Mineral Occurrence and Development Potential Report

LOCATABLE AND SALABLE MINERALS
MAY 2005 – FINAL

Kobuk-Seward Peninsula Resource Management Plan

BLM Alaska State Office
Division of Energy and Solid Minerals
Branch of Solid Minerals

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LIST OF ABBREVIATIONS

AEIDC	**- Arctic Environmental Information and Data Center**
AMIS	**- Alaska Minerals Information System**
AMRAP	**- Alaska Mineral Resource Assessment Program**
ANCSA	**- Alaska Native Claims Settlement Act of 1971**
ANILCA	**- Alaska National Interest Conservation Act**
ARDF	**- Alaska Resource Data File**
BLM	**- Bureau of Land Management**
DGGS	**- State of Alaska, Division of Geological and Geophysical Surveys**
DNR	**- Alaska Department of Natural Resources**
FLPMA	**- Federal Land Policy and Management Act of 1976**
KMDA	**- Known Mineral Deposit Areas**
KSP	**- Kobuk-Seward Peninsula**
LMP	**- Locatable Mineral Potential**
MAS/MILS	**- Mineral Availability System/Mineral Industry Location System**
MODPR	**- Mineral Occurrence and Development Potential Report**
Ma	**- Mega-annum, millions of years before the present**
MTA	**- Mineral Terranes of Alaska**
NEPA	**- National Environmental Policy Act**
NGDB	**- National Geochemical Database**
NPS	**- National Park Service**
NURE	**- National Uranium Resource Evaluation**
RASS	**- Rock Analysis Storage System**
RDI	**- Research Data Institute**
REE	**- Rare Earth Element**
RFD	**- Reasonably Foreseeable Development Scenario Report**
RMP	**- Resource Management Plan**
SEDEX	**- Sedimentary Exhalative lead-zinc deposit**
USBM	**- U.S. Bureau of Mines**
USFWS	**- U.S. Fish and Wildlife Service**
USGS	**- U.S. Geological Survey**
VMS	**- Volcanogenic Massive Sulfide deposit**

Mineral Terranes of Alaska (MTA) Mineral Terrane Units

IGA	**- Alkalic Granitic Rocks**
IGF	**- Felsic Granitic Rocks**
IGI	**- Intermediate Granitic Rocks**
IGU	**- Undivided Granitic**
IMA	**- Mafic Intrusive**
VFU	**- Felsic Intrusive Rocks, undivided**
VFA	**- Alkalic felsic and Intermediate Volcanic Rocks**
VSF	**- Sedimentary and Felsic Volcanic Rocks, undivided**
VSM	**- Sedimentary and Mafic Volcanic Rocks**
VOP	**- Ophiolitic**
SLS	**- Limestone and Shale**
SBS	**- Black, Carbonaceous Shale and Limestone**
SLU	**- Limestone and Dolomite**
SGS	**- Graywacke and Shale**

Elemental Abbreviations

Ag = silver	**Ni = nickel**	**REE = rare earth elements (eg, lanthanum, cerium, neodymium)**
Au = gold	**Pb = lead**	**U = uranium**
Co = cobalt	**PGE = platinum group elements (e.g., platinum, palladium, iridium)**	**V = vanadium**
Cr = chromium	**Pt = platinum**	**W = tungsten**
Cu = copper	**Sn = tin**	**Zn = zinc**
Mo = molybdenum		

I. INTRODUCTION

The Northern Field Office of the Bureau of Land Management (BLM) is preparing the Kobuk-Seward Peninsula Resource Management Plan (RMP) to provide a comprehensive framework for managing and allocating uses of public lands and resources in the northwest portion of the State of Alaska (Figure 1). The planning process will meet the requirements of the National Environmental Policy Act (NEPA) through a detailed description of the alternatives and environmental consequences resulting from each alternative. The Federal Land Policy and Management Act of 1976 (FLPMA), as amended, provides the authority for BLM land use planning on public lands. In particular, FLMPA Sec. 202 (a) requires the Secretary of the Interior, with public involvement, to develop, maintain, and when appropriate, revise land use plans that provide by tracts or areas for the use of the public lands. Implementing regulations which provide procedures and guidance for the planning process are contained in the Code of Federal Regulations 43 CFR 1610, and in BLM Manuals 1601 (Land Use Planning) and H-1601-1 (Land Use Planning Handbook). This Mineral Occurrence and Development Potential Report (MODPR) was prepared following the guidance of BLM Manual Section 3031 (Energy and Mineral Resource Assessment).

Mineral resources on BLM-managed surface and subsurface lands are divided into three categories - locatable, leasable, and salable - based on provisions of various mining laws. In the late 1800s, the U.S. Department of Interior began to define hardrock minerals as “locatable” if they could be found on public lands in quantity and quality sufficient to make the land more valuable by their existence. The General Mining Law of 1872 established the authority for locatable mineral mining claims, and provided the basis for subsequent mining laws that, over time, substantially reduced the number of minerals considered locatable. Two primary laws, the Mineral Leasing Act of 1920 and the Materials Act of 1947, excluded certain mineral types that could only be acquired through a federal leasing program or disposed of by sale. “Leasable” minerals include oil and gas, coalbed methane, geothermal fluids, and certain solid minerals such as potassium, sodium, phosphate, and oil shale. “Salable” minerals include common varieties of mineral materials such as construction aggregate (sand and gravel), building stone, pumice, clay, and limestone. Mineral types remaining in the locatable category following these modifications include metallic and certain nonmetallic industrial minerals generally found in lode or placer deposits. Under certain circumstances, mineral materials can be considered locatable minerals.

A. PURPOSE OF REPORT

The goal of the planning process with respect to locatable and salable minerals is to identify areas open or closed to the operation of the mining laws, mineral material disposal, and nonenergy leasing, and in open areas, to identify any area-wide terms, conditions, or other special considerations needed to protect resource values. This report was drafted in order to provide land use planners with the basic locatable and salable minerals information used in developing the various alternatives analyzed in the NEPA documents and to identify areas of High, Medium, and Low mineral potential. Leasable minerals and energy resources are beyond the scope of this report and will be published in a separate report.

B. LANDS INVOLVED AND LAND STATUS

The Kobuk-Seward Peninsula Planning Area (KSP Planning Area) encompasses approximately 31.6 million acres in northwestern Alaska, of which approximately 13 million acres are BLM-administered lands managed by the Northern Field Office. A portion of the BLM-managed lands includes lands selected by, but not yet conveyed to, the State of Alaska and native Alaskans - referred to as State-selected and Native-selected lands. State lands in Alaska came about through the Alaska Statehood Act of 1959, which gave the new state selection rights to federal land to foster development and state independence, a process which was supposed to end in 1984. Native lands were designated as a result of the Alaska Native Claims Settlement Act (ANCSA) of 1971, which superseded the Statehood Act and provided for Native claims to traditional lands. ANCSA and the Alaska National Interest Conservation Act (ANILCA) of 1980 froze state selection rights to previously open federal lands. ANILCA granted a 10-year extension to complete the state-selection process by 1994. Due to initial over-selection by the State and Native Corporations, management of some of these selected lands will be retained by BLM (become “unencumbered” BLM lands) at the completion of the conveyance process.

BLM is responsible for administering subsurface minerals on an additional 7 million acres of federal split estate lands in the KSP, which include U.S. Fish and Wildlife Service (USFWS), National Park Service (NPS), and Department of Defense (military) lands. Mineral development and surface activities on split estate lands are managed by the appropriate surface agency, but BLM is responsible for administrative functions such as mining claim filings, adjudications, and record keeping (Cody, 1995 and Nichols, 1999). The KSP Planning Area encompasses the area from Point Lay, south to the Norton Sound, and from the Bering and Chukchi Seas east to the upper Kobuk River. It includes the Seward Peninsula and the eastern Nulato Hills at the boundary of the Central Yukon Planning Area. The KSP Planning Area generally encompasses the area included in the northwest Arctic Borough, the northern portion of the Bering Straits Region, and the western edge of the North Slope Borough. Three Regional Native Corporations hold lands in the KSP Planning Area: the Arctic Slope, NANA, and Bering Straits Corporations. There are approximately 22 communities within the area. The KSP Planning Area is mostly roadless except for about 200 miles of road on the Seward Peninsula originating in Nome, the 52-mile road from Red Dog mine to its port facility on the Chukchi Sea, and minor roads within the villages.

C. SCOPE AND OBJECTIVE

This report describes the known, existing mineral resources and current resource management in the Planning Area, and identifies areas of High, Medium, and Low mineral potential. By incorporating a wide variety of available geologic information, including Federal and State reports, this MODPR will present a summary of occurrence and development potential for the entire KSP Planning Area, regardless of land status. This assessment provides an intermediate level of detail, as required by Manual Section 3031 for all BLM land use plans (BLM, 1985).

Through an assistance agreement in support of the KSP RMP, the State of Alaska's Division of Geological and Geophysical Surveys (DGGS) provided BLM with a comprehensive summary of available geologic mapping and reporting pertaining to the Planning Area. Compilation results are included as appendices to this MODPR.

Information contained in this report will be used to construct a forthcoming Reasonably Foreseeable Development Scenario Report (RFD), detailing the type, location, and manner of potential environmental disturbance due to locatable minerals extraction.

D. OCCURRENCE AND DEVELOPMENT POTENTIAL

Mineral potential assessments require the understanding of two components: the potential for mineral occurrence and the potential for their economic development. The potential for mineral occurrence is a prediction of the likelihood of the presence of these resources. Mineral occurrence potential does not necessarily imply that the mineral can be economically exploitable, or that the quality and quantity of the resource is known. Whenever known, however, the current and projected development potential is part of the mineral resource assessment. For the purposes of the KSP RMP, development potential describes whether or not a mineral occurrence is likely to be explored or developed within the 10- to 15-year lifespan of the RMP under given geologic and non-geologic assumptions and conditions (BLM, 1985).

E. REPORT ORGANIZATION

The following section presents the organizational format for this report:

Section I – Introduction: identifies regulatory justification and guidance for the planning process and presents background information as it relates to locatable and salable minerals;

Section II – Description of Geology: used to provide a summary description of Planning Area geology and an overview of data types and resources used to compile geologic data for this report;

Section III - Description of Mineral Resources: presents a description of mineral resources; identifies and summarizes minerals information used in the development of potential ratings; identifies how each information type is applied to the determination of mineral potential;

Section IV – Development of Potential Ratings: provides rationale for generating potential ratings and explains the level of confidence criteria;

Section V – Potential for the Occurrence of Mineral Resources: provides a summary of mineral occurrence and development potential for the Planning Area;

Section VI – Recommendations: presents recommendations and identifies suggestions for further study;

Section VII – Statement of Qualification (author);

Section VIII – Acknowledgment of those who assisted with the completion of this report; and;

Section IX – References.

II. DESCRIPTION OF GEOLOGY

The following sections summarize KSP Planning Area geology, and provide an overview of geochemical and geophysical data available for the KSP Planning Area.

A. PHYSIOGRAPHY

The KSP Planning Area includes terrain ranging from coastal lowlands to mountainous regions with greater than 3,000 feet of local relief (Wahrhaftig, 1965). The majority of the area is underlain by permafrost to an approximate depth of 1,000 feet, and frozen ground geomorphologies such as thermokarst, pingos, and patterned (polygonal) ground are common. An active layer exhibiting seasonal thaw up to 4 feet thick is present at the surface. Wahrhaftig's (1965) description of Alaska's physiographic provinces remains the definitive reference, portions of which are excerpted below. Figure 1 presents a graphical representation of KSP Planning Area physiography.

1. Arctic Coastal Plain

The Arctic Coastal Plain extends south from the Arctic Ocean, rising gradually to a maximum elevation of 600 feet. The smooth plain is underlain by permafrost and permafrost landforms are ubiquitous. The area is poorly drained, with numerous lakes and marshy areas. A scarp 50 to 200 feet tall locally separates the Arctic Coastal Plain from the Arctic Foothills Province to the south. The Coastal Plain is underlain by Quaternary to Tertiary sedimentary units.

2. Arctic Foothills

The Arctic Foothills occupies the area between the Arctic Coastal Plain and the area north and west of the Western Brooks Range. Rolling plateaus and low linear mountains rise from 600 feet in the north to over 3,000 feet in the south. Upland tundra plateaus are typically dissected by north-flowing braided streams. Although not covered by glaciers, the area is entirely underlain by permafrost and exhibits frozen ground morphologies. Foothills Province bedrock consists of Quaternary to Devonian sedimentary units and mafic intrusives, with structural over-thrusting to the north.

3. Arctic Mountains (Western Brooks Range)

The Baird and DeLong Mountains, and an intervening lowland occupied by the Noatak River, comprise the Arctic Mountains physiographic province in the KSP Planning Area. Sharp, glaciated peaks in mountainous areas rise abruptly to 2,500 to 4,500 feet in altitude and are cored by Paleozoic metasediments (Baird Mountains) and Devonian to Cretaceous sediments (DeLong Mountains). Massive diabase dikes intrude the DeLong Mountains and are prominent cliff-forming features. Structural trends are predominantly east-west to northeast-southwest. The Noatak River valley and adjacent rolling uplands host numerous morainal and thaw lakes. Primary drainage for the province is via the south-flowing Noatak River; the south slopes of the Baird Mountains drain into the Kobuk River.

A small area near Ambler and Kobuk in the eastern portion of the KSP Planning Area is covered by intensely glaciated ridges along the abrupt southern front of the Brooks Range. Ridges in the Ambler area are composed of Mesozoic metamorphosed basalts (greenstone), while intervening valleys are underlain by folded Cretaceous sediments.

4. Bering Shelf

The Bering Shelf Province occupies a limited, less than 250,000 acre, portion of the KSP Planning Area adjacent to the coastal village of Shaktoolik on Norton Sound. The Bering Shelf is extensively covered by quaternary sand and silt. Local bedrock exposures range from Cretaceous and Tertiary volcanic units (chiefly basalts) to older Paleozoic crystalline rocks. The Bering Shelf, along with the Seward Peninsula and Western Alaska Provinces, was part of the ice-free Beringia Corridor that connected Alaska to Northeast Asia during the last glaciation.

5. Seward Peninsula

The entire Seward Peninsula Province is contained in the Seward Peninsula area, and as such represents the largest areal portion of the KSP Planning Area. The Seward Peninsula Province is approximately 200 miles wide in an east-west direction, 140 miles long in a north-south direction, and is bordered on the west by the Bering Strait and to the east by the Western Alaska Province. The Seward Peninsula Province consists of an extensive upland area with interior basins and coastal lowlands. The uplands portion ranges from mainly broad-sloping hills up to 2,000 feet in altitude; isolated groups of glaciated peaks below 4,700 feet in elevation are concentrated in the south. Interior basins are drained through narrow canyons which cut the uplands, transitioning into meandering streams which cross the lowlands to the ocean. Paleozoic bedrock is predominant on the Seward Peninsula, consisting of metasediments and metamorphosed volcanic rocks, all cut by later granitic intrusives. Quaternary lava flows occupy the north-central portion of the Seward Peninsula.

6. Western Alaska

The Western Alaska Province covers the southeast quarter of the KSP Planning Area. The province is dominated by the Kobuk-Selawik Lowlands and Nulato Hills, and numerous smaller lowland and hill areas. Most of the area drains into Kotzebue Sound via the Kobuk and Selawik Rivers, although streams draining the western slopes of the Nulato Hills discharge to Norton Sound. Thaw lakes are common in lowland areas. Local relief in the Nulato Hills area is 500 to 1,500 feet, with peaks that reach to 2,500 feet in elevation. Most of these low, rolling hills have been spared from recent glaciations and were part of the ice-free Beringia corridor linking North America and Asia. The Nulato Hills are cored by tightly folded Cretaceous sediments and minor volcanics. The Selawik Hills, which rise abruptly from the Kobuk-Selawik Lowlands to as much as 3,300 feet in elevation, have gently sloping to flat summits. Geology in the Selawik Hills is typified by Paleozoic and Mesozoic metavolcanic and granitic rocks.

B. ROCK UNITS - LITHOLOGY AND STRATIGRAPHY

The following section presents a summary of KSP area rock units, organized in a loosely chronologic order from oldest to youngest lithologies. Figure 2 presents a generalized geologic map for the KSP Planning Area after Beikman (1980). It should be noted that many mapped geologic units in the KSP Planning Area remain unnamed.

1. Basement Rocks

Crystalline basement lithologies occur near the surface across a wide swath of the Seward Peninsula and in the western Brooks Range. On the Seward Peninsula, the pre-Mississippian bedrock consist of blueschist-, greenschist-, and amphibolite-facies schist, phyllite, and marble (Till and Dumoulin, 1994). The southern flank of the Brooks Range and Baird Mountains comprise a structurally complex thrust and fold package of blueschist metamorphosed marine shelf sediments, which are likely correlative to basement rocks found on the Seward Peninsula based on similar age and lithology. Jurassic- to Mississippian-age ophiolites are mapped in the Southern Brooks Range (Angayucham Terrane), in the western Delong Mountains (Asik Mountain), and western Baird Mountains (Iyikrok Mountain). These mafic-ultramafic assemblages occur chiefly as pillow-basalt (greenstone), chert, diabase, and gabbro, with local interbedded clastic marine sediments.

2. Paleozoic Sediments

Paleozoic marine sediments extend from the Delong Mountains and western Baird Mountains, westward to the Chukchi Sea. The extent of near-surface exposures of Paleozoic rocks in the area is an east-west thrust fault just north of Kivalina, which also delineates the northern front of the Brooks Range. Many of these sedimentary units are correlative to metamorphosed basement rocks on the Seward Peninsula and

Southern Brooks Range, but are relatively un-metamorphosed. The lithologies represent a stratified sequence of Devonian-age continent-derived clastic rocks, Carboniferous shale and shelf carbonates, and Upper Paleozoic (to earliest Mesozoic) mainly deep marine chert, argillite, and calcareous rocks (Plafker and Berg, 1994). This section includes the Endicott and Sadlerochit Groups of the Mississippian, to the early Cretaceous Ellesmerian Sequence. The Heald Thrust Fault just east of Point Hope juxtaposes Paleozoic marine sediments on the west, against Mesozoic strata to the east.

