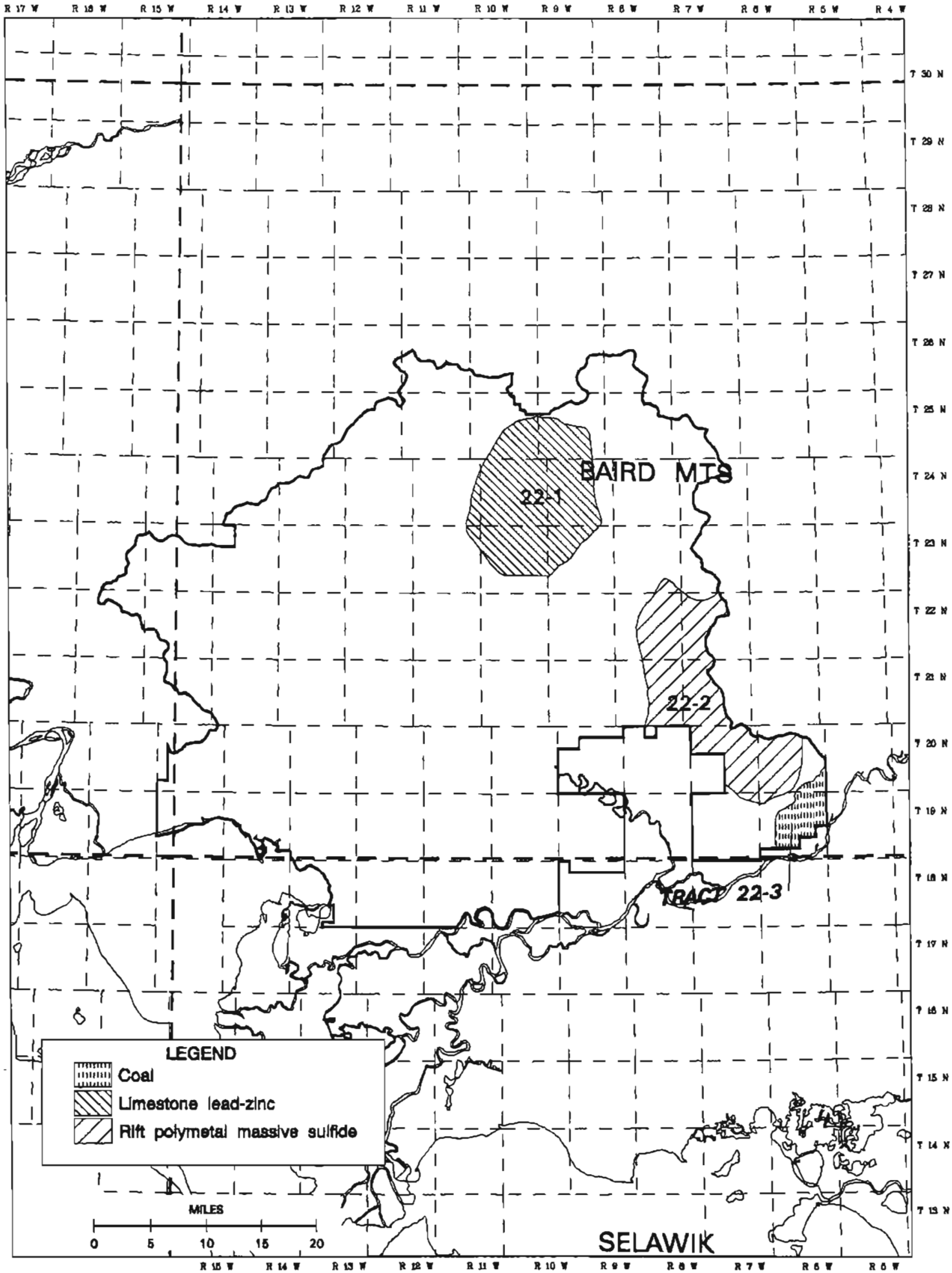
Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

LIMESTONE LEAD-ZINC

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 22-1	Medium area			
Ore	0	0	36 million tons	High
Lead	0	0	1,200 thousand tons	
Zinc	0	0	2,600 thousand tons	
Copper	0	0	48 thousand tons	
Silver	0	0	45,000 thousand oz	

RIFT POLYMETAL MASSIVE SULFIDE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 22-2	Medium area			
Ore	0	0	6.2 million tons	High
Zinc	0	0	290 thousand tons	
Copper	0	0	93 thousand tons	
Lead	0	0	140 thousand tons	
Silver	0	0	2,500 thousand oz	
Gold	0	0	27 thousand oz	



Unit 22, Squirrel River Unit

UNIT 23 - NORTHWEST DE LONG MOUNTAINS

GEOLOGIC SUMMARY

Unit 23 consists of approximately 2.4 million acres in the foothills of the western De Long Mountains that lie in the De Long Mountains and Point Hope Quadrangles, and along the northernmost edge of the Noatak Quadrangle. Most of the land in the unit has been previously selected by the state but has not been conveyed.

Unit 23 is underlain by three major groups of rock. The northern part is underlain by relatively gently deformed rocks of mid-Cretaceous (Albian) age of the Nanushuk Group and the underlying Torok Formation. The rocks are part of a deltaic complex that contains marine sandstone at the base and coal-bearing nonmarine sandstone, conglomerate, coal, and shale of the Corwin Formation at the top. Most of these rocks form a series of high mesa-like uplands that have relatively good exposures. The Torok Formation to the south of the Nanushuk Group underlies a broad lowland tundra-covered area with very few exposures, and consists dominantly of marine black shale.

The southern part of Unit 23 is underlain by complexly deformed thrust sheets composed dominantly of graywacke sandstone of the Lower Cretaceous Mount Kelly Graywacke (lower Albian) and the Okpikruak Formation (Neocomian), and areas of chert and black shale and limestone of Missisippian to Triassic age. An isolated thrust sheet of ultramafic rock is present in the extreme southern edge of the evaluation area. The Cretaceous rocks form rolling rubble- and tundra-covered uplands with few resistant outcrops. Areas underlain by chert are also rubble-covered but contain scattered bedrock exposures in stream cutbanks; the ultramafic rocks form a high isolated mountain with extensive rubble-covered outcrops.

With the exception of the area of ultramafic rocks, no significant geochemical anomalies and no mineral occurrences or production are known in the evaluation area. However, the areas of Mississippian to Triassic chert and shale contain a stratigraphic sequence that is very similar to the stratigraphic sequence in the area of lead-zinc production from Mississippian black shale and chert at the Red Dog Mine, about 25 mi southeast of the evaluation area. Based upon this similarity, the data suggest that there is a chance for lead-zinc mineralization in the evaluation area. In the area of ultramafic rocks, chromite is known to occur in outcrop, and there is potential for discovery of podiform chromite deposits.

MINERAL DEPOSIT TYPES - UNIT 23

The mineral deposit models chosen to estimate the mineral endowment of Unit 23 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 23-1 through 23-3. The location of plays and their probabilistic endowment are shown in the map for Unit 23 and table 23.

(1) Sediment lead-zinc: There is high mineral potential in play 23-1 and 23-2.
(2) Podiform chromite: There is a moderate mineral potential in play 23-3.

COAL RESOURCE POTENTIAL - UNIT 23

Tract 23-4 is an area of high potential which is mapped as the bituminous coal-bearing Cretaceous Corwin Formation. This tract delineates the southwest edge of the Deadfall Syncline, a geologic structure with minable quantities of coal.

Tract 23-5 is an area of high potential which is mapped as the bituminous coal-bearing Cretaceous Corwin Formation.

Tract 23-6 is an area of high potential which is mapped as the bituminous coal-bearing Cretaceous Corwin Formation in the Kukpowruk Syncline.

Tracts 23-7, 23-8, and 23-9 are areas of high potential which are mapped as the bituminous coal-bearing Cretaceous Corwin Formation. Tracts 23-7 through 23-9 are shown on the Unit 23 and 24 map.

Table 23. *Deposit types and estimated mineral endowment of Unit 23, Northwest De Long Mountains*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

SEDIMENT LEAD-ZINC

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 23-1	Small area			
Ore	0	0	200 million tons	High
Zinc	0	0	14,000 thousand tons	
Lead	0	0	7,500 thousand tons	
Silver	0	0	300,000 thousand oz	
PLAY 23-2	Medium area			
Ore	0	0	400 million tons	High
Zinc	0	0	38,000 thousand tons	
Lead	0	0	22,000 thousand tons	
Silver	0	0	950,000 thousand oz	

PODIFORM CHROMITE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 23-3	Small area			
Ore	0	0	0.12 million tons	Moderate
Chromium	0	0	36 thousand tons	

UNIT 24 - EAST LISBURNE HILLS

GEOLOGIC SUMMARY

Unit 24 encompasses 416,000 acres in the Lisburne Hills range and its eastern foothills in the Point Hope Quadrangle. Much of the land in the unit has been previously selected by the state but has not been conveyed. The area is underlain by two major groups of rocks: limestone and dolomite of the Mississippian to Early Pennsylvanian Lisburne Group on the west, and dominantly sandstone and shale of Cretaceous age to the east.

In the eastern part of Unit 24, on the east side of the Lisburne Hills, Cretaceous rocks underlie low rounded rubble- and tundra-covered hills. Exposures of rock in place are confined mostly to sea cliffs along the northern coast and to scattered stream cutbanks.

Most of the exposed rocks and rubble consists of graywacke, but these rocks have abundant interbedded shale that decomposes easily and is not normally seen in rubble. The Cretaceous rocks are divided into two groups: a Lower Cretaceous (Neocomian) unit of complexly deformed graywacke and shale of unknown thickness, and a mid-Cretaceous (Albian) sequence of the Nanushuk Group. The Nanushuk Group grades from thick marine shale with scattered floating conglomerate clasts upward into a nonmarine section of sandstone, conglomerate, shale, and coal of the Corwin Formation. These rocks are present locally in the extreme northeastern part of the area, in lands previously selected by the state. This includes the area of the Corwin mine, at which small-scale coal mining was carried out in the early 20th Century to supply whaling fleets. Minable coal also exists in the Cape Beaufort area east of the evaluation area.

The Lisburne Group forms rounded rubble-covered hills with few outcrops and almost no vegetation cover. It may be as much as 2,000 ft thick and has been imbricated by thrust faulting throughout the area. The total thickness of the imbricated limestone section is unknown, but it is probably more than 10,000 ft. In a few small areas, the Lisburne Group is overlain by a thin section of nonresistant shale and silty shale of the Permian Siksikpuk Formation and similar beds containing thin-bedded limestone in the Triassic Otuk Formation. Total thickness of these rock units is less than 600 ft. Locally in the southwestern part of the evaluation area, the Lisburne Group on some of the thrust sheets is underlain by the Lower Mississippian Kayak Shale, which is rarely exposed beneath rubble of Lisburne limestone. In addition, local areas of sandstone, shale, and coal of the basal Mississippian Kapaloak Formation are present, dominantly in low rubble-covered hills.

MINERAL DEPOSIT TYPES - UNIT 24

The mineral deposit model chosen to estimate the mineral endowment of Unit 24 is listed below. The permissive areas for each mineral deposit type are referred to as "plays" and the play for Unit 24 is described below. The location of the play and its probabilistic endowment is shown in the map for Units 23 and 24 and table 24.

(1) Sedimentary barite: There is moderate mineral potential in play 24-1.

COAL RESOURCE POTENTIAL - UNIT 24

Tracts 24-2, 24-3, and 24-4 are areas of high potential which are mapped as the bituminous coal-bearing Cretaceous Corwin Formation. Minable quantities of coal exist at the nearby Cape Beaufort-Corwin Bluff region, and the Corwin Mine on the coast has documented coal mining in the past.

Tracts 24-5, 24-6, 24-7, and 24-8 are areas of high potential which are mapped as the bituminous coal-bearing Mississippian-age Kapaloak Formation which is structurally complex.

Tract 24-9 is a larger area of moderate potential which may be underlain by the structurally complex coal-bearing Mississippian Kapaloak Formation.