3. Mesozoic Marine and Volcaniclastic Sedimentary Rocks

Mesozoic sedimentary strata are prominent in three portions of the KSP Planning Area: the Arctic Foothills and Coastal Plain, along the Kobuk River, and in the Nulato Hills to Selawik Hills area. The westerns slope of the Nulato Hills is dominated by Cretaceous volcanic graywacke, mudstone, and sandstone. Lower Cretaceous marine sediments in the western Arctic Foothills and Kobuk Valley include graywacke, sandstone, shale, siltstone, and conglomerate of the Tiglukpuk (Kobuk Valley), Okpikruak, Fortress Mountain, Torok, and Kukpowruk Formations. Formations in the Arctic Foothills and Coastal Plain belong to the upper Ellesmerian and lower Brookian Sequences, and are likely conformable with older Paleozoic marine sediments in the Arctic Foothills.

4. Jurassic to Early Cretaceous Volcanic Rocks

An extensive belt of andesite flows and volcaniclastic rocks termed the Koyukuk Terrane spans the eastern portion of the KSP Planning Area from Kotzebue Sound on the west, eastward across the KSP Planning Area south of the Kobuk River. These rocks were likely deposited in a marine back-arc setting active from Jurassic to Early Cretaceous. Jurassic ophiolites comprise a portion of the basement lithologies, as described above.

5. Cretaceous Continental Rocks

The most recently consolidated lithologies consist mainly of continent-derived clastic rocks reflecting multiple marine transgression events. On the Arctic Coastal Plain, lower Cretaceous deposits up to 2,400 feet thick consist of Nanushuk Group (Brookian Sequence) continental rocks, mainly conglomerate, with shale, coaly shale, sandstone, coal, and minor tuffaceous or marine interbeds (Moore and others, 1994). In the Kobuk Valley, 16,000 to 26,000 feet of fluvial pebble conglomerates, shallow-marine conglomerates, and flyschoid sediments related to the continental margin were deposited in mid- to late-Cretaceous (Patton and others, 1994).

6. Cretaceous Intrusive Rocks

The Seward Peninsula and western Koyukuk Terrane record two distinct types of Cretaceous magmatism (Till and Dumoulin, 1994). The first consisted of large, granitic plutons which are responsible for high-grade metamorphism on the eastern Seward Peninsula. These early Cretaceous intrusives range from monzonite to syenite in composition, and include a small component of subsilicic, hypersolvus, nephaline-bearing rocks. These large plutons form part of a belt of alkaline subsilic complexes and dike swarms spanning Western Alaska and into the Russian Far East (Till and Dumoulin, 1994). More limited subsilicic exposures occur chiefly in the eastern Seward Peninsula and Selawik Hills of the western Koyukuk Terrane (Patton and others, 1994).

A second Cretaceous magmatic suite, tin-granites as small stock-like bodies, intrudes rocks of both the Seward and York Terranes. These biotite granite and minor mafic igneous rocks are related to numerous tin deposits on the Seward Peninsula.

7. Cenozoic (to late Cretaceous) Mafic Volcanic Rocks

Tertiary to Quaternary flood basalts form large plateaus on the Seward Peninsula and in the Selawik Hills. A large field south of Kotzebue Sound in the Selawik Hills consists of vesicular olivine basalt and is likely correlative with the Imuruk Volcanics located to the west on the Seward Peninsula (Patton and others, 1994).

8. Cenozoic Alluvial Deposits

Alluvial, glacial, lake, dune, and beach deposits, with local coal and volcaniclastic beds are prevalent in the Kobuk River Delta, and in coastal areas. Basin-fill sedimentation in basins tens of miles wide exist locally on the Seward Peninsula, and may contain very deep accumulations (Till and Dumoulin, 1994).

Glacial drift and morainal material deposited during numerous Cenozoic glacial advances exist in the southwest portion of the Seward Peninsula, the southern Brooks Ranges, and on the western slopes of the Delong and Baird Mountains. On the Seward Peninsula, ice-raft deposited erratics occur on the margins of these deposits.

C. GEOLOGIC FRAMEWORK - STRUCTURAL GEOLOGY AND TECTONICS

Alaska comprises a diverse assemblage of geologic terranes which were progressively accreted onto the margin of North America. Lithotectonic terrane models created to describe this complexity depict numerous distinct, fault-bounded packages of rock, or "lithotectonic terranes", each with internal similarities that differ from neighboring terranes. The model developed by Goldfarb (1997) produced a terrane map of the state which divides the KSP Planning Area into five separate exotic terranes and post-Jurassic [144 million years ago (Ma) to present] continental rocks. Figure 2 presented a geologic map for the KSP Planning Area which includes an inset map based on Goldfarb (1997) lithotectonic terranes. Nokleberg and others (2000) and Plafker and Berg (1994) present similar syntheses of Alaska's geology. The following presents a geologic framework for the KSP Planning Area.

The oldest rocks exposed in the KSP Planning Area occur along the southern flank of the Brooks Range in the south of the Arctic Alaska Lithotectonic Terrane, and on the York and the Seward Lithotectonic Terranes. Proterozoic to Middle Paleozoic (600-325 Ma) metamorphosed limestone and shale units exposed on these terranes represent continental shelf and marine slope sediments originally deposited along the passive margin of North America. These three terranes were possibly deposited as a single belt on the margin of the paleo-continent.

Middle Jurassic (163-178 Ma) tectonism generated subduction outboard of the North American continent's stable margin. The Koyukuk-Yukon Lithotectonic Terrane, representing an island arc-type assemblage formed on the overriding plate, consists of Late Jurassic to Early Cretaceous (157-135 Ma) andesitic volcanic and volcaniclastic rocks. As subduction continued, basalt, gabbro, and oceanic sediments - an oceanic assemblage labeled the early Mesozoic (245-144 Ma) Angayucham Lithotectonic Terrane - were thrust onto the Koyukuk-Yukon Terrane. A collisional event in the mid-Cretaceous eventually closed the intervening sea between the Arctic Alaska and Koyukuk-Yukon Terranes, pinning the Angayucham Terrane greenstones as the highest structural unit in the Brooks Range. Additional Jurassic- to Mississippian-age ophiolites of the Angayucham Terrane are mapped as thrust nappes in the western Delong Mountains (Asik Mountain) and western Baird mountains (Iyikrok Mountain). However, some ophiolites in the Western Brooks Range may have formed independently of the Angayucham Terrane rocks, and not as klippen on a synformal stack of thrust sheets as previously interpreted (Karl, 1992).

As this final suturing of northern Alaska's terranes was being completed, the composite Arctic Alaska/York/Seward/Angayucham/Koyukuk-Yukon Terrane was rifted away from North America. This Middle Jurassic rifting event marks the onset of the Brooks Range Orogeny and signals the opening the Canada Basin, or modern Arctic Ocean (Moore, 1994). Rifting continued through the mid-Cretaceous, eventually rotating the composite terrane 30 to 50 degrees away from the North American Craton to its present location through some combination of counter clockwise rotation, rifting and lateral translation (faulting) (Plafker and Berg, 1994). The early stages of the Brooks Range Orogeny involved the final suturing of the Arctic Alaska Terrane to the composite Koyukuk-Yukon/Angayucham Terrane, an event likely responsible for the widespread blueschist facies metamorphism of Paleozoic marine sediments now exposed on the Seward Peninsula and in the southern Brooks Range. As the orogeny continued, a north-vergent fold and thrust belt developed throughout the western Brooks Range. In the Arctic Alaska Terrane, thrusting related to the end of the orogeny gradually migrated northward from the Kobuk–Malamute Fault Zone to the Arctic Foothills, culminating in Tertiary thrusting and a modern compressional regime (Moore and others, 1994). The approximate northern extent of Brooks Range Orogen-related regional folding and thrusting is an east-west fault trace exposed just north of Kivalina in the KSP Planning Area, described as the northern front of the Brooks Range.

By Latest Cretaceous (65 Ma), the Kobuk–Malamute Fault Zone (Kobuk Fault) had formed in response to the accretion of additional interior-Alaska terranes to the south of the Koyukuk-Yukon Terrane (Plafker and Berg, 1994). North- to northwest-directed plate movements in the south created translational stresses that resulted in greater than 50 miles of generally right-lateral movement on the Kobuk Fault (Plafker and Berg, 1994). Although the Kobuk Fault is still active along a limited portion, most of the transpressive forces eventually migrated south to the Kaltag-Tintina Fault outside of the KSP Planning Area. The still-active Kaltag-Tintina Fault is a deep crustal break where the Brooks Range Orogeny likely ended its rotation of northern Alaska's lithotectonic terranes.

At the same time as latest Cretaceous movement began on the Kobuk Fault, strike-slip faulting on the western end of the composite Arctic Alaska/Seward/York Terrane began to displace the Seward and York Terranes southward and, by mid-Tertiary (44 Ma), had translated the Seward Peninsula to its current position adjacent to the Koyukuk Yukon Terrane. The exact relationship between the Seward and the Koyukuk-Yukon Terrane to the east is complicated by vertical faults and obscured by Cretaceous and Tertiary cover (Till and Dumoulin, 1994).

The Seward Peninsula is divided into its two lithotectonic terranes, the York and Seward, based on differing structural relationships, metamorphic history, and magmatism. Situated in the central and eastern portion of the Seward Peninsula, the Seward Terrane is dominated by Precambrian (?) to early Paleozoic schists and marble, and intruded by three suites of Cretaceous granitic rocks (Till and Dumoulin, 1994). Alternatively, the York Terrane occupies the western Seward Peninsula; it is composed of early- to middle-Paleozoic (and possibly older) limestone, argillaceous limestone, dolostone, and phyllite. The York Terrane is cut by Late Cretaceous tin-bearing granites, but lacks evidence for the two additional intrusive suites apparent on the Seward Terrane. The boundary between the Seward and York Terranes is poorly exposed but thought to be a major thrust fault because of its sinuous map trace, a discontinuity in metamorphic grade, and differences in stratigraphy across the thrust zone (Till and Dumoulin, 1994).

Magmatism possibly related to the final digestion of subducted material beneath the Koyukuk-Yukon Terrane continued into the late Cretaceous, as evidenced by volcanism and intrusive events recorded on the eastern Seward Peninsula and across the Koyukuk-Yukon Terrane.

D. GEOPHYSICAL DATA

The following discussion provides an inventory and brief description of the limited geophysical data readily available for the KSP Planning Area. These data sets are routinely used in the identification/interpretation of mineral resource and potential.

1. State of Alaska, Division of Geological & Geophysical Surveys

The DGGS conducts geophysical surveys in areas of the State that are prospective for mineral deposits and, in many instances, spatially associated the State-selected Federal lands. A number of additional mineral terranes within the KSP area are being considered for future geophysical survey depending on state funding levels. The following list presents a summary of DGGS geophysics projects in the KSP Planning Area.

Geophysical survey data published for the Council Area of the Seward Peninsula in 2003 included portions of the Solomon and Bendeleben quadrangles. The data includes electromagnetic and total field aeromagnetic surveys.

Geophysics data collected in the Nome area during 1993-94 was released in 2004. Data includes airborne-electromagnetic and aeromagnetic surveys.

2. State of Alaska, Oil and Gas Conservation Commission and the Division of Oil and Gas

Seismic Reflection and Electric Downhole Log Data are commonly used in the oil and gas industry to identify exploration prospects and maximize well production. Seismic data related to oil and gas exploration are largely company-confidential and are not available. Electric logs for wells in developed fields and older exploration wells are typically available through the State of Alaska.

3. U.S. Geological Survey

The U.S. Geological Survey (USGS) data sets covering KSP Planning Area lands include: Alaska aeromagnetic compilation; digital grids and survey data, which is available in Open-File Report 97-0520.

The Alaska aeromagnetic compilation maps contained therein represent data from numerous separate surveys, digitized maps, and previous gridded compilations. A digital re-release was made available in Open-File Report 99-0503.

Merged aeroradiometric data for Alaska, gridded data and plot files, Open-File Report 99-0016, was made available in 1999. This publication contains uranium, potassium, and thorium equivalent concentration in red-green-blue format for the North Slope and Brooks Range.

E. GEOCHEMICAL DATA

The following discussion provides an inventory and brief description of geochemical data readily available for the KSP Planning Area. These data sets, along with geophysical surveys as noted above, are routinely used in the identification and interpretation of mineral resources; numerous studies are also available documenting the petrology and chemical composition of various rock types in the KSP area.

1. USGS National Geochemical Database

The USGS's National Geochemical Database (NGDB) consists of several online databases which provide results of approximately 1,000 elemental geochemical analyses from rock, sediment, soil, water, and vegetative samples collected within the KSP Planning Area. Data sets are described below.

An extensive regional geochemical evaluation was conducted in Alaska as part of the U.S. Department of Energy's National Uranium Resource Evaluation (NURE) between 1974 and 1981. NURE data, mainly stream- and lake-sediment samples, include analysis of numerous elements in addition to elemental uranium concentrations. Results from approximately 506 samples are available on a quadrangle basis for much of the KSP Planning Area (USGS, 1997).

The USGS's Rock Analysis Storage System (RASS) provides elemental geochemical data from stream sediments, soils, waters, and organic material that can be downloaded on a quadrangle basis. RASS is intended as a reconnaissance tool used in mineral exploration or environmental baseline studies, for purposes such as identifying the regional geochemical signature of an area. The dataset primarily contains analyses generated from assessments and investigations of the non-fuel mineral resources. Stream sediments were chosen as the principal sample medium for these regional programs because they represent the weathering products of many rock sources within the larger drainage basin, which allows for lower sample density. Over 12,000 sample analyses are available from RASS for the KSP Planning Area, with coverage existing for all but 4 quadrangles – Wainwright, Point Lay, and Utukok River with coverage for Shishmaref forthcoming (USGS, 1999 and 2000).

PLUTO is a USGS database that provides the results of geochemical analyses on plutonic and volcanic igneous rock samples. PLUTO contains data generated from many disparate investigations such as geologic mapping, volcanic hazards, and energy resources. Approximately 765 analyses are available in the PLUTO database, representing about 60 samples collected in the KSP Planning Area.

2. State of Alaska, DGGS and former Alaska Division of Mines and Geology

The State of Alaska has released numerous geologic mapping investigations documenting the petrology and chemical composition of various rock types in the KSP area. The reports typically cover restricted areas, from individual prospects up to multiple 1:63,630 scale quadrangles (e.g. Asher, 1969 and Fritts, 1970). The DGGS has also produced mineral (and other) resource potential reports for larger areas based on blocks of State-selected Federal lands. Two blocks are pertinent to the KSP Planning Area: Land Selection Unit 16 which includes portions of the Selawik, Candle, Norton Bay, Unalakleet, Kateel River, and Nulato quadrangles (Solie and others, 1993); and Land Selection Area 32 which includes a portion of the Shungnak quadrangle (Liss and others, 1993). These two publications provide sample location maps in addition to geochemical and major oxide analytical data.

III. DESCRIPTION OF MINERAL RESOURCES

A considerable body of Alaska geologic research has been published by the USGS, U.S. Bureau of Mines (USBM), and BLM. Many of these studies document specific mineral resources or occurrences and describe the potential for additional discovery. Resource development potential has been an important factor in the selection of Federal lands by the State and, with the passage of ANCSA and ANILCA, for the Native Corporations as well. As a result, many recent State DGGS and Native Corporation investigations assess the potential for mineral resource development in selected areas. The following subsections present a description of known mineral resources utilizing many of these sources, and also provide the basis for mapping mineral potential within the KSP Planning Area.

A. LOCATABLE MINERALS

Locatable minerals include primarily metallic and certain nonmetallic industrial minerals that are generally found in lode or placer deposits. Cox and Singer (1987) define "mineral occurrence" as a concentration of a mineral considered to have some value or scientific interest, and "mineral deposit" as an occurrence of sufficient size and grade that it could have economic development potential. With this in mind, the following subsections, 1) present an overview of the information that is used to describe locatable minerals, 2) summarize the existing mineral occurrences and deposits within the Planning Area, and, 3) discuss the criteria used to determine the level of mineral potential for the occurrences.

1. Mineral Occurrences

There is an abundance of publicly available information detailing mineral occurrences within the KSP Planning Area. Two databases were used to provide site-specific mineral occurrence information on a state-wide basis, the USGS's Alaska Resource Data File (ARDF) and BLM's Alaska Minerals Information System (AMIS).

The ARDF database is an online public database that records locations and descriptions for metallic mineral mines, prospects, and occurrences and certain other high-value industrial mineral commodities (USGS, 2004b). ARDFs are published by quadrangle for the entire KSP Planning Area, save for four quadrangles (Shishmaref, Point Hope, Utukok River, and Wainwright) with no mineral occurrences. Much of the data are based on earlier systematic listings compiled by USGS geologists (e.g., Cobb, 1984 and 1975), and are updated as funding is available. The Noatak and Point Lay quadrangles are currently being updated.

The AMIS database project is an effort to develop a modern relational database to enable mineral occurrence information storage and retrieval for the BLM Alaska Mineral Assessments program. AMIS is based on the original Mineral Availability System/Mineral Industry Location (MAS/MILS) database developed by the USBM from 1975 to 1995. BLM's AMIS is a database containing spatial and commodity data for documented mineral occurrences, deposits, mines, and processing plant sites in Alaska (BLM, 2004). Data is held by and can be accessed from the BLM Alaska State Office, Division of Energy and Solid Minerals, Branch of Solid Minerals. The data is updated on an area-by-area basis, supported by the Alaska Mineral program. ARDF locations for the KSP Planning Area have recently been incorporated into, or merged, with the AMIS database; hence, most ARDF sites are now included as AMIS locations and AMIS entries contain a reference to any corresponding/associated ARDF site(s).

Currently within the KSP Planning Area, 877 ARDF entries and 1,154 AMIS sites exist. A total of 817 AMIS sites contain direct reference to ARDF entries; a total of 885 individual ARDF sites are referenced by the 817 AMIS, as some AMIS sites include multiple ARDF references. Figure 1 presents the merged AMIS and ARDF site locations – a total of 885 sites.

As previously discussed, several online USGS databases contain geochemical analyses of earth material, mainly stream sediment samples, which can be used to delineate mineral occurrences. However, no comprehensive evaluation of geochemical data was completed for this report, as geochemical anomalies generated by the USGS are generally documented in the ARDF.

2. Types of Mineral Deposits (Cox and Singer Models)

The science of mineral prediction is based partly on classifications derived from mineral deposit models. Mineral deposit models describe the essential attributes of different classes of deposits, including the origin of the mineral-hosting rocks and their relationship to the commodity types found. Such models have been developed for numerous mineral types by the USGS and other researchers (e.g., Cox and Singer, 1986; Orris and Bliss, 1991; Mosier and Bliss, 1992), and have been refined and expanded for Alaska-specific lode and placer deposits by Nokleberg and others (1987 and 1994). The models presented by Cox and Singer (1986) form the basis for the following discussion.

Approximately 598 mineral sites in the KSP Planning Area have been assigned a deposit model in the ARDF database. An additional 81 sites lacking an ARDF-specified deposit model were assigned a practical model, one based on an evaluation of supplemental information available in the ARDF. A total of 192 ARDF mineral sites contained no explicit or practical deposit type information. Appendix A contains a copy of the complete descriptive text for each Cox and Singer model type occurring in the Planning Area. Table 1 presents a summary of the geological setting for those deposit model occurrences in the Planning area. Deposit Model occurrences in the KSP Planning Area are presented with the Locatable Mineral Potential Areas in Figures 6a and 6b.

3. Historic Production

An inventory of historic mining activity is used to identify the specific commodities and deposit types most likely to be developed or discovered, and in what areas in the future. Furthermore, the lands encompassed by the KSP Planning Area reflect a substantial history of mining and mineral exploration. Placer gold and tin deposits are the main historic commodities produced in the Planning Area, although numerous historic producing lode deposits exist. The following subsections briefly describe the historic production of locatable resources, by deposit type and/or resource, in the KSP Planning Area. Table 2 presents a summary of historic lode producers based on a query of the ARDF data base (USGS, 2004b). Figure 1 presents the locations of historical lode producers. Figure 3 presents the historic placer deposits and summarizes those areas, described in terms of Mining District (Ransome and Kerns, 1954) areas, where the most significant production has occurred (Nokleberg and others, 1994; and USGS, 2004b)

<u>Placer Gold:</u> Roughly 500 placer gold occurrences exist in the KSP Planning Area; all known occurrences are restricted to the area south and east of the Noatak River. For the purposes of this report all placer occurrences are considered to be at least past producers, although as reported above, few are considered to be currently producing.

Historically, the main producing areas have been on the Seward Peninsula. Although smaller placer gold showings had been known on the Seward Peninsula much earlier, it was the rich, 1898 strike on Anvil Creek in the Cape Nome Mining District that started a rush of nearly 20,000 prospectors to peninsula creeks and eventually to the beaches of Nome. Since that time, over 5 million ounces of gold have been mined from alluvial and beach deposits in the Cape Nome Mining District (Szumigala and others, 2004). An additional nearly 1.5 million ounces has been won from other districts on the Seward Peninsula, including the Council, Kougarok, Port Clarence, Koyuk, and Fairhaven Mining Districts. The Nome Gold Rush peaked by 1902 with hundreds of individual prospects and prospectors, and steadily declined thereafter. Placer mining continues today on the Seward Peninsula, albeit in a more limited fashion; the five placer operations reportedly active on the Seward Peninsula in 2003 produced approximately 1,000 total ounces of gold (Szumigala and others, 2004).

Significant placer production outside of the Seward Peninsula in the KSP Planning Area occurred in the Kiana District (Klery, Boldrin, and Gold Run Creeks) and the Shungnak Mining District in the Ambler Area (Shungnak River and Cosmos, Dahl, and Lynx Creeks). Historic gold production from these two districts totaled less than 100,000 ounces, mined mainly prior to 1950 (Szumigala and others, 2004).

<u>Sedimentary-Exhalative Pb-Zn (SEDEX) Massive Sulfide Deposits:</u> Upon its opening in 1989, the Red Dog Mine in the western DeLong Mountains became the largest zinc mine in the world. Production through 2002 totals: 5.9 million tons zinc (Zn); 970,320 tons lead (Pb); and 59.2 million ounces silver (Ag) (Szumigala and others, 2004). The Red Dog Deposit itself has an expected mine life of greater than 40 years and numerous, smaller, lower-grade deposits (e.g. Lik) lay in close proximity to the mine site.

Table 1 – Cox and Singer (1986, 1992) Deposit Model Classifications for the Kobuk-Seward Peninsula Planning Area.

Lithotectonic/Lithologic setting		Deposit model occurring in KSP Planning Area (see note)	No. of ARDF sites	Associated commodities
Mafic and ultramafic intrusions				
Tectonically unstable area	Ophiolites	***Major podiform chromite (8b)***	**1**	**Cr-(Ni)**
		(Placer Au-PGE) (39a)	433	Au-PGE
	Serpentine	***Serpentine-hosted asbestos (8d)***	**5**	**Asbestos(Cr-Au)**
		(Low-sulfide Au-quartz vein) (36a)	72	Au (Ag)
Felsic intrusions				
Mainly phanero-crystalline textures	Wallrocks are calcareous	***W skarn (14a)***	**7**	**W**
		Sn skarn (14b)	**8**	**Sn (U-Be-F)**
	Other wallrocks	***Sn veins (15b)***	**12**	**Sn (Be-F-Ag-Zn)**
		Sn greisen (15c)	**4**	**Sn (F-Be)**
Porphyro-aphanitic intrusions present	Deposits near contact	***Zn-Pb skarn (18c)***	**2**	**Ag-Pb-Zn (Cu)**
		Fe skarn (18d)	**11**	**Fe**
	Deposits far from contact	***Polymetallic replacement (19a)***	**17**	**Ag-Pb-Zn-Cu**
	Deposits within intrusions	***Porphyry Mo, low-F (21b)***	**4**	**Mo-Pb-Zn**
	Deposits within wallrocks	***Polymetallic veins (22c)***	**15**	**Au-Ag-Pb-Cu-Zn**
		(Low-sulfide Au-quartz vein) (36a)	72	Au (Ag)
Extrusive rocks				
Mafic extrusive	Continental or rifted craton	***Basaltic Cu (23)***	**2**	**Cu**
Felsic-mafic extrusive rocks	Deposits in older clastic sedimentary rocks	***Hot-spring Hg (27a)***	**1**	**Au-Ag-Cu-Sb-Hg**
		Simple Sb (27d)	**13**	**Sb (Au)**
	Marine	***Kuroko massive sulfide (28a)***	**13**	**Cu-Pb-Zn (Au-Ag)**
		(Low-sulfide Au-quartz vein) (36a)	72	Au (Ag)
Sedimentary rocks				
Clastic sedimentary rocks	Conglomerate and sedimentary breccia	*(Sandstone U) (30c)*	1	U-Th
		(Basaltic Cu) (23)	2	Cu
	Sandstone	***Sandstone U (30c)***	**1**	**U-Th**
		(Basaltic Cu.) (23)	2	Cu
		(Kipushi Cu-Pb-Zn) (32c)	9	Cu-Pb-Zn (Ag-Au)
	Shale-siltstone	***Sedimentary exhalative Zn-Pb [SEDEX] (31a)***	**9**	**Zn-Pb (Ag-Ba)**
		Bedded barite (31b)	**2**	**Ba**
		(Basaltic Cu) (23)	2	Cu
Carbonate rocks	No associated igneous rocks	***Southeast Missouri Pb-Zn (32a)***	**1**	**Pb-Zn-Ag**
		Kipushi Cu-Pb-Zn (32c)	**9**	**Cu-Pb-Zn (Au-Ag)**
		SEDEX (31a)	9	Zn-Pb (Ag-Ba)
	Igneous heat sources present	*(Polymetallic replacement) (19a)*	17	Ag-Pb-Zn-Cu
Chemical sediments	Restricted basin	*(SEDEX)(31a)*	9	Zn-Pb (Ag-Ba)
Regionally metamorphosed rocks (Derived mainly from eugeosynclinal rocks)				
		(Serpentine-hosted asbestos) (8d)	5	Asbestos(Cr-Au)
		Low-sulfide Au-quartz vein (36 a)	**72**	**Au (Ag)**
		Graphite Veins (37g)	**4**	**C**
Surficial and unconformity-related (Depositional)				
		Stream placer Sn (39e)	**37**	**Sn (W-Au-U)**
		Placer Au-PGE (39a)	**433**	**Au (Ag-Sn-W-U)**
		Total number of Deposit Model determinations in KSP Planning Area	**679**	
		Sites where Deposit Model is Unknown or Undetermined	**206**	
		Number of ARDF sites in KSP Planning Area	**885**	

Note – Bold deposit models are considered the primary mode of classification.
– Italics denote an "Alternative Classification" – a deposit type setting is less favored by Cox and Singer (1987).

Lode Gold: The only significant producing lode gold mine on the Seward Peninsula was the Big Hurrah. Between 1903 and 1907, 27,000 ounces of gold were produced from underground workings at the mine site (Asher, 1969). The Rock Creek Gold project is currently in development-phase and is scheduled to begin production in 2006. Published resource estimates at Rock Creek exceed 0.5 million ounces contained gold at 0.059 ounces per ton (oz/t) (Szumigala and others, 2004).

Placer and Lode Tin Deposits (Hudson and Reed, 1997): Over 8.1 million pounds of tin have been produced in Alaska since the earliest 20th century, mainly from alluvial deposits on the Seward Peninsula such as Cape Mountain, Potato Mountain, Buck Creek, and Cape Creek. Lode production in the KSP Planning Area has been mainly from greisen and tin-bearing skarn at the Lost River deposit, from which about 315 tons of tin-tungsten-fluorite ore were mined in the early 1950's. Graphite, iron, beryllium, tungsten, asbestos, and fluorite were mined at Tin City. The Potato Mountain placer is likely genetically related to a quartz-cassiterite vein system model.

Pb-Zn-Ag Deposits (polymetallic): 400 tons of Pb-Zn massive sulfide ore, containing 10% Pb, 40 oz/ton Ag, and up to 10% Zn, were produced during 1881 to 1900 at Omilak (Szumigala and others, 2004).

Table 2 – Historic Lode Producers, Kobuk-Seward Peninsula Planning Area

Name	Quadrangle	Deposit model ID[1]	Deposit type, Description[1]	Commodity	Production
Jade Mountain	Ambler River	8d	Serpentine-hosted asbestos	Jade	Small
Omilak	Bendeleben	19a (22c?)	Polymetallic vein or replacement in marble	Ag, Pb, Sb	Small
Pargon Mountain	Bendeleben	?	Granite pegmatite	Muscovite	Small
Red Dog	**DeLong Mtns.**	**31a**	**SEDEX**	**Zn-Pb**	**Large, Current**
Sliscovich	Nome	27d, 36a	Simple Sb/ Au-quartz vein?	Au, Sb	Small
Breen West (Bison)	Nome	27d , 36a	Simple Sb/ Au-quartz vein?	Au, Sb	Small
McDuffee; McDuffie	Nome	36a	Low-sulfide Au-quartz veins	Au	Small
Last Chance	Nome	36a	Low-sulfide Au-quartz veins	Sb	Small
Widstedt – Anvil Ck.	Nome	36a	Low-sulfide Au-quartz veins	Au, Sb	Small
Big Hurrah	**Solomon**	**36a**	**Low-sulfide Au quartz vein**	**Au**	**Medium**
Rock Creek	**Solomon**	**36a**	**Low sulfide Au-quartz vein**	**Au**	**Pending**
Quiggley; Gray Eagle	Solomon	27a	Simple Sb deposits	Sb	Small
Fish River	Solomon	?	Vein or replacement in schistose marble?	Ag, Hg, Pb	Small
Wheeler	Solomon	?	Vein or replacement in schistose marble?	Cu	Small
Wheeler	Solomon	?	Vein or replacement in schistose marble?	Ag, Au, Pb, Zn	Small
Bluff	Solomon	36a	Low-sulfide Au-quartz veins	Au	Small
Wheeler	Solomon	?	Vein or replacement in schistose marble?	Ag, Au, Cu	Small
Lost River District	Teller	15 -c; (14b)	Greisen and Tin-Vein; (Tin-Skarn)	Sn-W-Fluorite	Medium
Cape Mountain	Teller	15b	Tin vein model	Sn	Small
Ward	Teller	?	Vein or replacement in schistose marble?	Cu	Small
Christophosen Creek	Teller	37g	Disseminated graphite in metasedimentary rocks	Graphite	Small
Ruby Creek	Teller	37g	Disseminated graphite in metasedimentary rocks	Graphite	Small
Graphite Creek	Teller	37g	Disseminated graphite in metasedimentary rocks	Graphite	Small

[1] Deposit models based on Cox and Singer, (1987); Cox and Singer deposit models are summarized in Section III.A.4
Bold denotes "Significant Deposit" (Nokleberg and others, 1994), all others are small producers (USGS, 2004b)

4. Significant Deposits

While the AMIS and ARDF electronic databases list all reported occurrences and deposits regardless of economic potential, Nokleberg and Others (1987 and 1994) provide summaries of those lode deposits considered most significant based on size, favorable geology, likelihood of economic development, and industry interest at the time of press. The proposed Rock Creek Mine on the Seward Peninsula was added to the Nokleberg and Others list significant deposits as a result of this compilation, based on near-term development plans (Szumigala and others, 2004 and USGS, 2004b). The final list consists of eight Planning Area deposits and is herein referred to as the "Significant Deposits" data set. Significant Deposit locations are presented on Figure 1; Table 3 presents a summary of Significant Deposits of the Planning Area. It should be noted that the Significant Deposits data includes only lode projects; a summary of significant placer production by district was presented above in Section III.A.1 - Placer Gold.

Table 3 – "Significant Deposits", Kobuk-Seward Peninsula Planning Area

Deposit name	Quadrangle	Deposit model type[1]	Commodity	Production
Arctic	Ambler River	Massive sulfide, Kuroko (28a)	Cu-Ag-Zn	None
Ruby Creek (Bornite)	Ambler River	Kipushi Cu (32c)	Cu-Ag-Zn	None
Smucker	Ambler River	Massive sulfide, Kuroko (28a)	Cu-Ag-Zn	None
Sunshine Creek	Ambler River	Massive sulfide, Kuroko 28a)	Cu-Ag-Zn	None
Lik - Su	DeLong Mtns.	SEDEX (31a)	Zn-Pb-Ag	None
Red Dog	DeLong Mtns.	SEDEX (31a)	Zn-Pb	Large
Big Hurrah	Solomon	Low-sulfide Au quartz vein (36a)	Au	Medium
Rock Creek	Solomon	Low sulfide Au-quartz vein (36a)	Au	Pending

[1] Deposit models based on Cox and Singer (1987).

5. Mining Claims

Mining claim locations are available electronically from BLM (Federal) and DNR (State) for mining claims on a state-wide basis. Mining claim activity indicates industry interest in a region or locality, which is used to delineate area of high-mineral occurrence and development potential. Federal and State claims are shown on Figures 4a and 4b. Table 4 presents a summary of current claim activity wholly or partially coincident to the KSP Planning Area.

Table 4 - Mining Claims and Prospecting Sites, Kobuk-Seward Peninsula Planning Area

Type	Acres claimed[1]	No. of individual claims[2]	No. of unique owners[3]
160-acre State prospecting sites	27,700	175	13 names
40-acre State mining claims	298,100	6,652	78 names
State claims Total	325,800	6,827	91 names
Federal mining claims (unpatented)	13,934	622	22 names
Grand Total	339,734	7,449	106 names

[1]State claims data based on a 12/17/04 extract from State of Alaska database.
[2]Federal claims data based on the most current 01/16/03 version of the data set.
[3]Unique names represent large mining companies, Native Corporations, individuals, or small associations.

Federal mining claim locations generally indicate a level of mineral potential and exploration known prior to 1971. There has been no opportunity to stake Federal mining claims on most BLM lands within the KSP Planning Area since that time due to ANSCA and ANILCA land withdrawals. Approximately 205 of the total 622 Federal mining claims are, at least partially, covered (over-staked) by later State mining claim activity on State-selected and dually State/Native-selected lands. It is likely that in the final conveyance, many of these dually-claimed parcels will not remain under Federal ownership due to the high level of mineral interest, as indicated by claim activity.

There are two types of State mining leasehold, the 40-acre mining claim and the 160-acre prospecting site, typically referred to under the common general term "claim". A legal mining claim is located (staked) to acquire the locatable mineral rights in an area. The location of a mining claim necessitates the prior discovery of locatable minerals within the claimed area. A prospecting site grants the owner an exclusive right to explore a 160-acre parcel of State land. During a prospecting sites' two-year term, owners have an exclusive right to record mining claims or leasehold locations within the boundaries of the site. The main difference between the prospecting site and a mining claim is that no legal "discovery" is necessary for locating a prospecting site. Claims and prospecting sites staked on State-selected Federal lands do not require the annual maintenance fees until the final land ownership is resolved. Once the final ownership status is determined, these State mining claims staked on Federal or Native lands will be declared null and void, and those on State-conveyed lands will require annual payments/assessment.

6. Mineral Terranes of Alaska and Known Mineral Deposit Areas

The word "terrane" is typically used where an assemblage of related rocks occupy a certain geographic area (Thrush, 1968). Mineral terrane maps were developed to depict rock associations whose geologic settings are considered highly favorable for the existence of metallic mineral resources. Specific commodities and mineral deposit types are more likely to exist within each terrane based on a terrane's particular geologic nature. Unmapped areas are generally evaluated as having poor to only moderate mineral potential. Mineral Terranes of Alaska (MTA) were originally described and mapped in Alaska by the USBM and subsequently revised and published several times by the Arctic Environmental Information and Data Center (AEIDC) (1979); Hawley and AEIDC (1982); Resource Data, Inc. and others, (1995); and Szumigala and others (1999). The MTAs identified in the KSP Planning Area are described in Table 5 and shown in Figures 4a and 4b.