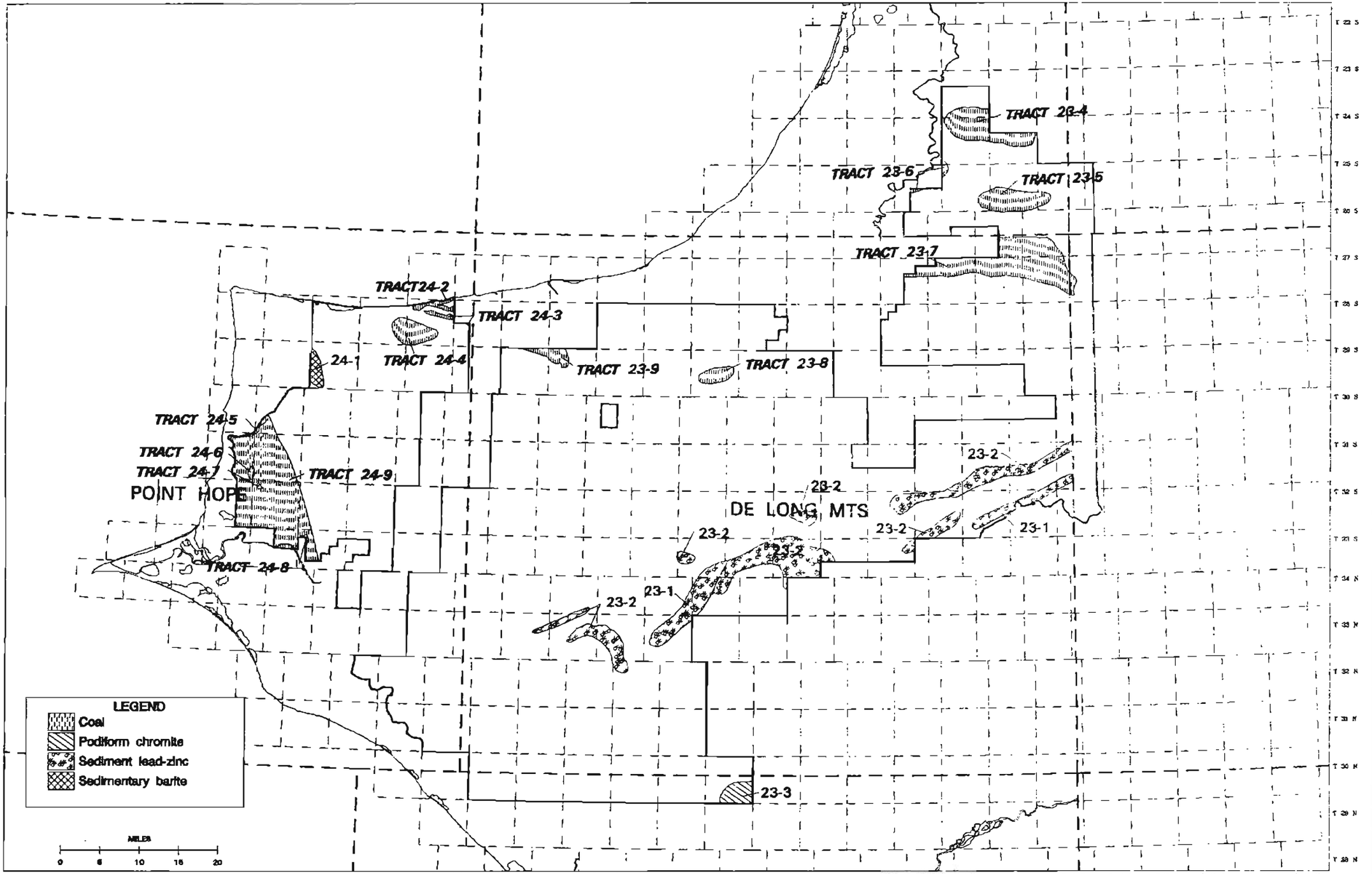
Tracts 24-2 through 24-9 are shown on the map for Units 23 and 24.

Table 24. *Deposit types and estimated mineral endowment of Unit 24, East Lisburne Hills*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

SEDIMENTARY BARITE

Probability	*95*	*50*	*5*	*Mineral Potential*
PLAY 24-1	Small area			
Ore	0	0	0 million tons	Moderate
Lead	0	0	0 thousand tons	
Zinc	0	0	0 thousand tons	
Barite	0	0	0 tons	
Silver	0	0	0 thousand oz	



Units 23 and 24, Northwest Delong Mountains and East Lisburne Hills Unit

UNIT 25 - NATIONAL PETROLEUM RESERVE ALASKA (NPRA)

Unit 25 is not open to land selection.

UNIT 26 - WESTERN KILLIK

GEOLOGIC SUMMARY

Unit 26 encompasses 464,000 acres in a narrow north-south trending belt adjacent to the eastern boundary of the National Petroleum Reserve in Alaska (NPRA) south of the Colville River in the western Killik River Quadrangle. Most of the land in this unit has been previously selected by the state but has not been conveyed.

The unit is underlain by three general groups of rocks. On the north, in the northern foothills of the Brooks Range, a small area is underlain by coal-bearing deltaic rocks of the Chandler Formation of the Nanushuk Group of mid-Cretaceous (Albian) age that lies north of an extensive lowland area of marine black shale of the Torok Formation. The central part of the unit is underlain by dominantly thin-bedded Paleozoic and lower Mesozoic chert and shale that have been intensely deformed by thrust faulting in a belt that is informally referred to as "the disturbed belt." These rocks are exposed in an area of scattered, isolated, rubble-covered hills and knobs.

The southern third of the unit, which lies within the Brooks Range, is underlain dominantly by Upper Devonian rocks of the Kanayut Conglomerate, Noatak Sandstone, and Hunt Fork Shale. These rocks were deposited as part of a large delta system in which the nonmarine Kanayut Conglomerate prograded southward over the marine Noatak Sandstone and upper Hunt Fork and over the prodelta shale of the lower Hunt Fork. The mountains range up to 5,100 ft in elevation but are dominantly rubble-covered and contain actual bedrock exposures only in areas of steeper topography. A narrow belt of Mississippian-age sooty black shale, chert, and carbonate rocks of the Kuna Formation of the Lisburne Group and fissile black Kayak Shale overlie the Kanayut at the northern mountain front.

MINERAL DEPOSIT TYPES - UNIT 26

The appraisal indicates that Unit 26 has no significant potential for mineral resources.

COAL RESOURCE POTENTIAL - UNIT 26

Tract 26-1 has high potential for coal resources. Tract 26-1 is shown on the map for Units 26, 27, 28, and 29 as nonmarine Chandler Formation of the Nanushuk Group, which is known to contain considerable coal.

UNIT 27 - CENTRAL KILLIK FOOTHILLS

GEOLOGIC SUMMARY

Unit 27 contains 546,000 acres in the north-central part of the Killik River Quadrangle. The lands are entirely within the Brooks Range foothills province and are underlain mostly by a thick section of rocks of Cretaceous (Albian) age.

The northern part of the area is underlain by thick nonmarine coal-bearing sediments of the Chandler Formation of the Nanushuk Group deposited in a deltaic environment; these rocks form rolling tundra-covered uplands with a few rubble-covered ridges and scattered stream cutbanks with bedrock exposures. The belt is bounded on the south by a lowland area underlain by thick black shale of the Torok Formation. Bedrock exposures are confined only to a few stream cutbanks. Most of the southern part of the Unit 27 consists of rolling rubble-covered hills underlain by graywacke sandstone of the Fortress Mountain Formation deposited in a turbidite fan depositional setting. However, a small area at the extreme southern edge of the area is underlain by graywacke and a small amount of basalt.

MINERAL DEPOSIT TYPES - UNIT 27

The appraisal indicates that Unit 27 has no significant potential for mineral resources.

COAL RESOURCE POTENTIAL - UNIT 27

Tract 27-1 has high potential for coal resources. It is mapped as nonmarine Chandler Formation of the Nanushuk Group, which is known to contain considerable coal. Trace 27-1 is shown on the map for Units 26, 27, 28, and 29.

UNIT 28 - NORTHEAST KILLIK FOOTHILLS

GEOLOGIC SUMMARY

Unit 28 is a small area of 46,000 acres located entirely within the belt of the Nanushuk Group of mid-Cretaceous (Albian) age. The area consists dominantly of rolling tundra-covered hills with a few ridges composed of sandstone rubble; a few bedrock exposures are present along the valley walls of the Okpikruak River. These rocks are dominantly nonmarine sandstones of the upper part of the Nanushuk Group, which commonly contain interbedded coal beds elsewhere in Nanushuk Group outcrop belt in the Brooks Range foothills.

MINERAL DEPOSIT TYPES - UNIT 28

The appraisal indicates that Unit 28 has no significant potential for mineral resources.

COAL RESOURCE POTENTIAL - UNIT 28

Tract 28-1 has high potential for coal resources. It is mapped as nonmarine Chandler Formation of the Nanushuk Group, which is known to contain considerable coal. Tract 28-1 is shown on the map for Units 26, 27, 28, and 29.

UNIT 29 - ANAKTUVUK RIVER

GEOLOGIC SUMMARY

Unit 29 encompasses 70,000 acres on the central North Slope, 25 miles southeast of Umiat (Umiat oil field) and 15 miles south of the Gubik gas field. Unit 29 is in the Chandler Lake and Umiat Quadrangles, and is cut by the Anaktuvuk and Nanushuk Rivers. Nearby communities include Anaktuvuk Pass, Nuiqsut, and Umiat. Three petroleum wells are located in Unit 29: Tulugak-1, Shale Wall Unit-1, and Schrader Unit-1.

Bedrock consists of Nanushuk Group sandstone, conglomerate, and shale of Cretaceous age (about 65 to 145 million years old), and Colville Group sandstone, siltstone, shale, and conglomerate of Late Cretaceous age (about 65 to 95 million years old). The three principal requirements for petroleum accumulations: source, trap, and reservoir are found in the subsurface of Unit 29. The Nanushuk Group (Grandstand Formation) sands, in fault-bounded structures, are the most likely reservoirs.

Northern Foothills Belt structures and stratigraphy in Unit 29 include: (1) broad, east-west-trending synclines and anticlines, (2) north-vergent thrust faults commonly breaching anticline crests, (3) complex detachment-faults, (4) poor-quality reservoir rocks at depth, and (5) good-quality Nanushuk Group sands at shallow levels.

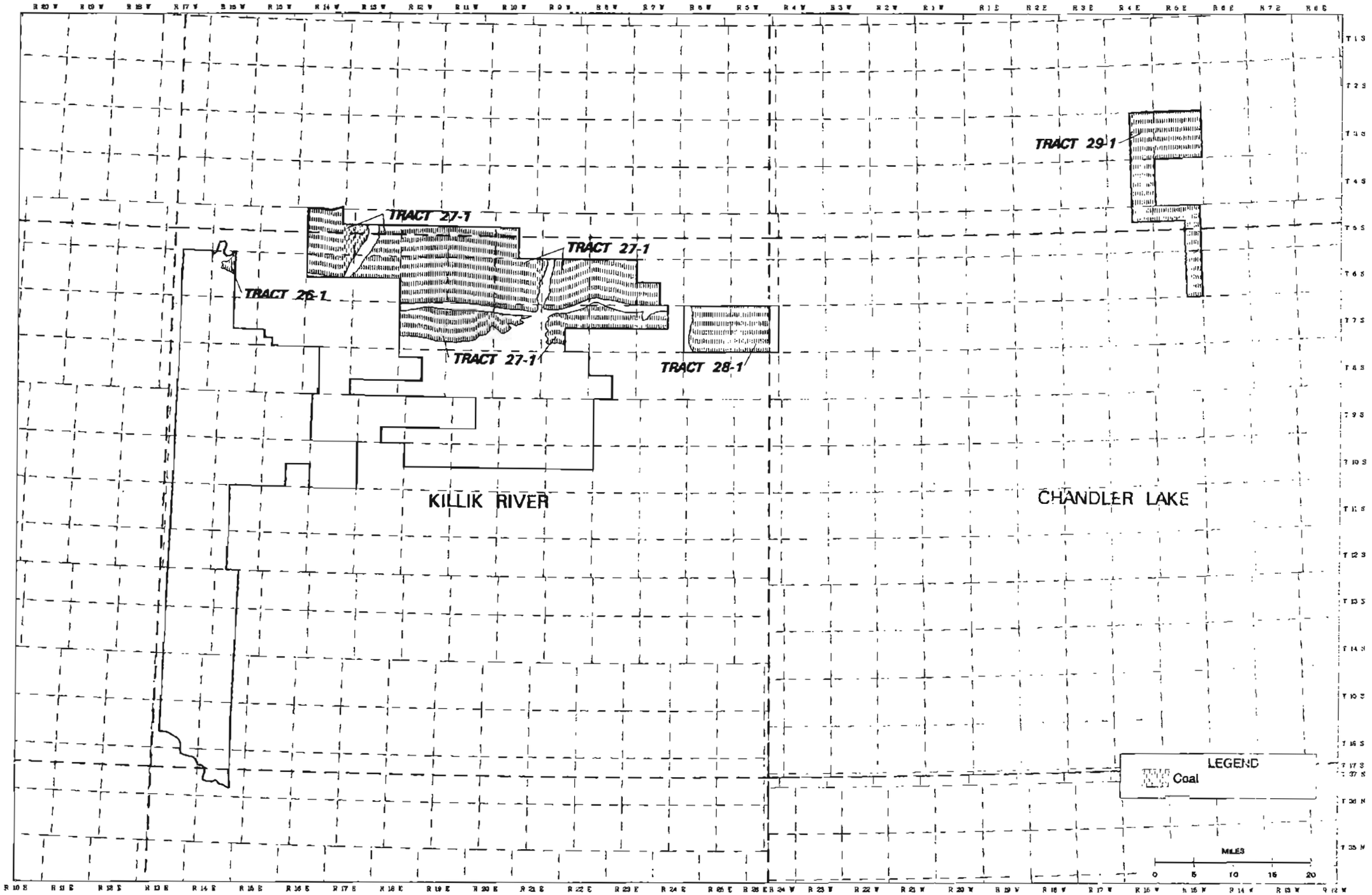
In summary, the estimated potential for small, noncommercial oil and gas accumulations is fair to good, but the potential for a single large commercial reserve in this part of the Northern Foothills Belt is poor. Reserve estimates of the Umiat oil field (70 to 122 million barrels) and the Gubik gas field (22 to 295 million barrels) supports the potential for small accumulations in Unit 29.