Mineral deposit types are divided into categories by formation process and rock type. Syngenetic mineral deposits form about the same time as the rocks they are encased in, while epigenetic deposits form by metamorphic or hydrothermal alteration processes following host rock deposition (AEIDC, 1979). Further subdivisions of mineral terranes into rock types are based on the recognition that certain kinds of minerals are specifically associated with certain kinds of host rocks. For example, the metallic elements copper, nickel, and chromium, and the nonmetallic mineral asbestos, are typically associated with mafic igneous rocks or gabbro; while copper and zinc are typically associated with layered submarine volcanic rocks and sulfide-rich sediments, referred to as volcanogenic massive sulfide (VMS) deposits (AEIDC, 1979; Hawley and AEIDC, 1982).

Known Mineral Deposit Areas (KMDA) are described as a management tool for determining the likelihood of future discoveries in a particular area (RDI and others, 1995). These area features are based on a high concentration of historic mines and prospects, mineral occurrences in the AMIS database, and favorable geologic trends determined by MTA mapping. KMDAs have a high concentration of mineral occurrences of a single type, suggesting an increased likelihood of hosting significant mineral deposits as compared to other areas. The most recent version of KMDA data is electronically available with the MTA (RDI and others, 1995). Figures 4a and 4b graphically present KMDA area in the KSP Planning Area.

The KMDA area information discussed above includes two subsets of site-specific data. The first is a subset of 156 specific deposits considered significant in the KSP Planning Area - a set of specific deposits referred to herein as "KMDA Deposits." The KMDA Deposits data essentially represents a derivative of the AMIS-ARDF data. Whereas AMIS-ARDF includes all documented mineral occurrences regardless of significance, KMDA Deposits represent those sites with noteworthy exploration or development history, and some indication of resource potential. The KMDA Deposits sites include all those labeled as Significant Deposits in this Minerals Report (see section 4 above). Of the total 156 KMDA Deposits that occur in the Planning Area, approximately 127 have deposit model classifications assigned.

The second subset from the KMDA data is "KMDA Placer Commodities," highlighting those stream courses determined to be the most significant in terms of placer production. Thirty-one separate stream portions comprise the Planning Area's KMDA Placer Commodities subset. KMDA Placer Commodities data is divided by this report into two commodity categories by this report, either Au-Ag-W or Sn-Au. KMDA Placer Commodities are presented on Figure 3.

Table 5 - Mineral Terranes of Alaska (MTA) Units Kobuk Seward Peninsula Planning Area

Map unit (% of KSP Planning Area covered)	Rock type	Favorable commodities
SYNGENETIC DEPOSITS		
Intrusive Terranes		
IGA (1.8%)	ALKALIC GRANITIC ROCKS – syenite, and locally peralkaline granite and monzonite.	Favorable for deposits of uranium and REE[1].
IGF (0.1%)	FELSIC GRANITIC ROCKS – granite and quartz monzonite.	Favorable for deposits of tin, tungsten, molybdenum, uranium, and thorium.
IGI (1.0%)	INTERMEDIATE GRANITIC ROCKS – granodiorite and quartz diorite.	Favorable for deposits of copper, gold, and molybdenum.
IGU (0.5%)	UNDIVIDED GRANITIC ROCKS – granite.	Favorable for deposits of the three above groups.
Mafic-ultramafic Rocks		
IUM (0.1%)	ULTRAMAFIC ROCKS – peridotite and dunite.	Favorable for deposits of chromium, nickel, and PGE[2], with by-product cobalt.
IMA (0.1%)	MAFIC INTRUSIVE ROCKS – gabbro, and locally mafic-rich intermediate rocks such as mafic monzonite and diorite.	Favorable for deposits of copper and nickel, with by-product platinum and cobalt.
Volcanic – Sedimentary Terranes		
VFU (0.2%)	FELSIC VOLCANIC ROCKS, UNDIVIDED – rhyolite and quartz latite.	Favorable for deposits of copper, lead, and zinc, with by-product silver and gold.
VFA (0.3%)	ALKALIC FELSIC AND INTERMEDIATE VOLCANIC ROCKS – trachyte, phonolite, trachyandesite, and peralkaline volcanics.	Favorable for deposits of uranium and thorium.
VSF (0.8%)	SEDIMENTARY AND FELSIC VOLCANIC ROCKS, UNDIVIDED – rhyolite, quartz latite, and associated sediments.	Favorable for deposits of copper, lead, and zinc, with by-product silver and gold.
Mafic Volcanic Rocks		
VSM (10.5%)	SEDIMENTARY AND MAFIC VOLCANIC ROCKS, UNDIVIDED – basalt and associated sediments.	Favorable for deposits of copper and zinc, with by-product silver and gold.
VOP (1.3%)	OPHIOLITIC TERRANE – pillow basalt and associated mafic and ultramafic intrusives with minor chert and other pelagic sediments.	Favorable for deposits of copper, nickel, and chromium, with by-product PGE[2] and gold.
Sedimentary Terranes- Marine rocks		
SLS (1.2%)	LIMESTONE AND SHALE – limestone and dolomite with interbedded shale.	Favorable for deposits of copper, lead, and zinc.
SBS (3.4%)	BLACK, CARBONACEOUS SHALE AND LIMESTONE – limestone, dolomite, black shale, and chert.	Favorable for deposits of zinc, lead, and barium, with by-product silver.
EPIGENETIC DEPOSITS		
Sedimentary Terranes		
SLU (1.0%)	LIMESTONE – limestone and dolomite.	Favorable for deposits of copper or deposits like those of igneous terranes.
SGS (5.5%)	GRAYWACKE AND SHALE – interbedded greywacke and shale with minor volcanic rocks, favorable for mineral deposits introduced by metamorphic or epithermal processes.	Favorable for deposits of gold, plus deposits like those of igneous terranes.

Sources: AEIDC (1979); Hawley and AEIDC (1982); RDI and others (1995)
[1]REE = rare earth elements (e.g., lanthanum, cerium, neodymium)
[2]PGE = platinum group elements (e.g., platinum, palladium, iridium)

7. Undiscovered Mineral Occurrence Potential

Information discussing Undiscovered Mineral Occurrence Potential, specifically gold, silver, copper, lead, and zinc, is available through USGS Circular 1178 (USGS, 1998). Summary information contained in the report did not impact mineral potential ranking as determined by this Mineral Report. However, a list of important mineral deposits contained in this report was reviewed for consistency with those described in Section III.A.4, Significant Deposits.

8. Mineral Resource Reports

A number of investigations specific to mining districts and specific deposit localities have been conducted by the AEIDC, USBM, BLM, and the USGS over the past few decades. In the early 1970s, AEIDC mapped and described mineral deposits, metalliferous provinces, and mining activity throughout the state (Selkregg, 1974a). The DGGS published a mineral resource report covering KSP Planning Area as part of the State land-selection process (Smith, 1986). The USBM and BLM have conducted mining district and site specific studies throughout Alaska and the USGS have conducted numerous Alaska Mineral Resource Assessment Program (AMRAP) and other geologic studies throughout Alaska. All publicly available mineral resource reporting, identified to cover any portion of the KSP Planning Area, was used in developing LMP ranking for this report. The following paragraphs discuss the most significant mineral resource reports utilized in formulating those rankings.

The DGGS completed the *Northwest Alaska Resource Mapping Project* in 1985, publishing a series of maps assessing mineral potential for an area roughly equivalent to the KSP Planning Area (Smith, 1986). Mineral Potential Rankings of 1 through 5 were assigned to individual townships based on favorability of geologic environment, known significant deposits, mining claim activity, favorable geochemical/geophysical signatures, and favorable metallogenic/tectonic terranes. Among the data sets utilized for the DGGS assessment included: the USGS's AMRAP and NURE data, DGGS geochemical surveys and aeromagnetic surveys, and 26 individual mineral deposit models. The criteria used by Smith (1986) to determine mineral potential are similar to those used for this minerals potential report. An assessment of data quality was also conducted, based on the level of mineral data available by township. Generally, higher density geophysical and geochemical surveys, combined with detailed geologic mapping and occurrence studies, resulted in a better data quality rank; from very poor, poor, fair, good, to very good. Figures 5a and 5b present *Northwest Alaska Resource Mapping Project* results, displaying color-coded Mineral Potential Ranks 1 through 5.

The DGGS examined mineral characteristics on numerous blocks of eligible Federal land prior to land selection. The results of this study were used to create probabilistic modeling of mineral occurrence potential on 36 blocks (units) of Federal lands available for State selection 1991-1993 (DGGS, 1993). Seven of these units were located in the KSP Planning Area, and provide detailed deposit type information and statistical probability for the existence of various size ore bodies, where possible.

For over 20 years as part of the "Special Report" series, DGGS has produced a series of annual reports documenting the status of exploration, development, and production for the Alaska mining industry (Bundtzen and others, 1986 and Szumigala and others, 2004). These annual reports document significant past activities and provide an update of current mineral resource development and production activities. "Selected significant mineral deposits and mineral districts in Alaska" are summarized as an Appendix in the more recent Special Report volumes, with current resource figures provided where available.

Mineral Deposits of Alaska (Goldfarb and Miller, 1997) presents an overview of Alaskan mineral deposits through a series of 15 separate papers. Papers presented in this monograph on Alaskan mineral deposits primarily focus on describing general deposit types or commodity assemblages that occur in the state. Deposit-specific information available for the state's most significant deposits is also summarized, often providing resource tonnages and grades, complete with citations.

9. Strategic and Critical Minerals

Certain mineral commodities have been termed "strategic" or "critical" by the U.S. Government. Strategic minerals are those that are essential to national defense, for which we are mostly dependent on foreign sources for during war, and for which strict measures controlling conservation and distribution are necessary. Critical minerals are also essential to national defense, but their procurement during war is less serious because they are either produced domestically or can be obtained through more reliable foreign sources (Thrush, 1968).

Bundtzen and others (1980 and 1982) summarize significant sources and reserves of strategic and critical minerals in Alaska. In addition, the AMIS database (through its precursor MAS/MILS) was initially developed as a systematic assessment of strategic and critical minerals. Of the 17 strategic minerals known to occur in Alaska, 16 have been identified within the KSP Planning Area; five of the seven critical minerals found in significant concentrations in Alaska also exist within the KSP Planning Area. Table 6 presents a summary of KSP Planning Area strategic and critical mineral occurrences, based mainly on AMIS commodity information.

Table 6 – Strategic and Critical Mineral Occurrences, Kobuk Seward Peninsula Planning Area

Commodity	Strategic/ Critical	No. of occurrences	Major AMIS deposits[1]
Antimony	Strategic	43	Big Hurrah, Omilak, Last Chance
Asbestos	Strategic	8	Misheguk Mountain, Jade Mountain, Shungnak River
Chromium	Strategic	9	Peace River, Sours Prospect, Misheguk Mountain, Iyikrok Mountain
Cobalt	Strategic	2	Ruby Creek (Bornite), Penny River
Columbite	Strategic	2	Lost River, Kiana
Fluorine	Strategic	10	Seward Peninsula: Lost River, Kougarok, Windy Creek, Rapid River
Manganese	Strategic	1	Monarch
Mercury	Strategic	29	Hot Springs, Kougarok, Swede, Peace River
Niobium	Strategic	2	Lost River
Nickel	Strategic	3	Jade Hills, Stockley Creek, Old Glory Creek
Optical Mica	Strategic	3	Paragon Mountain, Etookook
Platinum Group	Strategic	13	Misheguk Mountain, Penny River, Split Creek
Rare Earth	Strategic	15	Darby Mountains, Golovin, Burnt Creek
Tantalum	Strategic	2	Kougarok, Lost River
Tin	Strategic	93	Seward Peninsula: Cape Mountain, Potato Mountain, Buck Creek, Cape Creek, Lost River
Tungsten	Strategic	47	Seward Peninsula: Big Hurrah, Lost River, Darby Mountains, York Creek
Barium	Critical	5	Red Dog, Moil Creek
Cadmium	Critical	3	Lik, Dahl Creek, Punupkroak Mountain
Gold	Critical	765	Big Hurrah, Arctic, Rock Creek, Nome
Silver	Critical	200	Numerous occurrences, Lik, Nome, Last Chance, Red Dog
Zinc	Critical	92	Red Dog, Lik, Arctic, Ruby Creek (Bornite), Gold Run, Shungnak, Windy Creek

[1]Significant Deposits (Nokleberg and others, 1987 and 1994) underlined.

B. SALABLE/INDUSTRIAL MINERALS

The following section is an overview of the salable/industrial minerals discussion that is presented in the forthcoming Analysis of the Management Situation (AMS) report compiled for the RMP process.

Salable minerals include common varieties of mineral materials such as construction aggregate (sand and gravel), building stone, pumice, clay, and limestone. River bars and beach lines are an abundant source of mineral materials for construction projects in the KSP Planning Area. Villages in the region, due to their locations along rivers or coastlines, have developed local sources for mineral materials. Outside of these areas, mineral materials have no value unless they are in close proximity to a project under development. An exception to this, the high quality of rip-rap material at Cape Nome, located on private land and developed by the regional native corporation is shipped around the Pacific Rim for tidewater construction projects as well as local use.

There is a strong regional demand and dependence for mineral materials for structural pads, road-base, airports/airstrips, dock facilities, and general fill material. Due to low unit costs and high transportation costs for mineral materials, this demand must be met locally for the respective projects to be economically viable. Many of the communities within the KSP Planning Area are located on low marshy ground that is sometimes underlain by permafrost. Construction projects typically require large quantities of mineral materials to stabilize the ground. In terms of volume and unit cost, mineral materials are, except for oil and gas, the most valuable mineral resources produced in the state. Many construction projects would become uneconomic without local sources of mineral materials. It is rare to find mineral materials transported more than 20 miles from the source.

Mineral material sales in the KSP Planning Area peaked in 1984 (with a combined volume on the order of 100,000 cubic yards) and declined rapidly thereafter as lands surrounding villages were conveyed and the natives took control of these resources. In the past five years, mineral material sales have averaged one small sale on the order of 10,000 cubic yards per year.

The local demand for mineral materials in the KSP Planning Area is generally being met by producers located on private lands. These producers will continue to provide larger portions of the future requirements. There will be less demand for mineral materials from public lands in the future. No further analysis is required for this report.

IV. RATIONALE FOR THE DEVELOPMENT OF POTENTIAL RATINGS

This section provides the rationale for generating potential ratings and explains the level of confidence criteria. The final result of this process is the generation of mineral occurrence and development potential map(s) for locatable and salable mineral resources in the area. This section outlines how the rationale is used in generating mineral potential ratings and explains the level of confidence criteria for both locatable and salable mineral commodities. Areas of High and Medium Locatable Mineral Potential (LMP) will be tabulated and described in Section V - Mineral Occurrence and Development Potential.

A. LOCATABLE

As stipulated under the 1872 mining law, locatable minerals include a variety of uncommon minerals such as precious metals (e.g. Au and Pt) and base metals (e.g. Cu, Pb, and Zn). Minerals containing these common metals, and the rock they are contained in, are considered locatable. Locatable minerals can also include uncommon varieties of rock that are considered rare such as precious stones (e.g. jade and diamonds), industrial stones (e.g. garnet and quartz sand), or building/decorative stones (e.g. marble and high granite) that have building-stone quality.

1. Potential Ratings

Occurrence potential ratings for locatable minerals are based on the following rationale:

<u>High Locatable Mineral Potential [High LMP]:</u> Areas of High LMP will be demonstrated based on available data including: geologic environment, inferred geologic processes, reported mineral occurrences, known mines or significant deposits, favorable MTA conditions, and active Federal and State mining claims. Multiple data sources must be available that suggest high potential for any given area. These separate data sets are then combined to provide a qualitative "weight of evidence" supporting the determination of High LMP; the actual overlapping of significant data sets is used to draw the High LMP area. For example, areas within the KSP Planning Area are be mapped as High LMP where active Federal and State mining claims overly the Significant Deposits, KMDA Deposits, and where existing mineral potential investigations have identified areas of high mineral potential. Areas with only one or two overlapping data sets implying high mineral potential are typically assigned a Medium LMP.

<u>Medium Locatable Minerals Potential [Medium LMP]:</u> Areas mapped as Medium LMP include MTAs, placer mining districts, KMDAs, and other areas not specifically mapped as areas of high mineral potential by previous authors. The combined High and Medium LMP categories encompass nearly all of the mineral locations and occurrences identified in the AMIS and ARDF databases.

<u>Low Locatable Mineral Potential [Low LMP]:</u> All areas outside of the High and Medium LMP boundaries are interpreted to have Low LMP ranking for locatable mineral occurrences. No areas of the KSP Planning Area are considered to have a 'No' LMP ranking, since all geologic units have some measure of future mineral potential.

2. Application of Potential Ratings

A rating of High LMP based on the rationale outlined above embodies a specific set of data qualities. The bulk of this designation is based on the data provided in Section II (Description of Geology) and Section III (Description of Mineral Resources) - each information source listed in these two sections plays a role in assigning Potential Rating. Table 7 presents a summary of the most pertinent site specific factors involved with assigning potential. The High LMP rating areas encompass all Significant Deposits, and most KMDA Deposits and KMDA Placer Commodity streams; Medium LMP areas contain all remaining KMDA Deposits and Placer Commodities, in addition to any production sites and mining claims not included within the High LMP areas. The main tools used to extend specific LMP outlines outward from those areas with the highest densities of significant occurrences are KMDA, areas with favorable mineral potential reporting (e.g. Smith, 1986 and Selkregg, 1974a), and MTA mapping.