MINERAL DEPOSIT TYPES - UNIT 29

The appraisal indicates that Unit 29 has no significant potential for mineral resources.

COAL RESOURCE POTENTIAL - UNIT 29

Tract 29-1 has moderate potential for coal resources. It is mapped as nonmarine Chandler Formation of the Nanushuk Group, which contains substantial coal elsewhere. Tract 29-1 is shown on the map for Units 26, 27, 28, and 29.



Units 26, 27, 28, and 29, Western Killik, Central Killik Foothills, Northeast Killik Foothills and Anuktuvuk River Units

UNITS 30 AND 31 - PIPELINE UTILITY CORRIDOR AND CHANDALAR

GEOLOGIC SUMMARY

Units 30 and 31 encompass 2.3 and 1.1 million acres respectively in the Livengood, Beaver, Bettles, Wiseman, Chandalar, Tanana, and Phillip Smith Mountains Quadrangles of north-central Alaska. These units include the haul-road corridor and the towns of Wiseman, Nolan, and Coldfoot. The units extend 250 mi from north of Galbraith Lake, across the crest of the Brooks Range, to south of the Yukon River.

Units 30 and 31 contain several diverse geologic terranes which trend generally east-west. The Brooks Range is deformed into east-west trending fold and thrust belts, with a core of high-grade metamorphic rocks of Devonian to Proterozoic age (about 345 million to more than 600 million years old). These rocks are flanked to the north and south by lower grade metamorphic rocks that are also less deformed. The northern rocks of Unit 30 are geographically part of the North Slope foothills fold-and-thrust-belt, and also part of the regional Colville Basin which has oil and gas potential. On the southern flank of the Brooks Range unmetamorphosed sedimentary rocks with local coal lie on top of the lower grade metamorphic rocks and are part of the Koyukuk Basin. Devonian granitic plutons (about 345 to 395 million years old) intrude the northern portions of Units 30 and 31, and Cretaceous-age granitic and syenitic plutons (about 65 to 140 million years old) intrude the central and southern portions of Units 30 and 31.

The Upper Koyukuk gold district is the most productive in the Brooks Range and lies within Units 30 and 31. Production from the Upper Koyukuk district and the Chandalar gold district (40 mi east) is estimated to be 379,200 oz of gold; all but 17,400 oz was derived from placer deposits, particularly along the central portion of the pipeline corridor. Lode gold prospects are present near Nolan and Wiseman and continue in an east-west trending belt. Several small areas of plutonic rock elsewhere are of the appropriate composition to produce gold-bearing quartz veins.

More than a dozen mineralized skarn prospects are known near the northern part of Unit 31. The abundance of appropriate igneous rock and thick carbonates, both necessary rocks for skarn formation, suggest that one or more significant-sized skarn deposit could be present in the area. A small potential for tungsten skarn is present in the southern portion of Unit 31 and parts of Unit 30 along the margins of plutons. The small amount of carbonate in the southern area limits the size and probability of significant skarn.

A few granites in the northern part of area 31 are associated with major tin anomalies and greisen-like alteration; however, mineralization is not known. Documented tin anomalies are present in stream sediments and bedrock in and near the plutons in the southern part of Unit 30; these granites are probably associated with weak to moderate tin systems. The granite that appears most mineralized is Sithylemenkat pluton in western Unit 30 and in Unit 34 to the west.

Other possible mineral deposits include porphyry copper-molybdenum (prospects are present around Horace Mountain), chromite and platinum element deposits, and stratabound manganese. Coal, from deposits along the Koyukuk River-Middle Fork, has been mined since 1900 to fuel placer mining equipment.

The northern part of Unit 30 is underlain by Cretaceous Brookian rocks of the Colville Basin. Adjacent to and just south are older, folded and thrust-faulted Ellesmerian sequence rocks. Based on known structure, rock type, porosity, permeability, thermal maturity, source rock, and reservoir rock potential, small subcommercial oil and gas fields could be found in this area, whereas the chance for a large, commercial accumulation is remote.

MINERAL DEPOSIT TYPES - UNITS 30 AND 31

The mineral deposit models chosen to estimate the mineral endowment of Units 30 and Unit 31 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered from

30/31-1 through 30/31-27. The location of the plays and their probabilistic endowment estimates are shown in the map for Units 30 and 31 and table 30/31.

(1) Metamorphic gold veins: There is high mineral potential in plays 30/31-1, 2, and 3, and moderate mineral potential in plays 30/31-4 and 5.
(2) Granitic gold veins: There is moderate mineral potential in plays 30/31-6, 7, 8, and 9.
(3) Gold placers: There is high mineral potential in plays 30/31-11, 12, 13, and 15, and moderate mineral potential in plays 30/31-10, 14, and 16.
(4) Copper-silver skarns: There is high mineral potential in play 30/31-17.
(5) Lead-zinc skarns: There is moderate mineral potential in play 30/31-18.
(6) Tungsten-gold skarns: There is moderate mineral potential in play 30/31-19.
(7) Porphyry copper-molybdenum: There is high mineral potential in play 30/31-20.
(8) Granite tin greisen: There is moderate mineral potential in plays 30/31-21, 22, 23, and 24.
(9) Podiform chromite: There is moderate mineral potential in play 30/31-25.
(10) Platinum group metals: There is moderate mineral potential in play 30/31-26.
(11) Stratabound manganese and iron: There is moderate mineral potential in play 30/31-27.

COAL RESOURCE POTENTIAL - UNITS 30 AND 31

Coal tract 30/31-28 at the northern portion of Unit 30 in the Philip Smith Mountains Quadrangle has high potential for coal resources because it is mapped as nonmarine Chandler Formation of the Nanushuk Group which is known to contain considerable coal. Tract 30/31-28 and 30/31-29 are shown on the Units 30 and 31 map.

Smaller coal tracts 30/31-29 to the south of the Brooks Range in Units 30 and 31 have moderate potential for coal resources because locally they contain minor coal shows and are mapped as a Cretaceous coal-bearing unit. This coal-bearing unit is not related to the Chandler Formation of the North Slope and quantities and minability of coal are unknown. Tracts 30/31-28 and 30/31-29 are shown on the Units 30 and 31 map.

Table 30/31. *Deposit types and estimated mineral endowment of Units 30 and 31, the Pipeline Utility Corridor and Chandalar*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

METAMORPHIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 30/31-1	Medium area			
Ore	0	0.36 million tons	16 million tons	High
Gold	0	110 thousand oz	4,500 thousand oz	
Silver	0	0 thousand oz	120 thousand oz	
PLAY 30/31-2	Small area			
Ore	0	0.15 million tons	2.4 million tons	High
Gold	0	42 thousand oz	600 thousand oz	
Silver	0	0 thousand oz	45 thousand oz	
PLAY 30/31-3	Small area			
Ore	0	0.12 million tons	3.2 million tons	High
Gold	0	31 thousand oz	1,100 thousand oz	
Silver	0	0 thousand oz	49 thousand oz	
PLAY 30/31-4	Medium area			
Ore	0	0	2.1 million tons	Moderate
Gold	0	0	680 thousand oz	
Silver	0	0	160 thousand oz	
PLAY 30/31-5	Small area			
Ore	0	0	0.8 million tons	Moderate
Gold	0	0	230 thousand oz	
Silver	0	0	17 thousand oz	

GRANITIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 30/31-6	Small area			
Ore	0	0	0.32 million tons	Moderate
Gold	0	0	39 thousand oz	
PLAY 30/31-7	Small area			
Ore	0	0	0.32 million tons	Moderate
Gold	0	0	39 thousand oz	
PLAY 30/31-8	Small area			
Ore	0	0	0.32 million tons	Moderate
Gold	0	0	39 thousand oz	
PLAY 30/31-9	Small area			
Ore	0	0	2.2 million tons	Moderate
Gold	0	0	270 thousand oz	

GOLD PLACERS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 30/31-10	Medium area			
Ore	0	0	1.1 million tons	Moderate
Gold	0	0	16 thousand oz	
Silver	0	0	10 thousand oz	
PLAY 30/31-11	Small area			
Ore	0.32 million tons	4.4 million tons	21 million tons	High
Gold	3 thousand oz	64 thousand oz	280 thousand oz	
Silver	1 thousand oz	43 thousand oz	200 thousand oz	
PLAY 30/31-12	Small area			
Ore	0	0.53 million tons	3.6 million tons	High
Gold	0	7 thousand oz	48 thousand oz	
Silver	0	4 thousand oz	36 thousand oz	
PLAY 30/31-13	Small area			
Ore	0	0	2.3 million tons	High
Gold	0	0	31 thousand oz	
Silver	0	0	25 thousand oz	
PLAY 30/31-14	Small area			
Ore	0	0	4.3 million tons	Moderate
Gold	0	0	67 thousand oz	
Silver	0	0	44 thousand oz	
PLAY 30/31-15	Small area			
Ore	0	0	8.1 million tons	High
Gold	0	0	88 thousand oz	
Silver	0	0	35 thousand oz	
PLAY 30/31-16	Small area			
Ore	0	0	0.41 million tons	Moderate
Gold	0	0	5 thousand oz	
Silver	0	0	2 thousand oz	

COPPER SILVER SKARNS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 30/31-17	Small area			
Ore	0	0.087 million tons	27 million tons	High
Silver	0	100 thousand oz	58,000 thousand oz	
Copper	0	2 thousand tons	520 thousand tons	

LEAD-ZINC SKARNS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 30/31-18	Small area			
Ore	0	0	0 million tons	Moderate
Zinc	0	0	0 thousand tons	
Lead	0	0	0 thousand tons	
Copper	0	0	0 thousand tons	
Silver	0	0	0 thousand oz	
Gold	0	0	0 thousand oz	

TUNGSTEN-GOLD SKARNS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 30/31-19	Small area			
Ore	0	0	2.1 million tons	Moderate
Tungsten	0	0	14 thousand tons	
Gold	0	0	18 thousand oz	

PORPHYRY COPPER-MOLYBDENUM

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 30/31-20	Small area			
Ore	0	0	95 million tons	High
Copper	0	0	340 thousand tons	
Moly	0	0	14 thousand tons	
Gold	0	0	32 thousand oz	
Silver	0	0	3,400 thousand oz	

GRANITE TIN GREISENS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 30/31-21	Small area			
Ore	0	0	0 million tons	Moderate
Tin	0	0	0 thousand tons	
Niobium	0	0	0 tons	
Beryllium	0	0	0 tons	
Fluorine	0	0	0 thousand tons	
Silver	0	0	0 thousand oz	
Tungsten	0	0	0 thousand tons	
PLAY 30/31-22	Very large area			
Ore	0	0	83 million tons	Moderate
Tin	0	0	140 thousand tons	
Niobium	0	0	2,200 tons	
Beryllium	0	0	0 tons	
Fluorine	0	0	0 thousand tons	
Silver	0	0	4,200 thousand oz	
Tungsten	0	0	0 thousand tons	