Table 7 – Significance and Frequency of Deposit Models Kobuk Seward Peninsula Planning Area

Deposit model[1]	Commodities[1]	No. of individual KSP occurrences[2]	Production		KMDA deposit[4]	Significant Deposit[5]
			Current[3]	Past[2]		
Placer Au-PGE (39a)	Au (Ag-Sn-W-U)	433	Yes	Yes	Yes	Yes
Low-sulfide Au-quartz vein (36a)	Au (Ag)	72	Pending	Yes	Yes	Yes
Stream placer Sn (39e)	Sn (W-Au-U)	37		Yes		
Polymetallic replacement (19a)	Ag-Pb-Zn-Cu	17		Yes	Yes	
Polymetallic veins (22c)	Au-Ag-Pb-Cu-Zn	15		Yes	Yes	
Simple Sb (27d)	Sb (Au)	13		Yes	Yes	
Kuroko massive sulfide (28a)	Cu-Pb-Zn (Au-Ag)	13			Yes	Yes
Sn veins (15b)	Sn (Be-F-Ag-Zn)	12		Yes	Yes	
Fe skarn (18d)	Fe	11			Yes	
SEDEX (31a)	Zn-Pb (Ag-Ba)	9	Yes	Yes	Yes	Yes
Kipushi Cu-Pb-Zn (32c)	Cu-Pb-Zn (Au-Ag)	9			Yes	Yes
Sn skarn (14b)	Sn (U-Be-F)	8		Yes	Yes	
W skarn (14a)	W	7			Yes	
Serpentine-hosted asbestos (8d)	Asbestos (Cr-Au)	5		Yes	Yes	
Sn greisen (15c)	Sn (F-Be)	4			Yes	
Porphyry Mo, low-F (21b)	Mo-Pb-Zn	4				
Graphite veins (37g)	C	4		Yes		
Zn-Pb skarn (18c)	Ag-Pb-Zn (Cu)	2				
Basaltic Cu (23)	Cu	2			Yes	
Bedded barite (31b)	Ba	2			Yes	
Major podiform chromite (8a and 8b)	Cr-(Ni)	1			Yes	
Hot-spring Hg (27a)	Au-Ag-Cu-Sb-Hg	1			Yes	
Sandstone U (30c)	U-Th	1				
Southeast Missouri Pb-Zn (32a)	Pb-Zn-Ag	1			Yes	

[1]Cox and Singer, 1986 and 1992
[2]AMIS and ARDF
[3]DGGS reports on Alaska's mineral industry (Bundtzen and others, 1986; Szumigala and others, 2004)
[4]RDI and others, 1995
[5]Nokleberg and others, 1987 and 1994

3. Confidence Level

The level of certainty with which determinations of mineral potential were made is termed Confidence Level. Each area identified as having some potential also has a corresponding Confidence Level describing the quality and the abundance of data used to determine the Potential Rating. In addition to the data types discussed in Section 2 - Application of Potential Ratings, an important factor influencing the level of certainty is the quality, in this case – scale, of geologic mapping coverage. Simply put, a larger scale map implies better control and more certain, detailed geologic information. This qualification is based partly on the geologic information package that was prepared by DGGS specifically for this MODPR. A summary of the DGGS map coverage compilation is presented with DGGS-determined mineral potential in Figures 5a and 5b. Appendix B contains the complete set of geologic map indexes produced by DGGS.

is in the process of compiling a map index for the KSP Planning Area. This index will graphically present outlines for all available Federal and State geologic mapping completed to date in the KSP Planning Area. The final information package will include bibliographic records for geologic mapping, and contain information such as mapping scale, focus (bedrock, construction materials, surficial, etc), and publication date.

Level of certainty in the data is indicated on mineral potential maps by line type as follows:

Confidence Level A: Areas where abundant direct and indirect evidence support the interpretation are indicated by solid lines. This is considered to be the case for most mineralized areas identified as high mineral potential. These areas commonly have detailed geologic mapping completed at a scale of 1 inch = 1 mile (1:63,360), or better. Level A areas, with either a High or Medium LMP rating, typically require a relatively significant density of known mineral occurrences

Confidence Level B: Areas where direct evidence is available, but is quantitatively less, are indicated by long-dashed lines. Geologic map coverage for these areas is generally at least 1 inch = 4 miles (1:250,000). Areas with the same favorable geology and mapped mineral potential as an adjacent Level A area, but with lower density of documented occurrences are mapped Level B. High LMP areas have either Level A or B Confidence Levels; most areas of medium potential fall into the Confidence Level B category.

Confidence Level C: Areas where indirect evidence alone supports the interpretation are indicated by dotted lines. Areas where the only identified geologic mapping is at the regional compilation level (i.e. smaller scale than 1:250,000) are considered the fall in the “Level C” category. For areas which fall into this category, mineral potential is typically based on one or two specific data sources alone. For example, the MTA mapping layer is outlined as Medium LMP - Confidence Level C where it is the single source describing mineral potential in a specific area.

Confidence Level D: Areas with insufficient data are unmapped. This class is also used to delineate “Low mineral potential”.

B. SALABLE

As stated in Section III.B – Salable Mineral Resources, the local demand for mineral materials in the KSP Planning Area is generally being met by producers located on private lands. These producers will continue to provide larger portions of the future requirements. There will be less demand for mineral materials from public lands in the future. No further analysis is required for this report.

V. MINERAL OCCURRENCE AND DEVELOPMENT POTENTIAL

Areas of High LMP are tabulated and described in the following sections, and graphically presented in Mineral Potential map figures 6a and 6b.

A. LOCATABLE OCCURRENCE AND DEVELOPMENT POTENTIAL

This section describes the delineated High and Medium LMP areas. A tabular summary of specific deposit and occurrence information is provided with each High LMP area discussion. Sources for additional deposit-specific information, such as resource/reserve grade, tonnage, economics, etc., are identified where possible.

1. Areas with High LMP Rating

The following section presents the rationale and occurrence information used in the delineation of each High LMP Area presented on map Figures 6a and 6b (MODPR Locatable Mineral Potential). It should be noted that only those mineral Deposit Models that are actually documented to occur in a given High LMP area are tabulated and discussed. Additional deposit model occurrences - while possible based on Mineral Terrane mapping and other strictly geologic characteristics - are not substantiated by any documented exploration or development information and are not addressed in this section. Figure 6a contains the majority of High LMP Map outlines and covers the southern portion of the KSP Planning Area; Figure 6b focuses on the northern portion of the Planning Area and presents the Red Dog High LMP Area in its entirety.

Omar-Kiana High LMP Area: The Omar-Kiana High LMP Area is situated in the lower Kobuk River area, downstream and north from the village of Kiana on the Kobuk River (Figures 6b and 6a). This High LMP area includes the Omar River and Frost KMDA Deposits, and extends south to the Kobuk River near Kiana to include the historically producing KMDA Placer Commodity area on Klery Creek that is part of the Kiana Mining District. Coincident data sets contributing to the assignment of a high potential rating for the area as a whole include: KMDA and deposits, DGGS Mineral Potential Ranking 3 to 5, mineral terranes, and the existence of mining claims. The High LMP area encompasses a total of 18 AMIS sites, 10 of which have a deposit model assigned. Each of the two Confidence Level A areas mapped in the High LMP is associated with a specific set of potential deposit types, warranting further discussion as described below.

Table 8a - Omar-Kiana High LMP Area: Deposit Model Occurrences

Deposit model[1]	Commodities[1]	No. of individual occurrences in High LMP	Production		Deposits		
			Current[3]	Past[2]	KMDA[4]	Signi-ficant[5]	Resource estimate available
Placer Au-PGE (39a)	Au	7	--	--	--	--	--
Kipushi Cu-Pb-Zn (32c)	Cu-Pb-Zn-Ag	2	--	--	2	--	X
Southeast Missouri Pb-Zn (32a)	Ag-Pb-Zn	1	--	--	--	--	--

Table 8b - Omar-Kiana High LMP Area: Significant Deposits, KMDA Deposit Occurrences, and Lode Producers

Site name	AMIS ID	ARDF	Deposit model[1]	Commodities[2]	Producer[2]	Deposit class	
						KMDA[4]	Significant[5]
OMAR RIVER	**0020270020**	**BM012**	**32c**	**Cu**	**--**	**X**	**--**
FROST	**0020270028**	**BM011**	**32c**	**Ba, Cu, Zn**	**--**	**X**	**--**

BOLD entries have documented resource information (detailed in text)
[1]Cox and Singer, 1986 and 1992
[2]AMIS and ARDF: P = Past, C = Current
[3]DGGS reports on Alaska's mineral industry (Bundtzen and others, 1986; Szumigala and others, 2004)
[4]RDI and others, 1995
[5]Nokleberg and others, 1987 and 1994

Identified Lode Resources:

- Omar River: an inferred resource of 35 million tons at 4% Cu (BLM, 1994b);
- Frost: contains an estimated 9 million tons of barite (Szumigala and others, 2004).

Omar-Frost: In the north, Omar-Frost area deposits are hosted by the shale and limestone (SLS) mineral terrane and occur in the area mapped by DGGS High Mineral Potential Ranking (Rank 5). Deposit types with a high potential for occurrence include Kipushi Cu-Pb-Zn (32c), southeast Missouri Pb-Zn (32a), and bedded barite (31b) and to a lesser extent, placer Au-PGE (39a), Au-Ag-Pb-Cu-Zn polymetallic veins (22c), and SEDEX (31a).

Klery Creek: The southern Level A-High Rating area is dominantly a placer Au (39a) deposit area (KMDA Placer Commodity listing) along Klery Creek, at the center of the Kiana Mining District. There is additional, lesser potential for deposits similar to Red-Dog Area examples: 31a, 31b, 32a, 32c, and 22c**.** The eastern portion of the southern Level A-High LMP area is underlain by the VSF Mineral Terrane unit, and has the increased potential for sediment-hosted Zn-Pb-(Ag-Ba) deposits such as 31a, 31b, 32c, 32c, 22c and also Kuroko massive sulfide (28a), all at Confidence Level B.

Ambler High LMP Area: The eastern portion of the KSP Planning Area, located on the south flank of the Brooks Range north of the Kobuk River, contains the highly mineralized Ambler High LMP Area. Numerous Significant Deposits, a total of 49 AMIS mineral occurrences that include 30 deposit model designations, large claim blocks, and 15 KMDA Deposits are circumscribed by this High LMP outline. The Ruby Creek (Bornite), Arctic, Sunshine Creek, and Smucker Significant Deposits as well as numerous well-documented Cu-Pb-Zn-Ag lode occurrences occur here. The area is currently the focus of noteworthy exploration activity. There is high potential in the Ambler Area for Kuroko-type Cu-Pb-Zn-(Ag-Au) massive sulfide (28a), Kipushi Cu-Pb-Zn (32c), serpentine-hosted asbestos (8a), and placer Au-PGE (39a), polymetallic veins (22c), and basaltic Cu (23). Two producing lode mines were historically active in the Ambler Area, Jade Mountain and Asbestos Mountain, which produced small amounts of economic minerals (mainly Jade). Historically-producing placers in portions of the Kiana and Kobuk Mining Districts are also included in the Ambler Area and seven townships are mapped as Rank 5 Mineral Potential by DGGS. Level A Confidence outlines are drawn where MTA, KMDA, KMDA Deposits, KMDA Placer Commodities, and DGGS Mineral Potential Rank 4 to 5 data overlap, circumscribing most of the more significant occurrences. Confidence Level B outlines denote high potential areas where relatively fewer occurrences are known. Three Confidence Level A-High Potential Rating areas are drawn in the Ambler Area, and warrant further discussion as described below.

Arctic: The northern-most confidence Level A area includes the Arctic, Smucker, and Sunshine significant deposits and additional KMDA-listed deposits, including the Naniratkohort Creek, Ruby, and Dead Creek deposits. These massive sulfide prospects are hosted mainly by the VSF and VFU Mineral Terranes. The area is underlain by metamorphosed Lower and Middle Paleozoic sediments, basalt/rhyolite flows, and volcaniclastics. There is high potential for Kuroko-type Cu-Pb-Zn-(Ag-Au) massive sulfide (28a) and Kipushi Cu-Pb-Zn (32c), and to a lesser degree placer Au-PGE (39a), polymetallic veins (22c), and basaltic Cu (23) deposit type occurrences. The NovaGold mining and mineral exploration company that is currently developing a gold mine at Rock Creek on the Seward Peninsula, drilled their Ambler Property in 2004. The NovaGold property is centered on the Arctic Deposit, a Kuroko-type volcanogenic massive sulfide (VMS), in an area also considered to have high potential for Kipushi-type deposits.

Jade Mountain: The second Confidence Level A outline is located in the western portion of the Ambler Area. This High LMP area is dominated by the Angayucham Lithotectonic Terrane, subdivided here into VOP and IUM Mineral Terranes. The deposit types most likely to occur in the area are Kipushi Cu-Pb-Zn (32c) and serpentine-hosted asbestos (8a), with lesser potential for polymetallic veins (22c), basaltic Cu (23), and placer Au-PGE (39a) in the Kiana Mining District. The area includes the historic Jade Mountain Mine (Jade Hills site), as well as a number of nickel, asbestos, and Cu-Pb occurrences.

Bornite: The most southern of the Level A Confidence area contains the Ruby Creek (Bornite) Kipushi-type (32c) Cu-Pb-Zn deposit and historically-producing KMDA Placer Commodity gold placers in the Dahl Creek area of the Kobuk Mining District. Asbestos Mountain Mine produced a small amount of asbestos and tremolite during WWII. The Wesley Creek and Riley KMDA Deposits occur in the area. The area also lies partially along the Angayucham Lithotectonic Terrane, but is also underlain by limestone-dolomite of the SLU Mineral Terrane unit. The deposits with the highest potential for occurrence are placer Au-PGE (39a), serpentine-hosted asbestos (8a), Kipushi Cu-Pb-Zn (32c), Kuroko-type massive sulfide (28a), and polymetallic veins (22c), with lesser potential for basaltic Cu (23).

Table 9a - Ambler High LMP Area: Deposit Model Occurrences

Deposit model[1]	Commodities[1]	No. of individual occurrences in High LMP	Production		Deposits		
			Current[3]	Past[2]	KMDA[4]	Signi-ficant[5]	Resource estimate available
Placer Au-PGE (39a)	Au-(Pt)	11	--	11	--	--	--
Kuroko massive sulfide (28a)	Cu-Pb-Zn-(Ag-Au)	7	--	--	5	3	X
Kipushi (32c)	Cu-Pb-Zn-Au	6	--	--	1	1	X
Serpentine-hosted asbestos (8d)	Jade-asbestos-(Cr- Ni)	5	--	2	1	--	--
Polymetallic vein (22c)	Au-Ag-Pb-Zn	1	--	--	1	--	--

Table 9b - Ambler High LMP Area: Significant Deposits, KMDA Deposit Occurrences, and Lode Producers

Site name	AMIS ID	ARDF	Deposit model[1]	Commodities[2]	Producer[2]	Deposit class	
						KMDA[4]	Signific-ant [5]
IRON MOUNTAIN	0020280001	AR014	unknown	Fe	--	X	--
BORNITE	**0020280002**	**AR018**	**32c**	**Cu**	**--**	**X**	**X**
ARCTIC CAMP	**0020280004**	**AR025**	**28a**	**Ag, Au, Cu, P**	**--**	**X**	**X**
SHUNGNAK CAMP	0020280005	--	unknown	--	--	X	--
JADE HILLS	0020280032	AR007	8d	Ni	--	X	--
SMUCKER	**0020280033**	**AR033**	**28a**	**Ag, Cu, Pb, Zn**	**--**	**X**	**X**
KALURIVIK RIVER VALLEY	0020280035	--	unknown	--	--	X	--
RILEY CREEK LODE	0020280041	--	unknown	--	--	X	--
SUNSHINE CREEK (RUBY)	**0020280042**	**AR028**	**28a**	**Cu, Pb, Zn**	**--**	**X**	**--**
NANIRATKOHORT CREEK	0020280044	AR030	28a	Cu, Pb, Zn	--	X	--
RILEY LODE	0020280047	--			--	X	--
DEAD CREEK	0020280048	AR026	28a	Cu, Pb, Zn	--	X	X
SHUNGNAK RIVER	0020280056	--	unknown	--	--	X	--
WESLEY CREEK	0020370002	SH013	22c	Au, Pb	--	X	--
STOCKLEY CREEK	0020370016	SH009	unknown	Ni	--	X	--
ASBESTOS MOUNTAIN	0020280040	AR016	8d	Asbestos, Talc	P	--	--
JADE MOUNTAIN	0020280003	AR006	8d	Asbestos, Jade	P	--	--

BOLD entries have documented resource information (detailed in text)
[1]Cox and Singer, 1986 and 1992
[2]AMIS and ARDF: P = past producer, C = current producer
[3]DGGS reports on Alaska's mineral industry (Bundtzen and others, 1986; Szumigala and others, 2004)
[4]RDI and others, 1995
[5]Nokleberg and others, 1987 and 1994

Identified Lode Resources:

- Ruby Creek (Bornite): 100-million ton reserve at 1.2% Cu (Szumigala and others, 2004);
- Arctic: estimated reserves at 37 million tons with 4.00% Cu, 5.50% Zn, 0.80% Pb, 1.50 oz./t Ag and 0.02 oz/t Au (Newberry and others, 1997);
- Smucker: 7.2 million tons estimated reserve at 0.50% Cu, 4.90% Zn, 1.72% Pb, 5.59oz/t Ag, and 0.04 oz/t Au (Newberry and others, 1997);
- Sunshine Creek (Ruby): estimated reserve greater than 4 million tons of 0.7% Cu, 2.2% Zn, 0.4% Pb, and 0.7oz/t Ag ore (Newberry and others, 1997).

Shaktoolik High LMP Area: The High LMP area near Shaktoolik is delineated by 5 AMIS sites (4 with deposit model designation), MTA, and DGGS High Mineral Potential Rank 4 to 5. The area's designation as High LMP is primarily based on KMDA Placer Commodity production listed for Unaglik Creek, which is within the Koyuk Mining District. The High LMP area has a high potential for further discovery of placer Au (29a), with additional lesser potential for polymetallic base and precious metal vein mineralization (22c, 36a, 27d, and 8b).

Table 10a - Shaktoolik High LMP Area: Deposit Model Occurrences

Deposit model[1]	Commodities[1]	No. of individual occurrences in High LMP	Production		Deposits		
			Current[3]	Past[2]	KMDA[4]	Signi-ficant[5]	Resource estimate available
Placer Au-PGE (39a)	Au	4	--	5	--	--	--

Table 10b - Shaktoolik High LMP Area: Significant Deposits, KMDA Deposit Occurrences, and Lode Producers

AMIS ID	ARDF	Site name	Deposit model[1]	Commo dities[2]	Producer[2]	Deposit Class		Resource estimate reference
						KMDA[4]	Significant [5]	
--	None	--	--	--	None	--	None	--

BOLD entries have documented resource information (detailed in text)
[1]Cox and Singer, 1986 and 1992
[2]AMIS and ARDF: P = Past, C = Current
[3]DGGS reports on Alaska's mineral industry (Bundtzen and others, 1986; Szumigala and others, 2004)
[4]RDI and others, 1995
[5]Nokleberg and others, 1987 and 1994

Identified Lode Resources: None

Eastern Seward Peninsula High LMP Area: This area represents an extensive north-south-oriented High LMP area located along the Seward Peninsula's eastern margin, and includes that portion of Western Alaska west of the Nulato and Selawik Hills. The High LMP outline encompasses 112 AMIS sites in the intervening area between the villages of Buckland and Koyuk, 41 of which have designated Deposit Models. The area encompasses placer production areas in the Fairhaven Mining District and a portion of the Koyuk Mining District, and the large mining claim blocks on Candle Creek and others on the Koyuk River. The Independence Mine, located in the northwestern portion of the High LMP area, was a small producer of Ag-Zn-Pb metals (polymetallic vein, 22c). Level A Confidence outlines encompass placer producing areas and DGGS Mineral Potential Rank 5 lands, and the most significant mineral occurrences, including KMDA Deposits and the KMDA Placer Commodity listing on Candle Creek.

The High LMP area is underlain by three main Mineral Terrane assemblages - VSM, IGA, and SGS. The occurrence of specific deposit types can be broadly generalized on the basis of this mineral terrane mapping although significant deposit overlap exists between terranes. For areas underlain by SGS and VSM Mineral Terranes, high potential exists for polymetallic base and precious metal vein mineralization polymetallic veins (22c), low-sulfide Au-quartz vein (36a), and placer Au-PGE (39a), with lesser potential for Zn-Pb or Fe skarns (18c and 18d, respectively) and Kuroko massive sulfide (28a). Sediments derived from IGA Mineral Terrane lithologies have high potential for hosting placer Au (39a).

Table 11a - Eastern Seward Peninsula High LMP Area: Deposit Model Occurrences

Deposit model[1]	Commodities[1]	No. of individual occurrences in High LMP	Production		Deposits		
			Current[3]	Past[2]	KMDA[4]	Signi-ficant[5]	Resource estimate available
Placer Au-PGE (39a)	Au (Ag-Sn-W-U)	34	--	34	1	--	--
Polymetallic veins (22c)	Au-Ag-Pb-Cu-Zn	1	--	1	--	--	--
Low-sulfide Au-quartz vein (36a)	Au (Ag)	1	--	--	1	--	--
Basaltic Cu (23)	Cu	1	--	--	1	--	--
Polymetallic replacement (19a)	Ag-Pb-Zn-Cu	1	--	--	--	--	--
Kuroko massive sulfide (28a)	Cu-Pb-Zn (Au-Ag)	1	--	--	--	--	--
Fe skarn (18d)	Fe	1	--	--	--	--	X
Zn-Pb skarn (18c)	Ag-Pb-Zn (Cu)	1	--	--	--	--	--

Table 11b - Eastern Seward Peninsula High LMP Area: Significant Deposits, KMDA Deposit Occurrences, and Lode Producers

AMIS ID	ARDF	Site name	Deposit model[1]	Commodities[2]	Producer[2]	Deposit class	
						KMDA[4]	Signif-icant [5]
0020440013	--	GOLDEN CIRCLE MINE	unknown	--	--	X	--
0020440109	BN077	PLOVER	unknown	Ag, Cu, Pb, Zn	--	X	--
0020440120	BN073	PATTERSON CREEK LODE	unknown	Au	--	X	--
0020440121	**BN075**	**BILLIKEN 1-110**	**18d**	**Fe, Ag, Cu, Pb, Zn**	**--**	**--**	**--**
0020440123	--	LITTLE MIDWAY RIDGE	unknown	--	--	X	--
0020440146	BN082	GCU	unknown	Cu	--	X	--
0020450001	CA013	PEACE RIVER	unknown	Ag, Au, Cu, Mo	--	X	--
0020450015	CA048	SPLIT CREEK LODE	23	Cu	--	X	--
0020450045	--	BEAR MOUNTAIN	unknown	--	--	X	--
0020450051	CA028	CANOE CREEK	unknown	Ag, Pb	--	X	--
0020450059	--	KIWALIK RIVER HEADWATERS	unknown	--	--	X	--
0020440013	--	GOLDEN CIRCLE MINE	unknown	--	--	X	--
0020440162	BN076	INDEPENDENCE MINE	22c	Pb-Zn-Ag	P	--	--
0020450048	--	GRANITE MOUNTAIN	unknown	--	--	X	--

BOLD entries have documented resource information (detailed in text)
[1]Cox and Singer, 1986 and 1992
[2]AMIS and ARDF: P = Past, C = Current
[3]DGGS reports on Alaska's mineral industry (Bundtzen and others, 1986; Szumigala and others, 2004)
[4]RDI and others, 1995
[5]Nokleberg and others, 1987 and 1994

Identified Lode Resources:

- Billiken 1-110: 1 to 100 million tons unspecified resource at 45% Fe and 0.2% Cu (Newberry and Others, 1996)

Overview of Central and Western Seward Peninsula High LMP Areas: Over 70% of the Seward Peninsula is ascribed a Moderate to High LMP rating through this data compilation, with the largest percentage of High LMP lands in the KSP Planning Area also located on the Seward Peninsula. A significant number of AMIS sites (n=781) fall within the High LMP areas on the Seward Peninsula. Together these facts support an assertion placing the Seward Peninsula among the most mineralized areas of Alaska. For this reason, the following general overview of Seward Peninsula geology and mineral potential is provided prior to discussing each High LMP Area. The Seward and York Lithotectonic Terranes which were presented in Section II.C- Geologic Framework, form the basis for this overview.

Central Seward Peninsula – Seward Lithotectonic Terrane: The Seward Lithotectonic Terrane underlies the central portion of the Seward Peninsula and hosts the Kougarok, Teller, Nome, and Darby Mountains High LMP Areas. Although the Central Seward Peninsula is most significant as a placer producing region, there is also high potential for both base and precious metal lode mineralization.

The Seward Lithotectonic Terrane is dominated by metamorphic and sedimentary rocks, mainly SGS and lesser amounts of SLU Mineral Terrane assemblages. Within the Central Seward Peninsula, the combined SGS and SLU Mineral Terranes host numerous Placer Au (39a) occurrences, as well as Fe skarn (18d), Kuroko massive sulfide (28a), polymetallic replacement deposits (22c), and Kipushi (32c) deposit types. There is additional high potential for polymetallic precious and base metal vein deposits, including low-sulfide Au-quartz Vein (36a), hot spring-Hg (27a), simple Sb (27d), and Bedded Barite (31b). High potential for Sn lodes (15c) and stream placer Sn (39e) exists in the Port Clarence and Kougarok mining districts.

Sedimentary marine lithologies are represented on the Peninsula by SLS and SBS Mineral Terranes. These two Mineral Terranes underlie a very limited area in the Central Seward Peninsula, but host numerous documented mineral sites including polymetallic replacement (22c) and vein, hot-springs Hg-Au (27a), low sulfide Au-quartz veins (36a), and Au/Sn placer (39a and 39d, respectively) deposit models. The Big Hurrah, low sulfide Au-quartz veins (36a) deposit is hosted by these sedimentary units.

Four separate intrusive MTA units are mapped on the Seward Lithotectonic Terrane, represented by IGA, IGF, IGI, and an IGU Mineral Terranes. A total of 27 deposit model occurrences are associated with these intrusives in the Central Seward Peninsula area. The most prevalent intrusive association on the Central Seward Peninsula is the IGI Mineral Terrane. Few deposit model occurrences are mapped in the IGI, representing only base-metal replacement and graphite veins. The IGF Mineral Terrane hosts one polymetallic vein occurrence, and the IGA Mineral Terrane none. Numerous W commodities sites (as W skarns and in placers) are reported to occur in the IGU Mineral Terrane areas, in addition to Zn-Pb skarns.

The VSM Mineral Terrane is the second most prevalent MTA unit on the Seward Lithotectonic Terrane. VSM lithologies host a number deposit model types including, in decreasing order of abundance, placer Au (39a), low-sulfide Au-quartz vein (36a), polymetallic replacement (22c), simple Sb (27d), porphyry Mo low-F (21b), basaltic Cu (23), and Sn greisen (15c).
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Western Seward Peninsula - York Lithotectonic Terrane: The York Lithotectonic Terrane, which occupies the extreme portion of the western Seward Peninsula, comprises early- to middle-Paleozoic (and possibly older) limestone, argillaceous limestone, dolostone, and phyllite. Both the Shishmaref and Wales High LMP Areas are hosted by the York Lithotectonic Terrane. The York Terrane includes Late Cretaceous tin-bearing granites, differing from the Seward Terrane where two additional intrusive suites are mapped. The types of mineral deposits hosted by the York Terrane are consequently different than those associated with the Seward Terrane. What sets the York Lithotectonic Terrane apart from the rest of the Peninsula, and the entire KSP Planning Area as a whole, is the presence of significant Tin-producing mines such as the Lost River Deposit.

The IGF Mineral Terrane on the Western Seward Peninsula is associated with numerous tin-bearing granites and tin occurrences including Sn skarn, veins, and placers (14b, 15b, 39e, respectively). The mapped SLU Mineral Terrane outlines areas with added high potential for skarn, replacement, and placer deposits including: W skarn (14a), placer Au-PGE (39a), polymetallic veins (22c), low-sulfide Au-quartz vein (36a), polymetallic replacement (19a), simple Sb (27d), Fe skarn (18d), Zn-Pb skarn (18c).

Inmachuk River High LMP Area: The Inmachuk River Area is located on the Central Seward Peninsula, approximately 15 miles inland to the southwest of the Village of Deering and located on the southern shore of Kotzebue Sound. The area is underlain by Seward Lithotectonic Terrane rock associations. A total of 24 AMIS sites occur in the High LMP area, including 12 with an identified deposit model. The area is partially delineated by the KMDA Placer Commodities in Inmachuk River area, which represents mainly Au-PGE placers (39a) with reported Sn-W-Ag-Pb-Bi commodities. Other coincident data used in the High LMP determination include SGS and VSM Mineral Terranes, KMDA, KMDA Deposits, and DGGS Mineral Potential Ranks of 4 to 5.

Table 12a - Inmachuk Creek High LMP Area: Deposit Model Occurrences

Deposit model[1]	Commodities[1]	No. of individual occurrences in High LMP	Production		Deposits		
			Current[3]	Past[2]	KMDA[4]	Signi-ficant[5]	Resource estimate available
Placer Au-PGE (39a)	Au (Ag-W)	9	--	9	--	--	--
Polymetallic Replacement (19a)	Ag-Pb-Zn-Cu	3	--	--	2	--	--

Table 12b - Inmachuk Creek High LMP Area: Significant Deposits, KMDA Deposit Occurrences, and Lode

Site name	AMIS ID	ARDF	Deposit model[1]	Commo dities[2]	Producer[2]	Deposit Class	
						KMDA[4]	Signif-cant [5]
HANNUM	0020440001	BN056	unknown	Pb, Zn	--	X	--
OLD GLORY CREEK GOSSAN	0020440017	BN065	19a	Au	--	X	--
MAG-LOUU 1-9	0020440028	--	unknown	--	--	X	--
PINNELL RIVER GOSSAN	0020440030	BN064	19a	Au	--	X	--
ASSES EARS	0020440077	--	unknown	--	--	X	--
UNNAMED OCCURRENCE	0020440126	BN058	unknown	Ag, Pb	--	X	--

BOLD entries have documented resource information (detailed in text)
[1]Cox and Singer, 1986 and 1992
[2]AMIS and ARDF: P = Past, C = Current
[3]DGGS reports on Alaska's mineral industry (Bundtzen and others, 1986; Szumigala and others, 2004)
[4]RDI and others, 1995
[5]Nokleberg and others, 1987 and 1994

Identified Lode Resources: None

<u>Darby Mountains High LMP</u>: The Darby Mountains are situated in the southeast quarter of the Seward Peninsula and are hosted by Seward Lithotectonic Terrane lithologies. Forty-two AMIS sites are located in the area, 15 of which have available mineral deposit model information. The historic Omilak Mine is located in the western portion of this High LMP area and the LMP straddles Gold-producing portions of the Koyuk and Council Mining Districts. Within the LMP area, high potential exists for discovery of polymetallic vein (22c), porphyry Mo (21b), polymetallic replacement (19a), sandstone U (30c), and low-sulfide Au-quartz vein (36a) deposits. Although gold is the main placer commodity, by-product base metals, Sn, and Ag have also been produced, in addition to documented uranium minerals. The High LMP designation is based primarily on DGGS Mineral Potential Ranks 4 to 5, KMDA, favorable MTA units (SLS, IGI, and VOP), and finally, the existence of numerous active mining claims.

Table 13a - Darby Mountains High LMP Area: Deposit Model Occurrences

Deposit model[1]	Commodities[1]	No. of individual occurrences in High LMP	Production		Deposits		
			Current[3]	Past[2]	KMDA[4]	Significant[5]	Resource estimate available
Placer Au-PGE (39a)	Au (Ag-Sn-W-U)	2	--	--	--	--	--
Polymetallic veins (22c)	Au-Ag-Pb-Cu-Zn	8	--	1	4	--	?
Low-sulfide Au-quartz vein (36a)	Au (Ag)	1	--	--	1	--	?
Polymetallic replacement (19a)	Ag-Pb-Zn-Cu	1	--	--	--	--	--
Porphyry Mo, low-F (21b)	Mo-Pb-Zn	2	--	--	--	--	--
Sandstone U (30c)	U-Th	1	--	--	--	--	X
Stream placer Sn (39e)	Sn (W-Au-U)	1	--	--	--	--	--

Table 13b - Darby Mountains High LMP Area – Significant Deposits, KMDA Deposit Occurrences, and Lode Producers

Site name	AMIS ID	ARDF	Deposit model[1]	Commodities[2]	Producer[2]	Deposit class	
						KMDA[4]	Significant[5]
OMILAK	0020440002	BN097	22c	Ag, Pb, Sb	P	X	--
FOSTER	0020440004	BN098	22c	Ag, Au, Cu, Pb	--	X	--
OTTER CREEK LODE	0020440112	BN088	36a	Ag, Au	--	X	--
UNNAMED OCCURRENCE	0020440130	BN116	22c	Pb	--	X	--
OMILAK EAST	0020440148	BN138	22c	Ag, Cu, Pb, Zn	--	X	--
DARBY MOUNTAINS	0020530231	--	unknown	--	--	X	--
Death Valley	**0020440157**	**BN089**	**30c**	**U-Th**	**--**	**--**	**--**
NORTHERN DARBY MOUNTAINS	0020530235	SO043	unknown	REE, U	--	X	--

BOLD entries have documented resource information (detailed in text)
[1]Cox and Singer, 1986 and 1992
[2]AMIS and ARDF: P = Past, C = Current
[3]DGGS reports on Alaska's mineral industry (Bundtzen and others, 1986; Szumigala and others, 2004)
[4]RDI and others, 1995
[5]Nokleberg and others, 1987 and 1994

Identified Lode Resources:

- Death Valley: inferred minimum reserve of one million pounds at 0.27% U_3O_8 (Szumigala and others, 2004.

Nome High LMP Area: As the largest High LMP area in the KSP, the Nome Area covers a portion of the southern Seward Peninsula that includes the cities of Nome, Solomon, and Council. A total of 543 AMIS sites exist in the area as a whole, including 390 documented Deposit Model occurrences, and 19 past producers from the ARDF database. The High LMP outline is based on a coincidence of the following data sets: KMDA, KMDA Deposits, KMDA Placer Commodity areas, Significant Deposits, Mineral Terranes (IGI, IGU, SGS, SLS, and VSM), Placer Producing Areas of both the Nome and Council Mining Districts, mining claim activity, DGGS Mineral Potential Ranking 3-5, and Historic Production. The most significant of these rationale are discussed in greater detail below.

Two Significant Deposits, Rock Creek and Big Hurrah, are both low-sulfide Au-quartz vein (36a) model deposits located in the High LMP area. Nine KMDA Placer Commodity Au placer areas are located in the Nome High LMP. The KMDA Placer Commodity-listed placer areas are: Iron Creek, Ophir (Council) Area, Solomon Area, Nome Area, Daniels Creek (Bluff), and Rocky Mountain Creek. There is high potential for Au mineralization, particularly Placer Au-PGE (39a) and low-sulfide Au-quartz vein (36a) deposit moles, and to a lesser degree simple Sb (27d) and Hot-spring Hg (27a). There is additional potential for metals mineralization associated with polymetallic replacement (19a), Fe skarn (18d), W skarn (14a), polymetallic veins (22c), and Kuroko massive sulfide (28a) deposits. Graphite deposits have previously been exploited in the Nome High LMP Area and high potential for additional deposits exists.