GRANITE TIN GREISENS CONTINUED

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 30/31-23	Large area			
Ore	0	0	94 million tons	Moderate
Tin	0	0	150 thousand tons	
Niobium	0	0	1,700 tons	
Beryllium	0	0	0 tons	
Fluorine	0	0	0 thousand tons	
Silver	0	0	4,200 thousand oz	
Tungsten	0	0	0 thousand tons	
PLAY 30/31-24	Medium area			
Ore	0	0	14 million tons	Moderate
Tin	0	0	33 thousand tons	
Niobium	0	0	540 tons	
Beryllium	0	0	0 tons	
Fluorine	0	0	80 thousand tons	
Silver	0	0	950 thousand oz	
Tungsten	0	0	0 thousand tons	

PODIFORM CHROMITE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 30/31-25	Small area			
Ore	0	0	0.12 million tons	Moderate
Chromium	0	0	56 thousand oz	

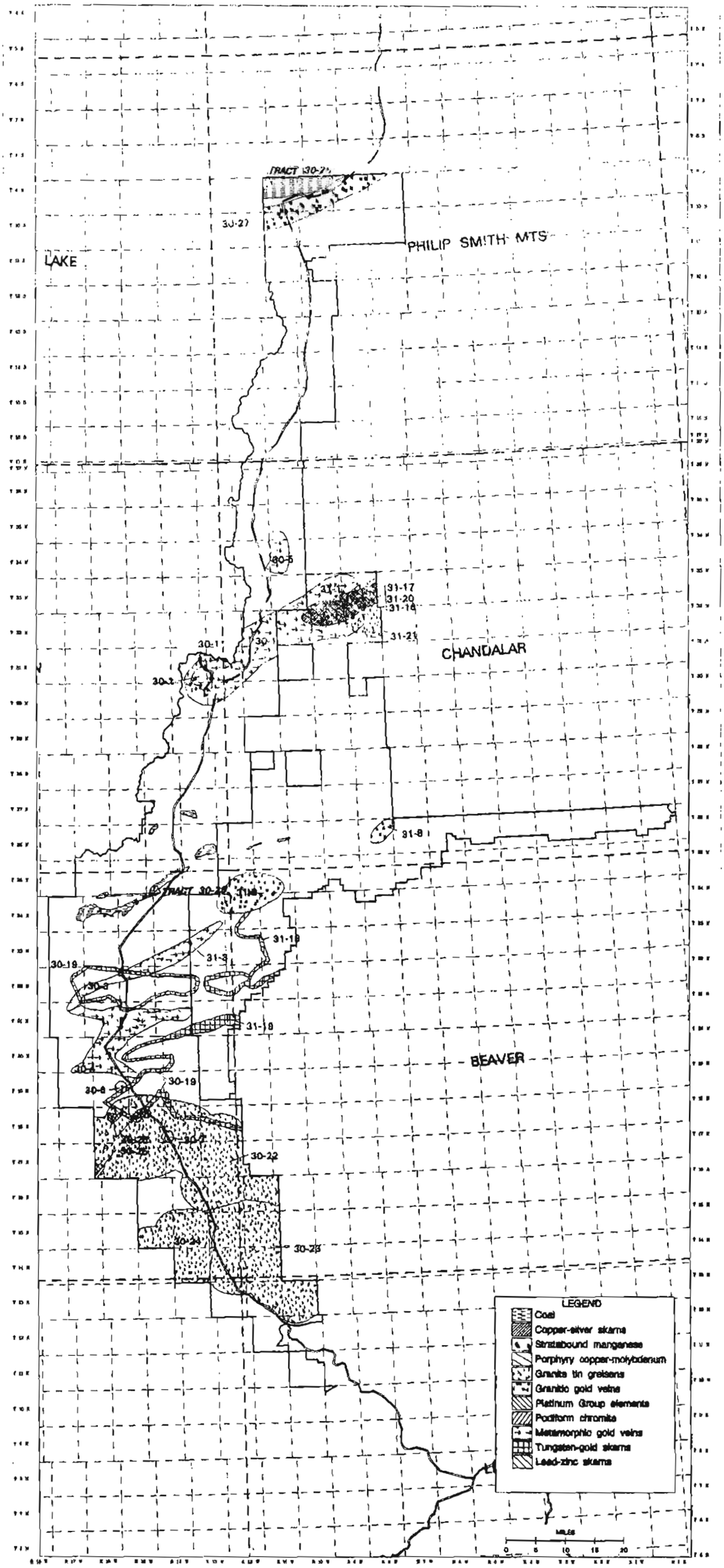
PLATINUM GROUP ELEMENTS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 30/31-26	Small area			
Ore	0	0	2.2 million tons	Moderate
Nickel	0	0	1.4 thousand tons	
Copper	0	0	0.1 thousand tons	
Platinum	0	0	0.5 thousand oz	
Palladium	0	0	4.4 thousand oz	

STRATABOUND MANGANESE AND IRON

Play 30/31-27 Small area

From Toolik Lake to the Sagavanirktok River, Early Cretaceous sedimentary rocks may contain stratabound manganese and iron. Selected rock samples from a 30-ft-thick interval on Cobblestone Creek, west of the land selection area 30, contains up to 0.70 percent manganese and up to 10 percent iron. Iron- and manganese-bearing rocks appear to trend across area 30, but the thickness and mineral content is unknown. In view of the lack of data, calculation of the mineral endowment is not possible at this time.


TRACT 30-27
30-27
PHILIP SMITH MTS
LAKE
30-5
31-17
31-20
31-16
31-21
30-1
30
CHANDALAR
30-2
31-8
TRACT 30-26
31-15
30-19
31-3
30-3
31-16
BEAVER
30-4
30-19
30-22
30-24
30-25
LEGEND
Coal
Copper-silver skarns
Stratabound manganese
Porphyry copper-molybdenum
Granite tin greisens
Granite gold veins
Platinum Group elements
Podiform chromite
Metamorphic gold veins
Tungsten-gold skarns
Lead-zinc skarns
MILES
0
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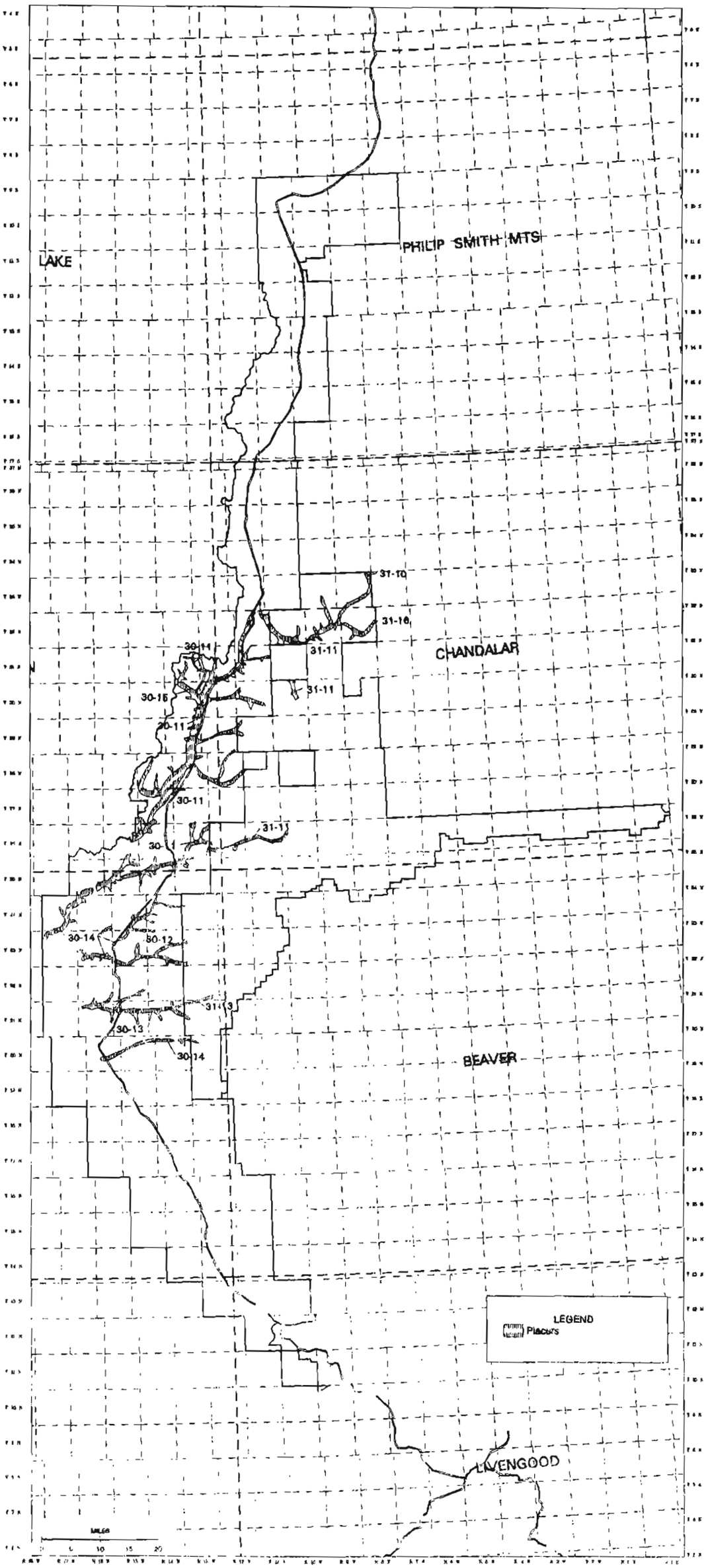


Figure [illegible] Units 30 and 31 Pipeline / Utility Corridor and Chandalar Units

UNIT 32 - HOGATZA

GEOLOGIC SUMMARY

Unit 32 encompasses about 3.5 million acres in the northeast Melozitna, southern Hughes, and eastern Shungnak Quadrangles. The area is part of the Koyukuk geologic terrane. The oldest exposed rocks are island arc volcanic rocks, 117 to 134 million years old, which include andesitic to basaltic flows, crystal lithic tuffs, breccias, and volcanic conglomerates. Volcanic-derived sediments, conglomerates, and sandstones surround the volcanic deposits and grade into mudstones and graywackes. Late Cretaceous plutons (about 65 to 95 million years old) are primarily granodiorites but include granites, monzonites, and quartz monzonites. The plutons intrude both the volcanic and sedimentary rocks and are deeply eroded. A hornfelsed zone surrounds these plutons. Volcanism, contemporaneous with the plutonism, produced latites and rhyodacites in the western part of Unit 32. Tertiary volcanic dacites (about 40 million years old) in the northeast Melozitna Quadrangles postdate the plutonism. Small hypabyssal rhyolite bodies are scattered throughout the region.

Mineralized zones are present within some plutons and near contacts with some volcanic rocks. A high-grade polymetallic vein with significant lead, silver, gold, zinc, and also anomalous chromium, copper, and arsenic occurs in the volcanic rocks in the southeastern part of Unit 32. Granitic uranium/thorium and rare-earth-element veins are found in the monzonite phase of the Zane Hills pluton and in the alaskite portion of the Wheeler Creek pluton (in the central and western portions, respectively, of the area). Both plutons are anomalous in radioactive elements. Gold-bearing veins are present in volcanic rocks east of the Zane Hills pluton and in the Triplet Stock pluton (western part of the area). Base-metal anomalies occur in gossans throughout the Purcell Mountain area in the northwestern part of Unit 32. Samples from a small roof pendant to the Zane Hills pluton contained 5-6 percent copper.

Significant placer gold production has occurred in Unit 32. In the central part, about 221,140 oz of gold have been mined from the Hogatza district to date, and dredge mining operations at Hogatza during the summer of 1992 made a third pass over tailings on Bear Creek. In the eastern portion 8,000 oz of placer gold have come from Utopias Creek valley to date, and as well as minor amounts from other tributaries in the area. Small mining operations are currently active on native selected lands in this portion of Unit 32. In the northwest, two small placer operations exist on the west side of the Purcell Mountain pluton. Production from these is not known. A sample taken from a small creek draining the Triplet Stock in the west indicates some placer gold potential for that area.