Table 14a - Nome High LMP Area: Deposit Model Occurrences

Deposit model[1]	Commodities[1]	No. of individual occurrences in High LMP	Production		Deposits		
			Current[3]	Past[2]	KMDA[4]	Signi-ficant[5]	Resource estimate available
Placer Au-PGE (39a)	Au (Ag-Sn-W-U)	275	5 (?)	NA	9	NA	--
Low-sulfide Au-quartz vein (36a)	Au (Ag)	66	--	8	31	2	X
Graphite Veins (37g)	C	4	--	2	--	--	X
Polymetallic replacement (19a)	Ag-Pb-Zn-Cu	7	--	1	3	--	--
Simple Sb (27d)	Sb (Au)	9	--	1	3	--	--
Hot-spring Hg (27a)	Au-Ag-Cu-Sb-Hg	1	--	1	1	--	--
Fe skarn (18d)	Fe	9	--	--	6	--	X
W skarn (14a)	W (U)	5	--	--	3	--	--
Polymetallic veins (22c)	Au-Ag-Pb-Cu-Zn	1	--	--	1	--	--
Kuroko massive sulfide (28a)	Cu-Pb-Zn (Au-Ag)	3	--	--	--	--	--
Zn-Pb skarn (18c)	Ag-Pb-Zn (Cu)	9	--	--	--	--	--
Kipushi (32c)	Cu-Pb-Z-Ag	1	--	--	--	--	--

Table 14b - Nome High LMP Area: Significant Deposits, KMDA Deposit Occurrences, and Lode Producers

Site name	AMIS ID	ARDF	Deposit model[1]	Commodities[2]	Producer[2]	Deposit class	
						KMDA[4]	Significant [5]
ROCK CREEK			**36a**	**Au**	**Pending**	**X**	**X**
BIG HURRAH			**36a**	**Au**	**P**	**X**	**X**
IMURUK BASIN GRAPHITE	**20430030**	**TE103-05**	**37a**	**Graphite**	**P**	**--**	**--**
COBBLESTONE RIVER	0020430032	--	unknown	unknown	--	X	--
UNNAMED OCCURRENCE	0020440071	BN106	39a	Au	--	X	--
UNNAMED OCCURRENCE	0020440073	--	unknown	unknown	--	X	--
AMERICAN	**0020520001**	**NM014**	**unknown**	**Fe**	**--**	**X**	**--**
TUB MOUNTAIN	**0020520002**	**NM018**	**18d**	**Fe**	**--**	**X**	**--**
MONARCH	**0020520003**	**NM017**	**18d**	**Fe**	**--**	**X**	**--**
MOGUL	**0020520004**	**NM020**	**18d**	**Fe**	**--**	**X**	**--**
CUB BEAR	**0020520007**	**NM133**	**18d**	**Fe, Mn**	**--**	**X**	**--**
QUARRY	0020520009	NM135	19a	Ag, Ba, F, Pb,	--	X	--
GALENA	**0020520005**	**NM130**	**18d**	**Fe, Pb, Zn**	**--**	**X**	**--**
NOME BEACHES	0020520017	NM252	39a	Au-Ag	P	--	--
STEINER	0020520026	NM163	36a	Au	--	X	--
CHRISTOPHOSEN	0020520027	NM141	28a	Zn	--	X	--
CHARLEY	0020520029	NM048	36a	Bi	--	X	--
CABIN CREEK	0020520030	NM044	14a	W	--	X	--
UNNAMED OCCURRENCE	0020520031	--	unknown	unknown	--	X	--
WINDY CREEK	0020520032	--	unknown	unknown	--	X	--
UNNAMED OCCURRENCE	0020520033	NM035	14a	W	--	X	--
UNNAMED OCCURRENCE	0020520034	NM027	14a	W	--	X	--
UNNAMED OCCURRENCE	0020520043	NM056	unknown	Cu (?)	--	X	--
COPPER MOUNTAIN	0020520044	NM054	19a	Cu, Pb	--	X	--
NOME-TELLER ROAD	0020520063	--	unknown	unknown	--	X	--
WATERFALL CREEK	0020520072	NM143	36a	Sb	P	X	--
LAST CHANCE LODE	0020520074	NM142	36a	Au, Pb, Sb	--	X	--
TWIN MOUNTAIN CREEK	0020520075	NM189	36a	Au	--	X	--
OSBORN CREEK	0020520089	NM278	36a	Au, Cu	--	X	--
PIONEER	0020520091	NM198	36a	Ag, Au	--	X	--
SEATTLE CREEK	0020520092	NM200	39a	W	--	X	--
CALIFORNIA	0020520096	NM062	36a	Au, Sb, Ag, Mo	P	X	--
HED & STRAND	0020520101	NM070	27d	Au, Sb	P	X	--
NORTH FORK	0020520102	--	unknown	unknown	--	X	--
MANILA RIDGE	0020520113	--	unknown	unknown	--	X	--
SLISCOVICH	0020520114	NM086	36a	Au, Sb	P	X	--
CAPE NOME	0020520124	NM299	unknown		--	X	--
BONITA	0020520128	NM291	27d	Au, Sb	--	X	--
HAYMAKER	0020520129	NM247	39a	Au	--	X	--
BREEN WEST	0020520131	NM087	36a	Au, Sb	P	X	--
MCDUFFEE	0020520132	NM092	36a	Sb, Au	P	--	--
STEEP CREEK	0020520132	NM092	36a	Au	--	X	--

Table 14b -- continued

Site name	AMIS ID	ARDF	Deposit model[1]	Commodities[2]	Producer[2]	Deposit class	
						KMDA[4]	Significant[5]
NEWTON GULCH	0020520139	NM263	36a	Au	--	X	--
BOULDER CREEK	0020520152	NM165	36a	As, Sb	--	X	--
REX	0020520158	NM293	unknown	Au (?)	--	X	--
GOLD HILL	0020520160	NM197	36a	Ag, Au	--	X	--
ALBION CREEK	0020520164	NM211	36a	Au	--	X	--
SOPHIE GULCH	0020520165	NM208	36a	Au, W	--	X	--
NUGENT	0020520166	NM248	39a	Au	--	X	--
DEXTER	0020520170	--	unknown	unknown	--	X	--
GLACIER CREEK	0020520174	NM221	36a	Au, W	--	X	--
KING MOUNTAIN	0020520175	--	unknown	unknown	--	X	--
GOLD BUG	0020520178	NM228	36a	Au	--	X	--
MOUNTAIN CREEK	0020520180	NM265	39a	Au	--	X	--
LAMOREAUX	0020520181	NM230	36a	Pb, Sb	--	X	--
SLEDGE LODE	0020520183	NM170	36a	Au (?)	--	X	--
ROCK CREEK LODE	0020520187	NM214	36a	Au	P	X	X
KERN	0020520190	NM237	36a	Au	--	X	--
KING MOUNTAIN	0020520191	NM244	18d	Au	--	X	--
ROCKY MOUNTAIN	0020520197	NM080	unknown	Sb	--	X	--
HOLMASON & HELDE	0020520198	NM290	unknown	Cu	--	X	--
BOULDER	0020520199	NM168	39a	Au	--	X	--
GOODLUCK GULCH	0020520200	NM202	36a	Au	--	X	--
PROSPECT	0020520201	NM204	22c	Au, Bi (?), Cu	--	X	--
NEW ERA	0020520202	NM223	36a	Au	--	X	--
JORGENSEN	0020520203	NM229	36a	Au	--	X	--
COOPER GULCH NO. 2	0020520212	--	unknown	unknown	--	X	--
WIDSTEDT	0020520316	NM226	36a	Sb, Au	P	--	--
HOMESTAKE	0020530003	SO135	39a	Au	--	X	--
CONSOLIDATED GROUP	0020530012	--	unknown	unknown	--	X	--
HILL LODE	0020530019	--	unknown	unknown	--	X	--
BUNKER HILL LODE	0020530032	SO008	36a	Au, Cu	--	X	--
BIG HURRAH MINE	0020530057	SO023	36a	Au, Ag, W	P	X	X
J C	0020530059	--	unknown	unknown	--	X	--
TRILBY MOUNTAIN	0020530060	SO020	36a	Au	--	X	--
UNCLE SAM MOUNTAIN	0020530061	--	unknown	unknown	--	X	--
LAST CHANCE	0020530062	SO019	27d	Sb, Cu, Au	P	X	--
LINDA VISTA CREEK	0020530063	SO144	36a	Au	--	X	--
FLYNN	0020530065	SO108	39a	Au	--	X	--
ALDER PROSPECT	0020530073	SO030	39a	Au	--	X	--
LEFT FORK IRON	0020530090	SO112	unknown	Cu	--	X	--
WHEELER SHERRETTE	0020530092	SO139	unknown	Ag, Au, Cu	P	X	--
IRON CREEK QUARTZ VEIN	0020530112	SO131	unknown	Cu	--	X	--
WHEELER	0020530113	SO132	unknown	Cu, Au, Pb	P	X	--
WHEELER (IRON CREEK)	0020530114	SO117	unknown	Cu	P	X	--

Table 14b -- continued

Site name	AMIS ID	ARDF	Deposit model[1]	Commodities[2]	Producer[2]	Deposit class	
						KMDA[4]	Significant[5]
IC 248	0020530115	SO130	unknown	Cu, Pb	--	X	--
SHERRETTE-IRON DIVIDE	0020530116	SO124	unknown	Cu	--	X	--
OSMUN LODE	0020530121	SO120	unknown	Au	--	X	--
LAST CHANCE COPPER	0020530127	--	unknown	unknown	--	X	--
MOONLIGHT DIVIDE	0020530146	SO100	unknown	Cu	--	X	--
SPRUCE	0020530171	SO077	unknown	Au?	--	X	--
POST	0020530187	SO059	36a	Au	--	X	--
CAMP	0020530188	SO173	36a	Au	--	X	--
BROOKINS	0020530191	SO055	27d	Sb	--	X	--
MOUNT DIXON	0020530212	SO068	unknown	Cu	--	X	--
FISH	0020530219	SO046	19a	Ag, Hg, Pb	P	X	--

BOLD entries have documented resource information (detailed in text)
[1]Cox and Singer, 1986 and 1992
[2]AMIS and ARDF: P = Past, C = Current
[3]DGGS reports on Alaska's mineral industry (Bundtzen and others, 1986; Szumigala and others, 2004)
[4]RDI and others, 1995
[5]Nokleberg and others, 1987 and 1994

Identified Lode Resources:

- Rock Creek: published gold resource estimates at Rock Creek 11.79 million tons at 0.059 ounces per ton, exceeding 0.5 million ounces contained gold (Szumigala and others, 2004);
- Big Hurrah: proven, inferred, and indicated reserves totaling over 100 thousands tons grading 0.61 oz/t Au, 0.55 oz/t Ag, and credits of tungsten (Szumigala and others, 2004);
- American: estimated resource of 40,000 long tons that contain 20 to 40 percent iron, with minor manganese (USGS, 2004b);
- Tub Mountain: estimated resource of 8,000 long tons containing 10 to 20 percent iron (USGS, 2004b);
- Monarch: estimated resource of 50,000 long tons of 30 to 45 percent iron and about 500,000 tons of 15 to 25 percent iron, Most of the iron ore has only 1 percent or less of manganese, and 1.37% manganese oxide (USGS, 2004b);
- Mogul: estimated resource of 5,000 long tons of rock with 10 to 20 percent iron (USGS, 2004b);
- Galena: estimated 100 long tons containing 30 to 45 percent iron and 10,000 long tons containing 10 to 20 percent iron (USGS, 2004b);
- Cub Bear: estimated resource of 100 tons of 30 to 45 percent iron and 10,000 tons with 10 to 20 percent iron (USGS, 2004b);
- Imuruk Basin (Christophosen Creek/Ruby Creek/Graphite Creek): estimated resource of 65,000 tons averaging about 60% graphite, with more than a total of 10 million tons of 10% or more graphite (USGS, 2004b).

Kougarok High LMP Area: Located just north of the village of Mary's Igloo in the Central Seward Peninsula, the Kougarok area covers placer producing portions of both the Port Clarence and Kougarok Mining Districts. The area is underlain by the Seward Lithotectonic Terrane. There are a total of 90 AMIS sites in the area, 57 have available Deposit Model information. The main commodities sought in the area include copper, tin, and gold with sites concentrated mainly in the Kougarok Mining District portion of the High LMP. The area is chiefly delineated based on Kougarok District KMDA Placer Commodities areas, with a total of six KMDA-listed placer streams, and the abundance (50 total) of placer Au (39a) deposit model occurrences. Five lode prospects also exist in the High LMP Area, including the Ward Copper Company Mine in the Teller Quadrangle that produced a small amount of copper ore, mainly azurite and possibly bornite, with minor chalcopyrite and malachite. Additional information supporting this delineation as a High LMP area include DGGS Mineral Potential Ranks of mainly 4 to 5, KMDA, KMDA Deposits, active mining claims, Mineral Terranes (SGS, SLU, IGI, IGU, and VSM).

Table 15a - Kougarok High LMP Area: Deposit Model Occurrences

Deposit model[1]	Commodities[1]	No. of individual occurrences in High LMP	Production		Deposits		
			Current[3]	Past[2]	KMDA[4]	Signi-ficant[5]	Resource estimate available
Placer Au-PGE (39a)	Au (Ag-Sn-W-U)	50	--	NA	2	--	--
Low-sulfide Au-quartz vein (36a)	Au (Ag)	2	--	--	1	--	--
Sn skarn (14b)	Sn (U-Be-F)	1	--	--	1	--	--
Sn greisen (15c)	Sn (F-Be)	1	--	--	1	--	--
Porphyry Mo, low-F (21b)	Mo-Pb-Zn	1	--	--	--	--	--

Table 15b - Kougarok High LMP Area: Significant Deposits, KMDA Deposit Occurrences, and Lode Producers

Site name	AMIS ID	ARDF	Deposit model[1]	Commodities[2]	Producer[2]	Deposit class	
						KMDA[4]	Significant[5]
TIN CUP	0020430034	TE073	14b	Sn	--	X	--
WORCESTER	0020430040	TE075	Unknown	Cu	--	X	--
UNNAMED OCCURRENCE	0020430041	TE076	39a	Au	--	X	--
KOUGAROK PROJECT	0020430042	TE072	15c	Sn	--	X	--
WARD COPPER CO.	0020430043	TE071	unknown	Cu	P	X	--
HUMBOLT	0020440007	--	unknown	unknown	--	X	--
SERPENTINE HOT SPRINGS	0020440011	--	unknown	unknown	--	X	--
MIDNIGHT MOUNTAIN	0020440018	BN047	36a	Au	--	X	--
KOUGAROK RIVER LODE	0020440032	BN034	unknown	Cu	--	X	--
WONDER GULCH LODE	0020440040	BN005	unknown	Au	--	X	--
DAHL	0020440128	BN007	unknown	Au	--	X	--
UNNAMED OCCURRENCE	0020440153	BN029	unknown	Cu	--	X	--

BOLD entries have documented resource information (detailed in text)
[1]Cox and Singer, 1986 and 1992
[2]AMIS and ARDF: P = Past, C = Current
[3]DGGS reports on Alaska's mineral industry (Bundtzen and others, 1986; Szumigala and others, 2004)
[4]RDI and others, 1995
[5]Nokleberg and others, 1987 and 1994

Identified Lode Resources: None

Teller High LMP Area: The Teller Area High LMP outline extends from near Teller on the western edge of the Seward Lithotectonic Terrane, south to and including the far-northwest portion of the Nome Mining District placer producing area. This area has highest potential for Au placer (39a) and low-sulfide Au veins (36a) and is drawn mainly upon the coincidence of KMDA, DGGS Mineral Potential Ranking (Rank 4), and MTA (VSM, IGI, SGS) mapping. This High LMP area includes placer producing portions of the Nome, Teller, and Port Clarence Mining Districts and two unnamed KMDA Placer Commodity Areas. A total of 26 AMIS sites are located in the Teller High LMP area, of which 22 have deposit model information. A small mining claim block is staked in the southern portion of the High LMP.

Table 16a - Teller High LMP Area: Deposit Model Occurrences

Deposit model[1]	Commodities[1]	No. of individual occurrences in High LMP	Production		Deposits		
			Current[3]	Past[2]	KMDA[4]	Signi-ficant[5]	Resource estimate available
Placer Au-PGE (39a)	Au (Ag-Sn-W-U)	20	--	NA	--	--	--
Low-sulfide Au-quartz vein (36a)	Au (Ag)	1	--	--	1	--	--
Porphyry Mo, low-F (21b)	Mo-Pb-Zn	1	--	--	--	--	--

Table 16b - Teller High LMP Area: Significant Deposits, KMDA Deposit Occurrences, and Lode Producers

AMIS ID	ARDF	Site name	Deposit model[1]	Commodities[2]	Producer[2]	Deposit class	
						KMDA[4]	Significa nt [5]
0020430027	TE095	Alder Creek Lode	36a	Au	--	X	--

BOLD entries have documented resource information (detailed in text)
[1]Cox and Singer, 1986 and 1992
[2]AMIS and ARDF; P = Past, C = Current
[3]DGGS reports on Alaska's mineral industry (Bundtzen and others, 1986; Szumigala and others, 2004)
[4]RDI and others, 1995
[5]Nokleberg and others, 1987 and 1994

Identified Lode Resources: None

Wales High LMP Area: The Wales High LMP area occupies a portion of the York Lithotectonic Terrane on the extreme western tip of the Seward Peninsula, in the Cape Prince of Wales area. The main economic mineral extracted in the Wales area is tin, specifically from numerous documented Sn placer sites, and from the Lost River and Cape Mountain Lode sites. Fifty-five deposit model occurrences represent the 53 AMIS sites that are documented in the Wales High LMP Area (at least one of the AMIS sites listed is associated with multiple ARDF deposits). There is high potential for Sn veins (15b) and Sn skarn (14b) deposits, and somewhat lesser potential for polymetallic replacement (19a) bodies, Placer Au-PGE (39a), Sn greisen (15c), and Fe skarn (18d). Data additionally supporting this area's High LMP designation includes DGGS Mineral Potential Rank 3-5, MTA mapping (SLU and IGF units), and KMDA.