Geothermal potential in the form of three hot springs (Hawk, South, and Upper Division) exists in Unit 32.

MINERAL DEPOSIT TYPES - UNIT 32

The mineral deposit models chosen to estimate the mineral endowment of Unit 32 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 32-1 through 32-17. The location of plays and their probabilistic endowment are shown on the map for Unit 32 and table 32.

(1) Gold placers: There is high mineral potential in plays 32-1, 32-3, and 32-15, and moderate mineral potential for play 32-12.
(2) Polymetallic veins: There is moderate mineral potential in play 32-2.
(3) Granite uranium-rare earth: There is high mineral potential in play 32-4 and 32-10, and moderate mineral potential in play 32-5 and 32-11.
(4) Granitic gold veins: There is high mineral potential in play 32-16, and moderate mineral potential in plays 32-6, 32-7, 32-8, and 32-13.
(5) Basalt-hosted copper: There is moderate mineral potential in play 32-9.
(6) Limestone lead-zinc: There is moderate mineral potential in play 32-14.
(7) Geothermal: There is moderate mineral potential in play 32-17.

Table 32. *Deposit types and estimated mineral endowment of Unit 32, Hogatza*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

GOLD PLACERS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 32-1	Small area			
Ore	0 million tons	0.2 million tons	1 million tons	High
Gold	0 thousand oz	2 thousand oz	18 thousand oz	
Silver	0 thousand oz	1 thousand oz	14 thousand oz	

POLYMETALLIC VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 32-2	Small area			
Ore	0	0	1 million tons	Moderate
Silver	0	0	54,000 thousand oz	
Gold	0	0	90 thousand oz	
Zinc	0	0	36 thousand tons	
Lead	0	0	130 thousand tons	

GOLD PLACERS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 32-3	Small area			
Ore	0.2 million tons	6.2 million tons	26 million tons	High
Gold	3 thousand oz	71 thousand oz	440 thousand oz	
Silver	1 thousand oz	34 thousand oz	360 thousand oz	

GRANITE URANIUM-RARE EARTH

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 32-4	Small area			
Ore	0	0.1 million tons	0.9 million tons	High
Uranium	0	89 tons	2,000 tons	
Rare Earths	0	72 tons	10,000 tons	
Thorium	0	930 tons	21,000 tons	
PLAY 32-5	Medium area			
Ore	0	0	1.1 million tons	Moderate
Uranium	0	0	2,200 tons	
Rare Earths	0	0	11,000 tons	
Thorium	0	0	24,000 tons	

GRANITIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 32-6	Medium area			
Ore	0	0.03 million tons	4.8 million tons	Moderate
Gold	0	4 thousand oz	580 thousand oz	

GRANITIC GOLD VEINS CONTINUED

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 32-7	Medium area			
Ore	0	0	1.4 million tons	Moderate
Gold	0	0	150 thousand oz	
PLAY 32-8	Small area			
Ore	0	0	0.7 million tons	Moderate
Gold	0	0	85 thousand oz	

BASALT-HOSTED COPPER

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 32-9	Small area			
Ore	0	0	0.1 million tons	Moderate
Copper	0	0	2 thousand tons	
Silver	0	0	140 thousand oz	

GRANITE URANIUM-RARE EARTH

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 32-10	Small area			
Ore	0	0	0.7 million tons	High
Uranium	0	0	1,400 tons	
Rare Earths	0	0	8,200 tons	
Thorium	0	0	1,500 tons	
PLAY 32-11	Large area			
Ore	0	0	1.3 million tons	Moderate
Uranium	0	0	2,700 tons	
Rare Earths	0	0	14,000 tons	
Thorium	0	0	2,800 tons	

GOLD PLACERS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 32-12	Small area			
Ore	0	0	0.4 million tons	Moderate
Gold	0	0	5 thousand oz	
Silver	0	0	3 thousand oz	

GRANITIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 32-13	Very large area			
Ore	0	0	0 million tons	Moderate
Gold	0	0	0 thousand oz	

LIMESTONE LEAD-ZINC

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 32-14	Large area			
Ore	0	0	0.7 million tons	Moderate
Lead	0	0	12 thousand tons	
Zinc	0	0	0 thousand tons	
Copper	0	0	0 thousand tons	
Silver	0	0	630 thousand oz	

GOLD PLACERS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 32-15	Small area			
Ore	0	0.1 million tons	0.7 million tons	High
Gold	0	1 thousand oz	10 thousand oz	
Silver	0	0 thousand oz	11 thousand oz	

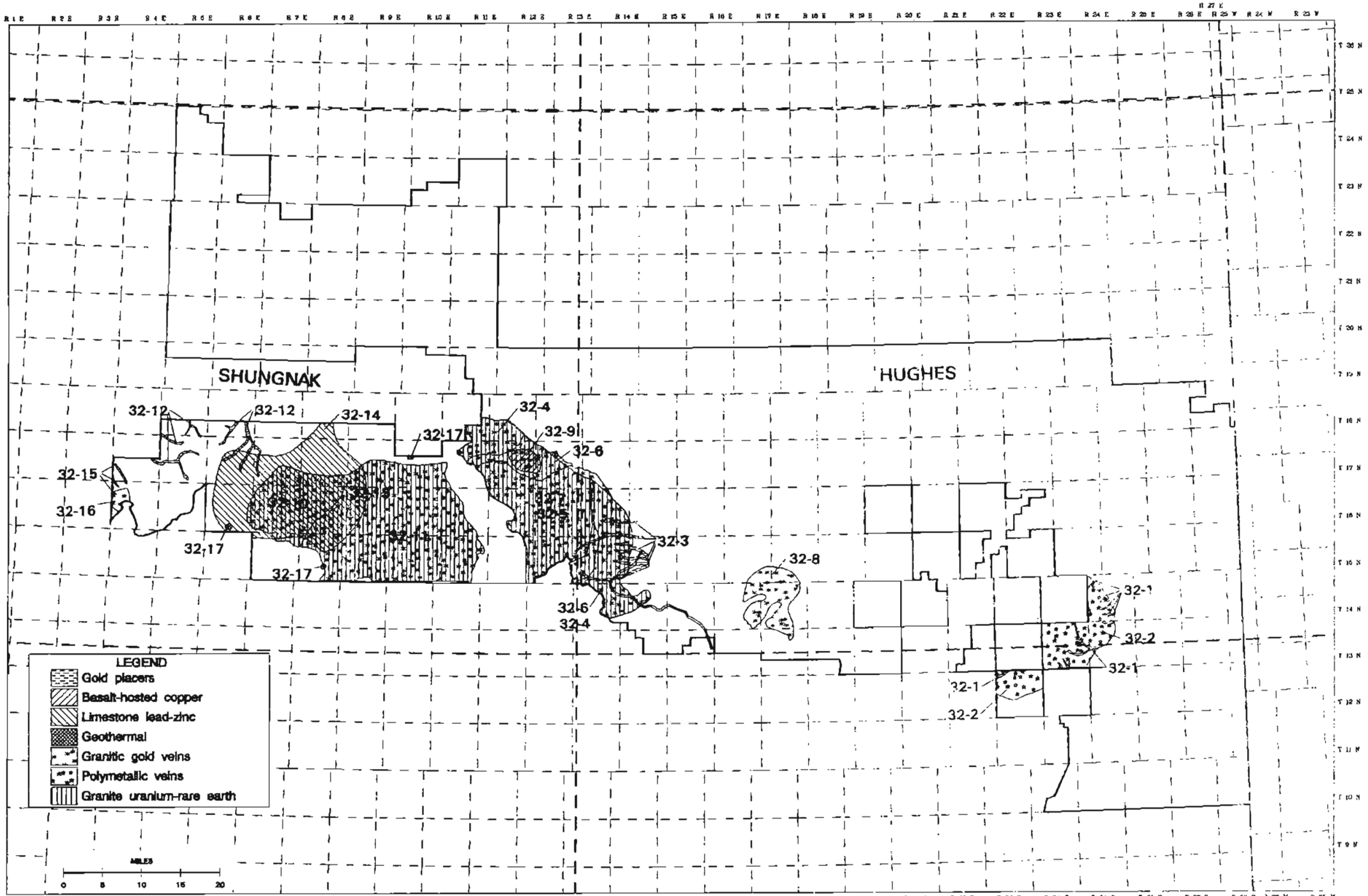
GRANITIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 32-16	Small area			
Ore	0	0	0.9 million tons	High
Gold	0	0	100 thousand oz	

GEOTHERMAL

PLAY 32-17

Geothermal resource is limited to potential for local use for heating, agriculture, and small-scale recreational development.



Unit 32, Hogatza Unit

UNIT 33 - MELOZITNA RIVER

GEOLOGIC SUMMARY

The Melozitna River Unit 33 encompasses 415,000 acres in the Melozitna and Tanana Quadrangles. The western and northern parts of the unit are underlain by Cretaceous sedimentary rocks and Tertiary-Cretaceous volcanic rocks ranging from mafic to intermediate in composition. The southeastern part of Unit 33 is underlain by Precambrian to Paleozoic metamorphic schist and quartzite. Cretaceous granitic rocks intrude the sedimentary, volcanic, and metamorphic rocks.

One of the intrusive rock units was found to be associated with previously unreported sulfide-bearing alteration, and rock grab samples collected by DGGS contained elevated concentrations of such elements as copper, molybdenum, gold, bismuth, arsenic, and zinc.

MINERAL DEPOSIT TYPES - UNIT 33

The mineral deposit model chosen to estimate the mineral endowment of Unit 33 is listed below. The permissive area for the mineral deposit type is referred to as a "play" and is described below. The location of the play and its probabilistic endowment estimate is shown on the map for Unit 33 and table 33.

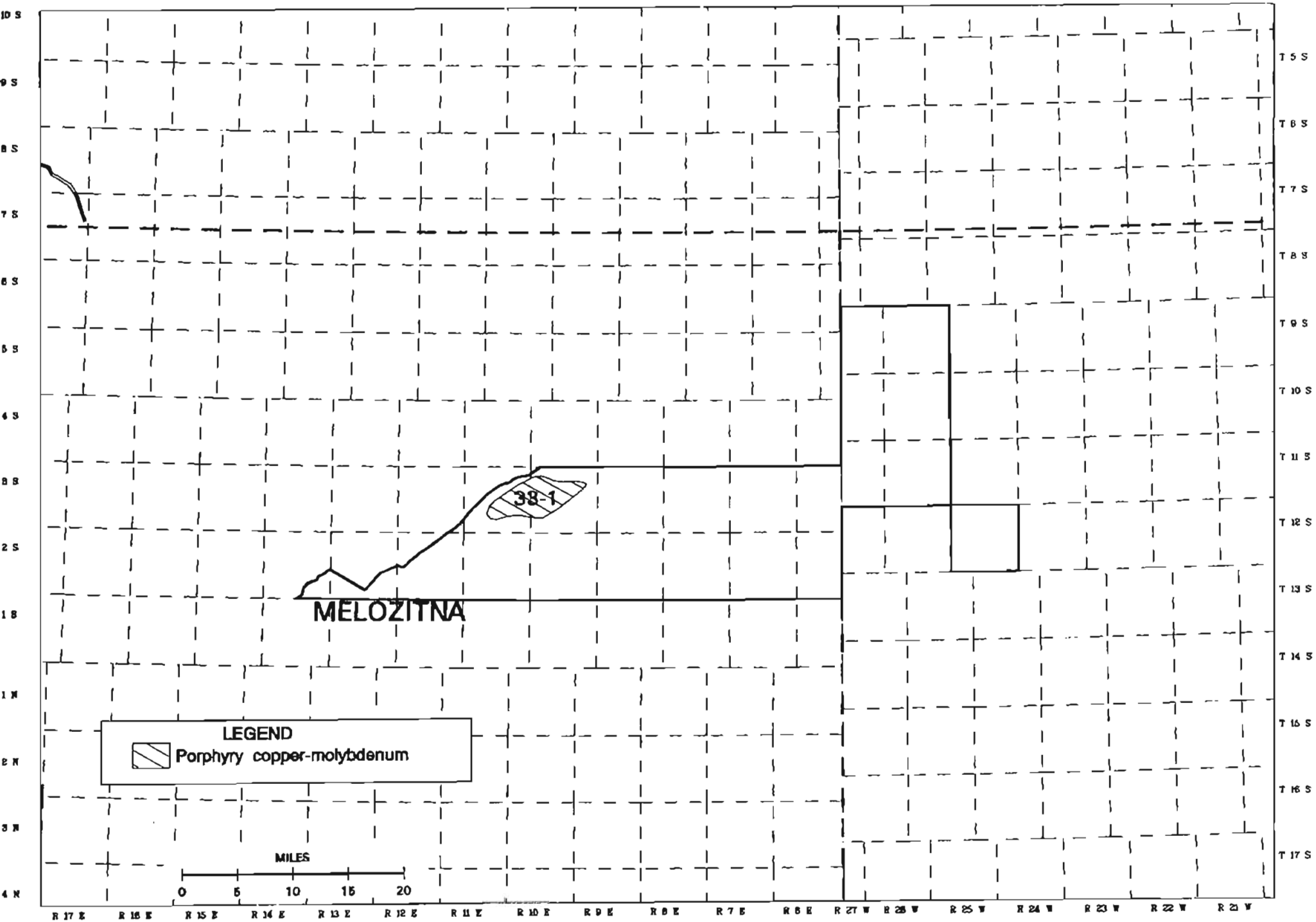
(1) Porphyry copper-molybdenum: There is moderate mineral potential in play 33-1.

Table 33. *Deposit types and estimated mineral endowment of Unit 33, Melozitna River*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

PORPHYRY COPPER-MOLYBDENUM

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 33-1	Small area			
Ore	0	0	180 million tons	Moderate
Copper	0	0	860 thousand tons	
Molybdenum	0	0	26 thousand tons	
Gold	0	0	0 thousand oz	
Silver	0	0	4,600 thousand oz	


38-1
MELOZITNA
LEGEND
Porphyry copper-molybdenum
MILES
0 5 10 15 20
T 5 S
T 6 S
T 7 S
T 8 S
T 9 S
T 10 S
T 11 S
T 12 S
T 13 S
T 14 S
T 15 S
T 16 S
T 17 S
R 17 E
R 16 E
R 15 E
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R 13 E
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R 11 E
R 10 E
R 9 E
R 8 E
R 7 E
R 6 E
R 27 W
R 26 W
R 25 W
R 24 W
R 23 W
R 22 W
R 21 W

UNIT 34 - TOZITNA/RAY MOUNTAINS

GEOLOGIC SUMMARY

The Tozitna/Ray Mountains Unit 34 encompasses 2.3 million acres in the Tanana and Bettles Quadrangles. The area is underlain by several different rock packages. The oldest consists of Precambrian-Paleozoic schist, quartzite, marble, greenstone and chert, and crops out from southwest to northeast across the center of the area. Paralleling this package are two belts of Permian-Jurassic basalt, gabbro, tuff, and ultramafic rock. In the northwest portion of the unit, Cretaceous sedimentary rocks are overlain and/or interlayered with Tertiary-Cretaceous dacite and andesite volcanic flows and tuffs. Several large granitic bodies intrude the schist belt, and include the Sithylemenkat, Hot Springs, and Ray Mountains plutons. In the Tozitna River basin, Tertiary sedimentary rocks crop out along the river banks.

The large plutonic bodies are all compositionally similar to tin-bearing granitic systems; tin prospects are known in the Sithylemenkat pluton. The large size of the plutons suggests deep erosion and implies that high level tin deposits, if any existed, have been eroded away. The tin from any previously existing lodes may have been concentrated in placer deposits downstream from the plutons. In addition to tin, the Ray Mountains pluton may be associated with granitic uranium vein deposits.

The ultramafic rocks in the Permian-Jurassic belts are known to contain anomalously high concentrations of chromite, and samples collected by DGGS also contained consistently anomalous platinum and palladium.

Morelock Creek, in the southeastern portion of Unit 34, has a history of modest gold and tin placer production 1,280 oz of gold and about 10,000 lbs. Lode sources have not been recognized, but in light of the local geology, we have modeled a low probability for a tin skarn deposit in the Morelock Creek basin, as well as a placer deposit model.

MINERAL DEPOSIT TYPES - UNIT 34

The mineral deposit models chosen to estimate the mineral endowment of Unit 34 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 34-1 through 34-15. The location of the plays and their probabilistic endowment estimates are shown on the map for Unit 34 and table 34.

(1) Granite tin greisen: There is high mineral potential in play 34-1 and moderate mineral potential in plays 34-2, 34-3, 34-4, and 34-5.
(2) Podiform chromite: There is moderate mineral potential in plays 34-6 and 34-8.
(3) Platinum group elements: There is moderate mineral potential in plays 34-7 and 34-9.
(4) Tin skarns: Play 34-10 shows no resources at the 5th percentile.
(5) Gold placers: There is moderate mineral potential in play 34-11.
(6) Tin placers: There is high mineral potential in plays 34-12 and 34-13.
(7) Granitic uranium veins: There is moderate potential in play 34-14.
(8) Geothermal: There is moderate mineral potential in play 34-15.

Table 34. *Deposit types and estimated mineral endowment of Unit 34, Tozitna/Ray Mountains*

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

GRANITE TIN GREISENS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 34-1	Very large area			
Ore	0	0	120 million tons	Moderate
Tin	0	0	250 thousand tons	
Niobium	0	0	3,100 tons	
Beryllium	0	0	0 tons	
Fluoride	0	0	0 thousand tons	
Silver	0	0	5,900 thousand oz	
Tungsten	0	0	0 thousand oz	
PLAY 34-2	Small area			
Ore	0	0	0 million tons	Moderate
Tin	0	0	0 thousand tons	
Niobium	0	0	0 tons	
Beryllium	0	0	0 tons	
Flouride	0	0	0 thousand tons	
Silver	0	0	0 thousand oz	
Tungsten	0	0	0 thousand tons	
PLAY 34-3	Large area			
Ore	0	0	1.8 million tons	Moderate
Tin	0	0	2 thousand tons	
Niobium	0	0	0 tons	
Beryllium	0	0	0 tons	
Fluoride	0	0	0 thousand tons	
Silver	0	0	0 thousand oz	
Tungsten	0	0	0 thousand oz	
PLAY 34-4	Very large area			
Ore	0	0	7.1 million tons	Moderate
Tin	0	0	15 thousand tons	
Niobium	0	0	69 tons	
Beryllium	0	0	0 tons	
Flouride	0	0	0 thousand tons	
Silver	0	0	330 thousand oz	
Tungsten	0	0	0 thousand tons	
PLAY 34-5	Small area			
Ore	0	0	1.9 million tons	Moderate
Tin	0	0	3 thousand tons	
Niobium	0	0	0 tons	
Beryllium	0	0	0 tons	
Flouride	0	0	0 thousand tons	
Silver	0	0	0 thousand oz	
Tungsten	0	0	0 thousand tons	

PODIFORM CHROMITE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 34-6	Small area			
Ore	0	0	0.2 million tons	Moderate
Chromium	0	0	73 thousand tons	

PLATINUM GROUP ELEMENTS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 34-7	Small area			
Ore	0	0	4.3 million tons	Moderate
Nickel	0	0	3 thousand tons	
Copper	0	0	0 thousand tons	
Platinum	0	0	4 thousand oz	
Palladium	0	0	11 thousand oz	

PODIFORM CHROMITE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 34-8	Small area			
Ore	0	0	3.7 million tons	Moderate
Chromium	0	0	1,600 thousand tons	

PLATINUM GROUP ELEMENTS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 34-9	Small area			
Ore	0	0	23 million tons	Moderate
Nickel	0	0	36 thousand tons	
Copper	0	0	11 thousand tons	
Platinum	0	0	83 thousand oz	
Palladium	0	0	160 thousand oz	

TIN SKARNS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 34-10	Small area			
Ore	0	0	0 million tons	Moderate
Tin	0	0	0 thousand tons	
Silver	0	0	0 thousand oz	
Tungsten	0	0	0 thousand oz	
Lead	0	0	0 thousand tons	
Zinc	0	0	0 thousand tons	

GOLD PLACERS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 34-11	Small area			
Ore	0	0	0.6 million tons	Moderate
Gold	0	0	9 thousand oz	
Silver	0	0	4 thousand oz	

TIN PLACER DEPOSIT

PLAY 34-12 Large area High

In the basin drained by the Kanuti Kilolitna River, heavy mineral concentrates collected from surface alluvium "contained up to 51.2 pct Sn (0.02 to 0.4 lb/yd^3 Sn), up to 5 pct W, up to 0.4 pct Cb (Nb), and up to 0.1 pct Ta. The concentration of heavy minerals is expected to increase with depth." (Barker and Foley, 1986).

Barker, J.C. and Foley, J.Y., 1986, Tin reconnaissance of the Kanuti and Hodzana Rivers uplands, central Alaska; U.S. Bureau of Mines Information Circular 9104, 27 p.

PLAY 34-13 Medium area High

Estimated tin resources in the Ray River drainage are "between 28 and 78 million kgs. However, these estimates are subject to a wide margin of error. Most of the tin resources in the Ray River valley are at grades of 59 to 269 g/m^3" (Barker, 1991).

Barker, J.C., 1991, Tin placers associated with the downcutting of fissure basalts, Ray River drainage, Alaska; *in* Short Notes on Alaskan Geology 1991, R.D. Reger, ed., DGGS Professional Report 111, p. 1-8.

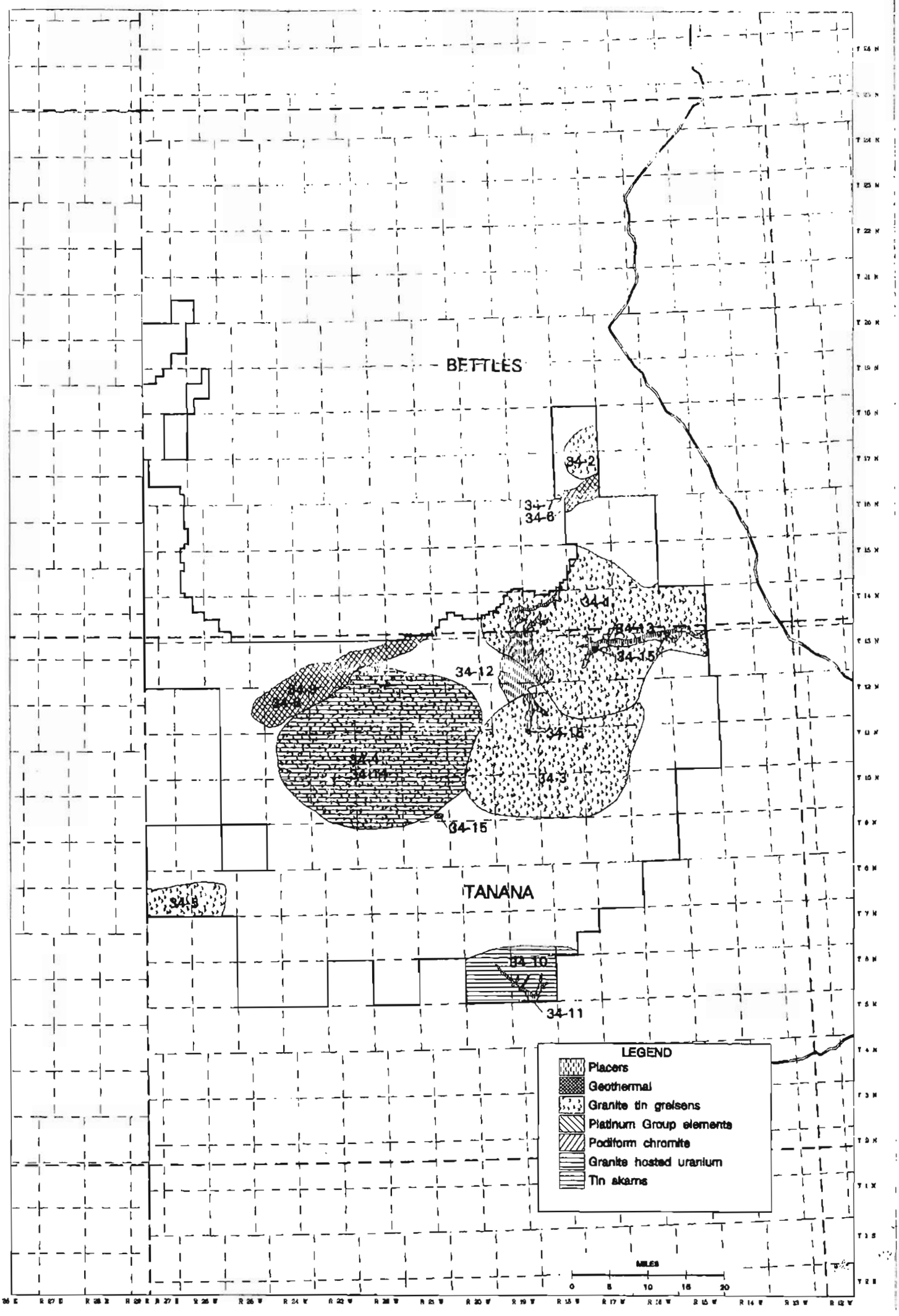
GRANITE HOSTED URANIUM

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 34-14	Very large area			
Ore	0	0	2.5 million tons	Moderate
Uranium	0	0	2,900 tons	

GEOTHERMAL

PLAY 34-15 Small area

Geothermal resource is limited to potential for local use for heating, agriculture, and small-scale recreational development.