Table 17a - Wales Area High LMP Area: Deposit Model Occurrences

Deposit model[1]	Commodities[1]	No. of individual occurrences in High LMP	Production		Deposits		
			Current[3]	Past[2]	KMDA[4]	Signi-ficant[5]	Resource estimate available
Stream placer Sn (39e)	Sn (W-Au-U)	26	--	NA	--	--	--
Placer Au-PGE (39a)	Au (Ag-Sn-W-U)	5	--	NA	--	--	--
Sn veins (15b)	Sn (Be-F-Ag-Zn)	11	--	2	2	--	X
Sn skarn (14b)	Sn (Be-F)	7	--	--	2	--	--
Sn greisen (15c)	Sn (F-Be)	3	--	--	--	--	--
Polymetallic replacement (19a)	Ag-Pb-Zn-Cu	2	--	--	--	--	--
Fe skarn (18d)	Fe	1	--	--	--	--	--

Table 17b - Wales High LMP Area: Significant Deposits, KMDA Deposit Occurrences, and Lode Producers

Site name	AMIS ID	ARDF	Deposit model[1]	Commodities[2]	Producer[2]	Deposit class	
						KMDA[4]	Significant [5]
CAPE MOUNTAIN LODE	0020430001	TE009	15b	Sn	P	X	--
LOST RIVER	**0020430003**	**TE048-TE051**	**14b**	**Fluorite, Sn**	**P**	**X**	**--**
BLACK MOUNTAIN LODE	0020430016	TE088	14b	Sn	--	X	--
POTATO MOUNTAIN LODE	0020430047	TE024	15b	Sn	--	X	--

BOLD entries have documented resource information (detailed in text)
[1]Cox and Singer, 1986 and 1992
[2]AMIS and ARDF: P = Past, C = Current
[3]DGGS reports on Alaska's mineral industry (Bundtzen and others, 1986; Szumigala and others, 2004)
[4]RDI and others, 1995
[5]Nokleberg and others, 1987 and 1994

Wales Area Identified Lode Resources:

- Lost River Deposits (Hudson and Reed, 1997; ARDF):

A- Cassiterite dike exogreisen: calculated reserves for two types of ore, with Type 1) 200,500 tons grading 1.3% tin and 0.125% WO3, and Type 2) 105,000 tons grading 0.76% tin and 0.6% WO3;

B- Lost River-skarn: An open pit resource of 23, 527,000 tons grading 16.43% fluorite, 0.26% tin, and 0.04% WO3, with an additional underground minable 1,275,000 tons of 11.66% fluorite, 0.15% tin, and 0.01% WO3;

C- Lost River-Ida Bell dike exogreisen: resource of about 840,000 tons that averages 0.26% tin and less than 0.1% WO3, including 60,000 tons of 1.06% tin;

D- Camp Creek (tributary to Lost River) resource calculation of 2,116,000 tons of 30.6% fluorite in an open-pit configuration and 1,695,000 tons of 30.0 % fluorite that would require underground mining determined

<u>Shishmaref High LMP Areas</u>: Two, relatively small, High LMP areas are located approximately 30 miles south southwest of the village of Shishmaref on the northwestern Seward Peninsula. The areas are underlain by York Lithologic Terrane rock associations. Together the two High LMP outlines comprise 11 AMIS sites, all of which are represented by deposit model types. Tin resources have the highest potential for additional discovery, in conjunction with Sn placer and vein (39e and 15b) deposits. There is also potential for placer Au (39a) and low-sulfide Au-quartz veins (36a). The High LMP Area is also coincident with DGGS Mineral Potential Ranks 4-5 and KMDA areas.

Table 18a - Shishmaref High LMP Area: Deposit Model Occurrences

Deposit model[1]	Commodities[1]	No. of individual occurrences in High LMP	Production		Deposits		
			Current[3]	Past[2]	KMDA[4]	Signi-ficant[5]	Resource estimate available
Stream placer Sn (39e)	Sn (W-Au-U)	8	--	NA	--	--	--
Placer Au-PGE (39a)	Au (Ag-Sn-W-U)	1	--	NA	--	--	--
Sn veins (15b)	Sn (Be-F-Ag-Zn)	1	--	--	1	--	--
Low-sulfide Au-quartz vein (36a)	Au (Ag)	1	--	--	--	--	?

Table 18b - Shishmaref High LMP Area, Significant Deposits, KMDA Deposit Occurrences, and Lode Producers

Site name	AMIS ID	ARDF	Deposit model[1]	Commodities[2]	Producer[2]	Deposit class	
						KMDA[4]	Significant [5]
EAR MOUNTAIN LODES	0020430036	TE060	15b	Sn	--	X	--

BOLD entries have documented resource information (detailed in text)
[1]Cox and Singer, 1986 and 1992
[2]AMIS and ARDF: P = Past, C = Current
[3]DGGS reports on Alaska's mineral industry (Bundtzen and others, 1986; Szumigala and others, 2004)
[4]RDI and others, 1995
[5]Nokleberg and others, 1987 and 1994

Identified Lode Resources: None

Red Dog High LMP Area: This area includes the Red Dog Mine and well-documented resources of the undeveloped Lik and Su ore bodies. The extents of this area are based on the coincidence of the SBS Mineral Terrane, KMDA outline, Significant Deposits, as well as mining claims covering documented occurrences. In addition to the Red Dog, SEDEX (31a) deposit type analogs, there is high potential for added discovery of Bedded Barite (31b) occurrences. The High LMP area is corroborated by DGGS High Mineral Potential Ranking of 4 and 5. The Red Dog High LMP Area contains 16 AMIS sites, 10 with documented deposit model occurrences. Since geologic mapping in this area is generally quite detailed, the level of confidence assessment is based mainly on the density of mining claims and documented occurrences. This area is generally well documented, and has a generally high level of certainty (Confidence Level A). High LMP areas mapped at Level B Confidence have High LMP, but generally few, if any, documented occurrences.

Table 19a - Red Dog High LMP Area: Deposit Model Occurrences

Deposit model[1]	Commodities[1]	No. of individual occurrences in High LMP	Production		Deposits		
			Current[3]	Past[2]	KMDA[4]	Signi-ficant[5]	Resource estimate available
SEDEX (31a)	Pb-Zn-(Ag)	8	1	1	3	3	X
Bedded barite (31b)	Ba	2	--	--	--	--	--

Table 19b - Red Dog High LMP Area: Significant Deposits, KMDA Deposit Occurrences, and Lode Producers

Site name	ARDF	AMIS ID	Deposit model[1]	Commodities[2]	Producer[2]	Deposit class	
						KMDA[4]	Significant[5]
LIK	**DL005**	**0020180001**	**31a**	**Pb-Zn-(Ag)**	**--**	**X**	**X**
RED DOG	**DL001**	**0020180002**	**31a**	**Pb-Zn-(Ag)**	**P/C**	**X**	**X**
SU	**DL005**	**0020180004**	**31a**	**Pb-Zn-(Ag)**	**--**	**X**	**X**

BOLD entries have documented resource information (detailed in text)
[1]Cox and Singer, 1986 and 1992
[2]AMIS and ARDF: P = Past, C = Current
[3]DGGS reports on Alaska's mineral industry (Bundtzen and others, 1986; Szumigala and others, 2004)
[4]RDI and others, 1995
[5]Nokleberg and others, 1987 and 1994
Note: Su orebody resources are reported as part of Lik orebody resources.

Resources:

- Lik-Su deposit: proven reserve estimates exist for the LIK-Su ore body, detailing 21.8 million tons grading 9% Zn, 3.1% Pb, and 1.4 oz/t Ag (Schmidt, 1997a);
- Red Dog deposit (main orebody): proven reserve of 46.2 million tons grading 19.2% Zn, 5.2% Pb, and 2.92 oz/t Ag (Szumigala and others, 2004).

2. Areas with Medium Potential Rating

The following section presents an overview of those KSP Planning Area portions which are rated to have Medium LMP. Particular attention is paid to Confidence Level A areas with Medium LMP. No deposit specific tabulations are made for Medium LMP areas, partially because over 70% of the documented mineral sites in the KSP occur in the High LMP areas documented in the previous section. Generally, Medium LMP area mineral potential involves those deposit types associated with any adjacent High LMP - these adjacent High LMP areas should be referenced for a complete listing of deposit model occurrences likely applicable to Medium LMP areas. LMP Mapping outlines are presented on map Figures 6a and 6b (MODPR Locatable Mineral Potential); Figure 6a covers the larger central and southern portion of the KSP, while the reader should reference Figure 6b for northern areas form Noatak and Kivalina to Cape Lisburne.

Central and Southern Planning Area:

(Refer to Figure 6a for site locations)

Lower Kobuk River: This area is located to the south and east of the Omar-Kiana High LMP area and abuts the north-south oriented KSP Planning Area boundary in the lower Kobuk River area. The VSF terrane unit underlies most of the Medium LMP area, and is favorable for the following deposits: sediment-hosted Pb-Zn (Ag-Ba) deposits (31a and 32a), volcanogenic massive sulfide (28a), polymetallic veins (22c), placer Au (39a), and possibly low-sulfide Au-quartz veins (36a). The area is further delineated by DGGS Medium-High Mineral Potential Rank 3 to 4, and by a few poorly described mineral occurrences.

The Kiana Prospect occurrence is located just northwest of the Village of Kiana within the Lower Kobuk River Area. The prospect represents a strategic mineral occurrence of the Rare Earth Element (REE) columbium. The small area surrounding the is outlined as a Confidence Level B separate from other areas, as the only supporting information available is the single AMIS and its inclusion in the KMDA and deposits. This site represents one of the two REE occurrences mapped in the KSP Planning Area.

Ambler*:* Local areas in the Ambler region are outlined as Medium LMP based on moderate-low DGGS Mineral Potential Ranks 2-3 where underlain by mineral terrane units. Few occurrences are documented in this Medium LMP, although potential exists for deposits similar to those in the adjacent High LMP areas: Kuroko-type Cu-Pb-Zn-(Ag-Au) massive sulfide (28a), Kipushi Cu-Pb-Zn (32c), serpentine-hosted asbestos (8a), placer Au-PGE (39a), polymetallic veins (22c), and basaltic Cu (23). The felsic granitics (MTA unit IGF) mapped in the Brooks Range to the north also carries moderate potential for the occurrence of tin, tungsten, molybdenum, and/or uranium minerals.

Koyukuk: A sizeable portion of the east and southeastern KSP Planning Area is underlain by bimodal volcanics, mainly mafic basalt and minor rhyolite flows, and related volcaniclastic sediments representing Mineral Terrane VSM that occurs on the Koyukuk Lithotectonic Terrane. The area described here as the Koyukuk Medium LMP includes the Selawik Hills and the far-northern portion of the Nulato Hills and is situated as an east-west belt spanning the KSP Planning Area from near Buckland and Kotzebue Sound on the west, to the far-eastern planning boundary. The Koyukuk Medium LMP has potential for hosting polymetallic veins (22c), polymetallic Ag-Pb-Zn-Cu replacement (19a), and Sandstone U (30c). Small portions of the area are underlain by the VFU, IGF, and IGA Mineral Terrane units. The basic outline of the Medium LMP area is delineated as Level C confidence by following the outline of the mapped Mineral Terranes (mainly VSM). Certainty was improved to Level B in those areas also displaying a moderate DGGS Medium Mineral Potential Ranking (Ranking 3 to 4). A Confidence Level A was assigned to limited areas demonstrating an increased density of documented mineral occurrences, and/or active claims.

The most significant Koyukuk Medium LMP-Level A areas are south of the village of Selawik in the Selawik Hills. Eight townships which host numerous mineral occurrences are also evaluated by DGGS as Medium-High Mineral Potential Rank 4. Polymetallic veins (22c), basaltic copper (23), and sandstone U (30c) deposits from the KMDA data are underlain by a portion of the 50 mile-long IGA Mineral Terrane unit mapped here along the Selawik Hills. Many of Level A areas in the Koyukuk Medium LMP are drawn to reflect the occurrence of mineral sites associated with IGA units. Many of these sites are documented

U-REE-Th occurrences in alkaline granite, and may be best associated with the volcanogenic U (25f) model although not documented as such in either the AMIS or ARDF databases.

Few claims are located in the Koyukuk Medium LMP, and none are associated with documented occurrences. A group of 12 mining claims located on the southern KSP Planning Area boarder, about 60 miles due south of Ambler Village, forms the heart of a small Level A outline underlain by the VFU Mineral Terrane.

Shaktoolik: The Shaktoolik area has potential for the additional discovery of placer Au (39a) and multi-metal vein mineralization including hot-spring Hg (8b), simple Sb (Au-W) (27d), and polymetallic vein (22c). The area is based on DGGS Mineral Potential Ranks of 2 to 3 overlap with Mineral Terrane SGS. No documented occurrences are found in this medium potential area.

Three townships located 30 miles north of Shaktoolik have been identified by DGGS Medium-High Mineral Potential Ranking (Rank 4) for placer Au (29a) and sandstone U (30c), and possibly volcanogenic U (25f).

Seward Peninsula - York and Seward Lithotectonic Terranes: Over 70% of the Seward Peninsula is ascribed a Moderate to High LMP rating through this data compilation. The majority of these rated lands have High LMP for certain deposit types, although subordinate Medium LMP areas generally have potential for deposit models similar to those on adjacent High LMP areas. By way of comparison, a total of 781 AMIS sites fall within the High LMP area of the Seward Peninsula, while only 81 fall within the Medium LMP rating area. Medium LMP mapping on the Peninsula covers nearly all DGGS Mineral Potential Rank 3 lands.

Although most of the Medium LMP areas are designated as Confidence Level B and C, an exception is the area surrounding the ARDF past producing Paragon Mountain Mine (mica). This Level of Confidence A area is central to the Seward Peninsula and located in the northern part of the Council Mining District, north of the Village of Council. In this Level A area, there is a moderate potential for the existence of polymetallic veins (22c) and Pb-Zn skarn (18c) deposits.

The small Level A – Medium LMP areas located just north of Elim on the Peninsulas south coast reflect the overlap of the IGA and IGF Mineral Terranes with DGGS Mineral Potential Ranks of 3-4. Relatively few AMIS occur in the area, only one has a deposit model assigned (polymetallic replacement, 19a).

Across the Seward Peninsula as a whole, there is potential for numerous deposit types and commodities listed in the specific High LMP area text discussions above. The only deposit types with a low occurrence potential on the Seward Peninsula are those related to the mafic-ultramafic and ophiolitic, or IMA-IUM and VOP, Mineral Terranes respectively.

Northern Planning Area:

(Refer to Figure 6b for site locations)

Red Dog-Kivalina: Medium LMP areas are drawn across a wide swath of the northern part of the KSP Planning Area from Kivalina on the coast, inland through the Red Dog Area, and including the De Long Mountains. These areas generally represent favorable geologic conditions for the potential existence of Red Dog-area deposits, such as SEDEX (31a), Bedded barite (31b), and Southeast Missouri Pb-Zn (32C) that are associated with the SBS mineral terrane.

Two regions of the Medium LMP area are described as Confidence Level A. The first is centered on the documented occurrence at Iyikrok Mountain in the VOP terrane; no mining claims exist in the area. This area has medium potential for the occurrence of mafic-ultramafic associated deposits including Podiform chromite (8b), Placer Au-PGE (39A), and Serpentine-hosted asbestos (8d). A portion of the area west of Red Dog at Iyikrok Mountain is underlain by the ophiolitic terrane (VOP) unit. The A second region of Medium LMP, Confidence Level A, lies north and west of the Red Dog High LMP area, and contains large discontinuous blocks of mining claims, but relatively few locatable mineral occurrences.

Cape Lisburne South: The arc-shaped Medium LMP area extends south from Cape Lisburne. Mississippian limestone, shale, and subordinate chert mapped in the area (Mineral Terrane unit SBS) has moderate potential of hosting Bedded Barite (31b). No current locatable mineral sites exist in the area, resulting in Level of Confidence B.

West of Noatak: An area of Medium LMP is mapped 10 miles west of the village of Noatak. This area is based solely on the DGGS High Mineral Potential Ranks 5 in one township. The area has potential for Red Dog area analog, including SEDEX (31a), Bedded barite (31b), and southeast Missouri Pb-Zn (32c) deposits.

Southeast of Noatak: An area of Medium LMP is mapped just southeast of the Village of Noatak. The LMP area stretches from the Noatak River on the southwest to the Planning Area boundary in the northeast. Coincident data contributing to the Medium LMP rating include VOP Mineral Terrane unit mapping, moderate DGGS Mineral Potential Ranking of 2-4, and KMDA. The area has potential for hosting Cu-Ni, Cr, or PGE occurrences. The Sours Prospect at Asik Mountain is at the core of the Confidence Level A outline that is mainly defined by the KMDA. No active claims currently exist in the area.

North of the Omar and Frost Deposits: An area of Medium LMP is mapped along the planning boundary north of the Omar and Frost Deposits. The area is dominated by DGGS Mineral Potential Rank 3 and is underlain by lithologies of the SLS Mineral Terrane. Only a few poorly described mineral occurrences are mapped in the area. Medium potential exists in the Medium LMP area for the discovery of sedimentary-hosted Cu-Pb-Zn deposits similar to those that occur in the High LMP area that includes Omar and Frost. Assessed at Confidence Level B, these deposits include: Kipushi Cu-Pb-Zn (32c), southeast Missouri Pb-Zn (32a), and bedded barite (31b) and to a lesser extent, placer Au-PGE (39a), Au-Ag-Pb-Cu-Zn polymetallic veins (22c), and SEDEX (31a).

VI. RECOMMENDATIONS

The main objective of this report is to delineate areas with high potential for the discovery of locatable and salable minerals. Mineral potential for the resulting areas is based entirely on the data sets described in the body of this report. This report recommends that deposit types in those areas described by Section V (Mineral Occurrence and Development Potential) as having High Locatable Mineral Potential be used to formulate the Reasonably Foreseeable Development Scenario Report, which predicts future development over the 10- to 15-year lifespan of the completed RMP.

VII. STATEMENT OF QUALIFICATION

Report text and graphics were prepared by Robert M. Ellefson, Geologist for BLM's Division of Energy and Minerals, Branch of Solid Minerals, headquartered at the Alaska State Office in Anchorage.

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Drafts of this document were reviewed by Solid Minerals Branch Chief Earle Williams, former Minerals Branch Chief Don Baggs, and by Mark Meyer, Planning Liaison for Solid Minerals, all located at the Alaska State Office. Additional review was provided by BLM geologists Jim Deininger (Northern Field Office) and Robert Brumbaugh (Anchorage Field Office).

Locatable Mineral Potential Areas in figures were digitized by Jerry Kouzes, Cartographic Technician with the Branch of Solid Minerals at the Alaska State Office.

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APPENDIX A

Kobuk-Seward Peninsula Planning Area,

Documented Mineral Deposit Models
[Cox and Singer (1986) and Cox (1992)]

APPENDIX B

Kobuk-Seward Peninsula Planning Area,

Assistance Agreement Results,
State of Alaska, Division of Geological and Geophysical Surveys,

Geologic Mapping Coverages

APPENDIX C

Kobuk-Seward Peninsula Planning Area,

Assistance Agreement Results,
State of Alaska, Division of Geological and Geophysical Surveys,

Geologic Reference List