UNIT 35 - KANDIK/BLACK RIVER

GEOLOGIC SUMMARY

Unit 35 encompasses 2.25 million acres in the Charley River and Black River Quadrangles. The unit can be divided into a northern and southern half, based on geology as well as by quadrangles. The southern part of Unit 35 lies within the Charley River fold and thrust belt and includes the Kandik basin which has been explored (unsuccessfully, to date) for hydrocarbons. The northern part of the unit comprises the southern edge of the Porcupine platform, an area of Precambrian through lower Paleozoic carbonate and clastic sedimentation. Thick Quaternary surficial deposits of alluvium, colluvium, and loess cover most of the lower elevations within the unit restricting lowland outcropping to river and stream cuts.

The southern half of Unit 35 (Charley River Quadrangle) is predominantly composed of sedimentary Precambrian to Tertiary clastic and carbonate rocks, locally metamorphosed to lower greenschist facies and minor volcanic rocks. The Permian Step Conglomerate, a chert-pebble conglomerate and arenite, contains lead-zinc mineralized zones on Step Mountain, which is outside and adjacent to Unit 35. This rock unit is considered to be favorable for similar mineralization within the unit. Unnamed Precambrian dolomite, limestone, chert, argillite and shale also shows potential as a carbonate-hosted lead-zinc deposit.

The northern half of Unit 35 (Black River Quadrangle) contains outcropping of Precambrian to lower Paleozoic phyllite, dolomite, limestone, argillite, and chert, and small Precambrian granitic and basic intrusive rocks. A Quaternary basalt flow occurs at the extreme northern edge of the unit. The Precambrian dolomite and limestone contains highly mineralized zones rich in lead and zinc at Pink Bluff, located on the south side of the Salmon Fork of the Black River. Further to the north, similar zones, although less mineralized, and prospecting trenches were found in this same map unit. This map unit and the younger Cambrian through Devonian-age dolomite and limestone show potential as a sediment and/or carbonate-hosted lead-zinc deposit.

MINERAL DEPOSIT TYPES - UNIT 35

The mineral deposit models chosen to estimate the mineral endowment of Unit 35 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 35-2 through 35-4. The location of plays and their probabilistic endowment are shown in the map for Unit 35 and table 35.

(1) Sediment lead-zinc: There is high mineral potential in plays 35-2 and 35-3, and moderate mineral potential
in play 35-1.
(2) Limestone lead-zinc: There is moderate mineral potential in play 35-4.

Table 35. *Deposit types and estimated mineral endowment of Unit 35, Kandik/Black River*

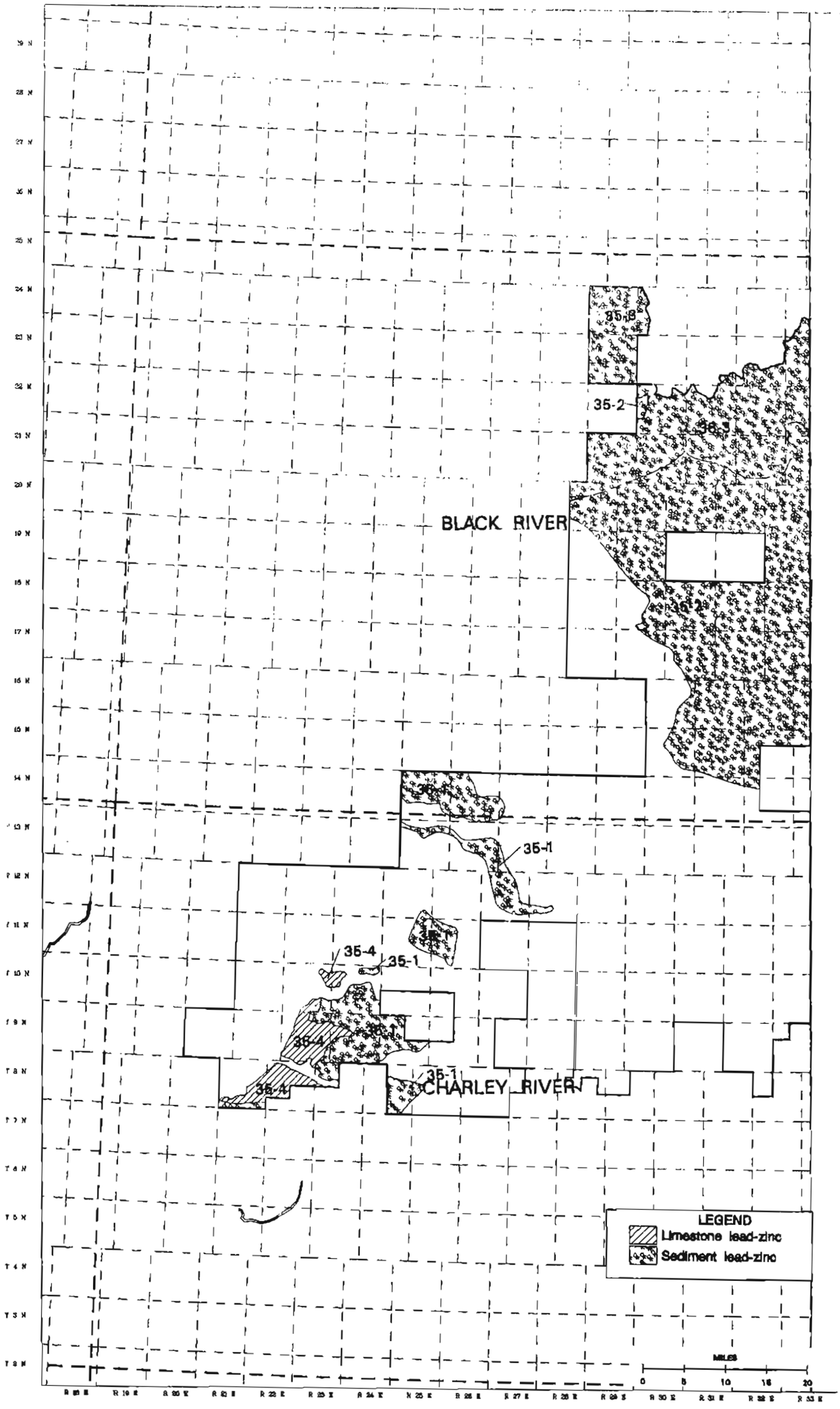
Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

SEDIMENT LEAD-ZINC

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 35-1	Large area			
Ore	0	0	24 million tons	Moderate
Zinc	0	0	2,600 thousand tons	
Lead	0	0	1,000 thousand tons	
Silver	0	0	20,000 thousand oz	
PLAY 35-2	Very large area			
Ore	0	0	240 million tons	High
Zinc	0	0	19,000 thousand tons	
Lead	0	0	10,000 thousand tons	
Silver	0	0	440,000 thousand oz	
PLAY 35-3	Very large area			
Ore	0	0	180 million tons	High
Zinc	0	0	11,000 thousand tons	
Lead	0	0	8,400 thousand tons	
Silver	0	0	170,000 thousand oz	

LIMESTONE LEAD-ZINC

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 35-4	Small area			
Ore	0	0	13 million tons	Moderate
Lead	0	0	250 thousand tons	
Zinc	0	0	640 thousand tons	
Copper	0	0	0 thousand tons	
Silver	0	0	10,000 thousand oz	


35-3
35-2
BLACK RIVER
35-1
35-4
35-1
35-4
35-1
35-4
35-1
CHARLEY RIVER
LEGEND
Limestone lead-zinc
Sediment lead-zinc
MILES
0 5 10 15 20

UNIT 36 - HAINES

GEOLOGIC SUMMARY

Unit 36 encompasses 513,000 acres in the Skagway Quadrangle. The area is divided geologically along the Chilkat-Klehini Rivers. The western part is dominated by metavolcanic and metasedimentary units of Paleozoic and Mesozoic(?) age, which are intruded by Cretaceous and Tertiary diorites and granodiorites, and Tertiary granites. The eastern portion consists almost entirely of plutonic rocks which are also of Cretaceous to Tertiary age, but are unrelated to the plutons to the west; a small area of amphibolite (metavolcanic rock) of probable Triassic age is also present in the eastern portion.

Many mineral prospects and several known deposits are present in the western half of the area. The main deposit types are volcanogenic massive sulfide deposits, gold lodes, and several types of skarn. The genesis of the lode gold has not been determined with certainty. The most favored explanation is that the deposits are related to plutons; however, a metamorphic gold system could also have formed the deposits, and would have a comparable, but not additional, endowment. The metamorphic gold system is not included in the simulation summary below. Both gold-copper bearing and lead-zinc bearing skarns are present in the area and contribute significantly to the potential endowment. Portions of the large gold placers within the Porcupine mining district are also present in Unit 36.

The eastern portion of the area consists mainly of plutons from mid-Cretaceous (110 Ma) to mid-Tertiary(?) age. The plutons are, from oldest to youngest, the Kashagnak pluton (a zoned quartz monzonite complex), the Klukwan zoned ultramafic complex, tonalite of the Great Tonalite Sill complex, and younger granite. Metamorphic country rock (volcanic?) is included as roof pendants in the tonalite, and amphibolites of Triassic(?) age are in fault contact with the plutonic bodies. The appropriate plutons were investigated for their gold potential and their porphyry copper potential. Gold deposits were simulated to have moderate amounts of gold, while the porphyry copper potential was negligible. Gold could also potentially be concentrated from metamorphic processes and this model was simulated, and should be used as an alternative hypothesis. The Klukwan ultramafic body contains anomalous iron and vanadium ore and is largely privately owned. The Klukwan alluvial fan has some potential for iron placers.

MINERAL DEPOSIT TYPES - UNIT 36

The mineral deposit models chosen to estimate the mineral endowment of Unit 36 are listed below. The permissive areas for each mineral deposit type are referred to as "plays" and are numbered consecutively from 36-1 through 36-2. The location of the plays and their probabilistic endowment estimates are shown in the map for Unit 36 and table 36.

(1) Granitic gold veins: There is high mineral potential for plays 36-1 and moderate mineral potential for plays 36-2, 36-3, and 36-4.
(2) Rift polymetal massive sulfide: There is high mineral potential in play 36-5 and less than 5 percent probability for reserves in play 36-6.
(3) Copper gold skarns: There is high mineral potential in play 36-7.
(4) Lead-zinc skarn: There is high mineral potential in play 36-8.
(5) Sediment lead-zinc: There is moderate mineral potential in play 36-9.
(6) Polymetal massive sulfide: There is moderate mineral potential in play 36-10.
(7) Porphyry copper-molybdenum: No endowment was generated by ROCKVAL modeling for play 36-11.
(8) Gold placers: There is moderate mineral potential in plays 36-12 and 36-13.
(9) Iron-titanium placer: There is high mineral potential in play 36-14.
(10) Iron-titanium lode: There is high mineral potential in play 36-15.

Table 36. Deposit types and estimated mineral endowment of Unit 36, Haines

Areal extent of plays in square miles:
0-100 = Small; 101-200 = Medium; 201-300 = Large; 301-550 = Very large; >550 = Extremely large

GRANITIC GOLD VEINS

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 36-1	Large area			
Ore	0	0.2 million tons	5.7 million tons	High
Gold	0	26 thousand oz	850 thousand oz	
PLAY 36-2	Medium area			
Ore	0	1.4 million tons	9.2 million tons	Moderate
Gold	0	170 thousand oz	1,100 thousand oz	
PLAY 36-3	Medium area			
Ore	0	0.04 million tons	3.4 million tons	Moderate
Gold	0	5 thousand oz	490 thousand oz	
PLAY 36-4	Very large area			
Ore	0	0.16 million tons	3.5 million tons	Moderate
Gold	0	20 thousand oz	460 thousand oz	

RIFT POLYMETAL MASSIVE SULFIDE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 36-5	Small area			
Ore	0.3 million tons	3.3 million tons	75 million tons	High
Zinc	11 thousand tons	160 thousand tons	4,700 thousand tons	
Copper	0 thousand tons	64 thousand tons	1,700 thousand tons	
Lead	4 thousand tons	70 thousand tons	2,100 thousand tons	
Silver	0 thousand oz	140 thousand oz	150,000 thousand oz	
Gold	0 thousand oz	18 thousand oz	1,800 thousand oz	
PLAY 36-6	Small area			
Ore	0	0	0 million tons	Moderate
Zinc	0	0	0 thousand tons	
Copper	0	0	0 thousand tons	
Lead	0	0	0 thousand tons	
Silver	0	0	0 thousand oz	
Gold	0	0	0 thousand oz	

COPPER GOLD SKARN

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 36-7	Small area			
Ore	0	0	18 million tons	High
Gold	0	0	2,400 thousand oz	
Silver	0	0	19,000 thousand oz	
Copper	0	0	190 thousand tons	

LEAD-ZINC SKARN

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 36-8	Small area			
Ore	0	0	17 million tons	High
Zinc	0	0	960 thousand tons	
Copper	0	0	47 thousand tons	
Lead	0	0	350 thousand tons	
Silver	0	0	55,000 thousand oz	
Gold	0	0	65 thousand oz	

SEDIMENT LEAD-ZINC

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 36-9	Medium area			
Ore	0	0	2.3 million tons	Moderate
Zinc	0	0	260 thousand tons	
Lead	0	0	120 thousand tons	
Silver	0	0	340 thousand oz	

POLYMETAL MASSIVE SULFIDE

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 36-10	Small area			
Ore	0	0	0.2 million tons	Moderate
Zinc	0	0	8 thousand tons	
Copper	0	0	0 thousand tons	
Lead	0	0	2 thousand tons	
Silver	0	0	0 thousand oz	
Gold	0	0	0 thousand oz	

PORPHYRY COPPER-MOLYBDENUM

Probability level	*95*	*50*	*5*	*Mineral Potential*
PLAY 36-11	Small area			
Ore	0	0	0 million tons	Moderate
Copper	0	0	0 thousand tons	
Molybdenum	0	0	0 thousand tons	
Gold	0	0	0 thousand oz	
Silver	0	0	0 thousand oz	

GOLD PLACERS

Placer gold potential estimated from published sources and personal knowledge.

GOLD PLACERS CONTINUED

PLAY 36-12 Small area

Nugget Creek drainage has a 25 percent possibility of 3,500,000 yd^3 with a grade of 0.01 oz/yd^3 for a total of 35,000 oz of gold.

PLAY 36-13 Small area

Porcupine Creek drainage has a 50 percent possibility of 7,000,000 yd^3 with a grade of 0.01 oz/yd^3 for a total of 70,000 oz of gold and also a 50 percent possibility of 800,000 yd^3 with a grade of 0.05 oz/yd^3 for a total of 40,000 oz of gold.

The sum total is roughly estimated of placer gold in the area is roughly estimated at 145,000 oz which corresponds with a gross in-place value (GIPV) of 57.3 million.

Sources:

Bundtzen, T.K. (written commun., 1992)

Bundtzen, T.K., 1986, Placer geology of the Porcupine mining district, Skagway B-4 Quadrangle, Alaska: Alaska Division of Geological & Geophysical Surveys Public-Data File 86-27, 26 p.

Hoekzema, R.B., Fechner, S.A., and Bundtzen, T.K., 1986, Distribution, analysis, and recovery of gold from the Porcupine mining area, southeast Alaska: U.S. Bureau of Mines Open-File Report 89-86, 49 p.

IRON-TITANIUM PLACER

PLAY 36-14 Small area

Estimates of potential resources of Klukwan alluvial fan 453 million tons, grading 10 percent titaniferous magnetite, based on Nokelberg and others (1987).

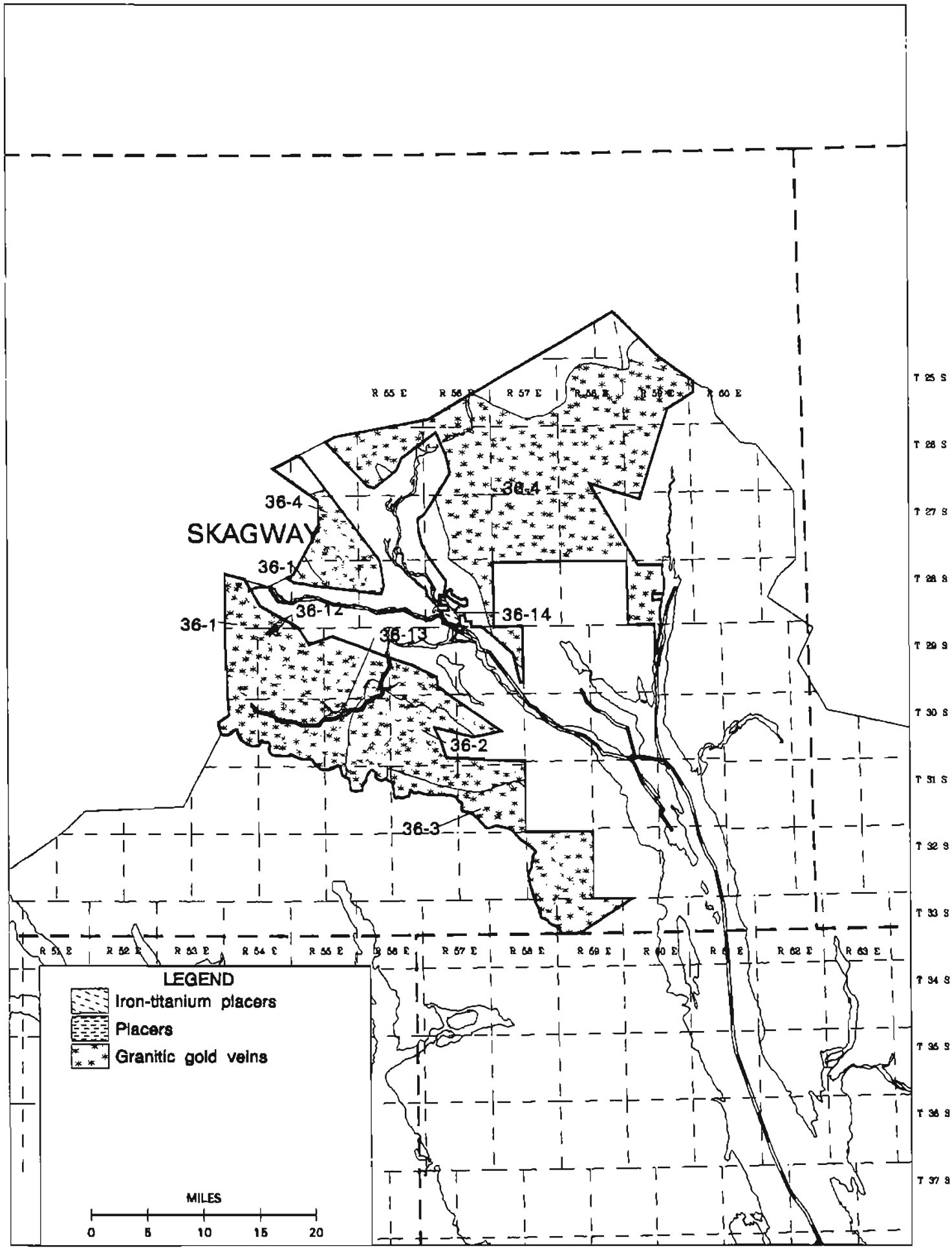
IRON-TITANIUM LODE

Play 36-15 Small area

Estimates of potential resources of Klukwan ultramafic body based on Nokelberg and others (1987). Iron, titanium, vanadium, and nickel, estimated 13 billion ton grading, 0.2 percent vanadium oxide, 13 percent magnetite, 1.5 to 4.4 percent titanium oxide.

Sources:

Nokleberg, W.J., Bundtzen, T.K., Berg, H.C., Brew, D.A., Grybeck, Donald, Robinson, M.S., Smith, T.E., and Yeend, Warren, 1987, Significant metalliferous lode deposits and placer districts of Alaska: U.S. Geological Survey Bulletin 1786, 104 p., 2 sheets, scale 1:5,000,000.


SKAGWAY
36-1
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36-14
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Iron-titanium placers
Placers
Granitic gold veins
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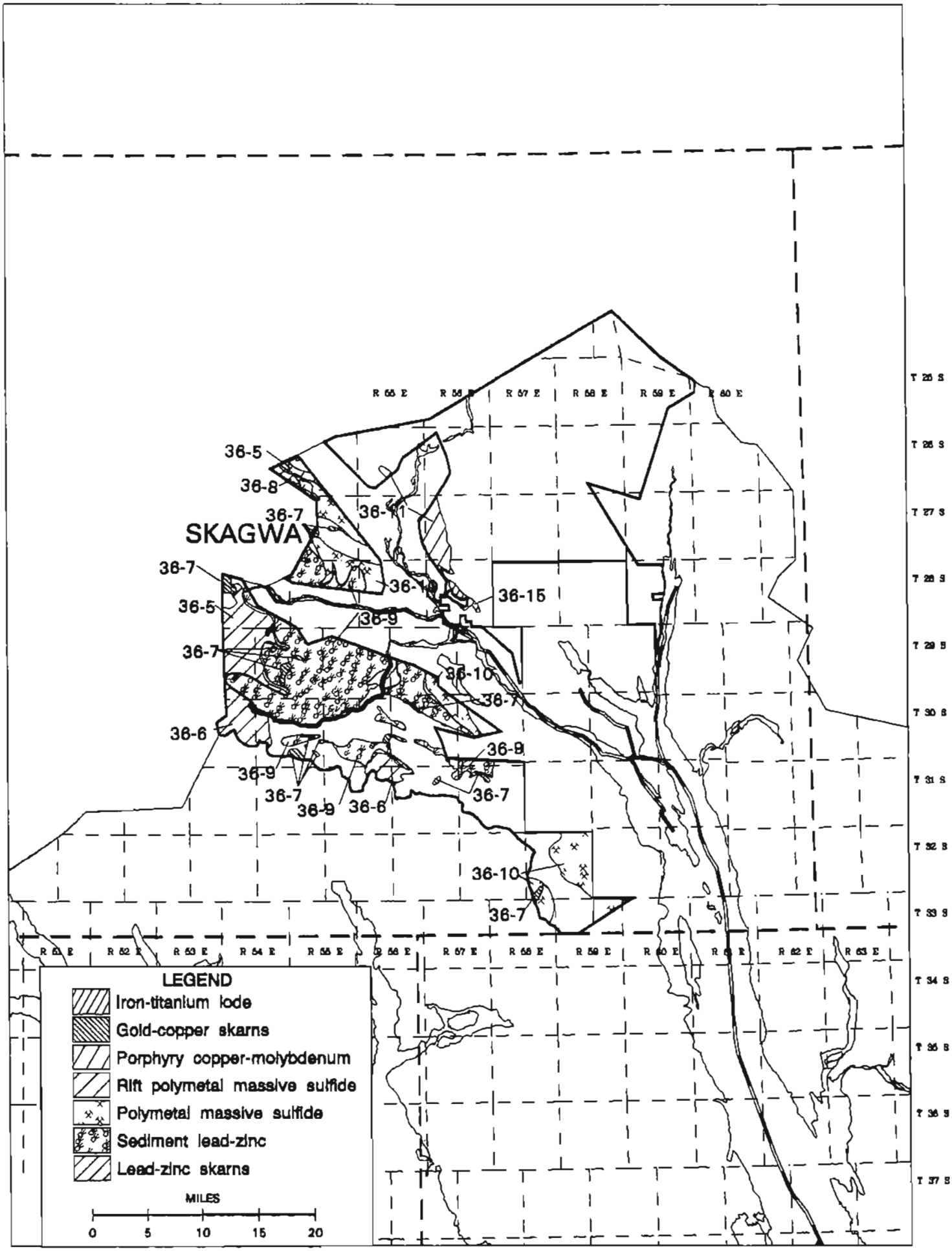

Unit 36, Haines Unit