Prepared in cooperation with the Alaska Division of Geological and Geophysical Surveys

Mineral Resource Assessment of the Iditarod Quadrangle, West-Central Alaska

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Pamphlet to accompany
Miscellaneous Field Studies Map MF–2219–B

The Idaho claim, a classic residual gold placer, lies near the top of Chicken Mountain.

2005

U.S. Department of the Interior
U.S. Geological Survey

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ABSTRACT

By Congressional mandate, the U.S. Geological Survey is charged with assessing the Nation's energy and mineral resources. This report provides information on the mineral resource potential of one of the least studied areas of the Nation and thus significantly improves the Bureau's ability to fulfill the mandate. The Iditarod quadrangle contains Alaska's third largest placer gold mining district and the recently identified Donlin deposit, the largest known lode gold deposit in Alaska. Our study provides a modern geological and metallogenic framework for the area. This assessment synthesizes new and previously existing geological, geochemical, and geophysical data to identify areas of high, moderate, and low potential for the existence of undiscovered metallic resources and also provides an estimate of the number of undiscovered deposits. To aid land-use planners, this information is summarized to show where mineral development would most likely take place. Past production from the quadrangle includes approximately 65,100 kg (2,093,000 oz) of gold, a minimum of 7,300 kg (235,000 oz) of silver, 51,700 kg (1,500 flasks) of mercury, and byproducts of antimony and tungsten; the vast majority of gold and silver production has come from placer deposits. The probability is high that additional resources of both lode and placer gold exist. The potential for silver-tin lode deposits is also high; however, this deposit type has not been mined in this quadrangle to date. Significant additional resources of mercury and antimony are also likely present. Although this report primarily addresses metallic resources, it also includes a summary and brief assessment of non-metallic resources (hydrocarbon and industrial minerals).

The mineral resource assessment of the Iditarod quadrangle is the final product of a multi-year effort by the U.S. Geological Survey in cooperation with the Alaska Division of Geological and Geophysical Surveys. The report is divided into sections beginning with summaries of the geology, geochemical databases, and available geophysical information. The geology is summarized from Miller and Bundtzen (1994), an earlier product of this cooperative study. The primary geochemical databases considered for this assessment are analyses of rock (McGimsey and others, 1988) and drainage basin samples (stream sediment, heavy-mineral concentrate, and aquatic moss) collected in the course of this study. The drainage basin data are summarized in three maps that show the distribution of samples containing anomalous concentrations of various metallic elements (Gray and others, 1997a, c, and d). No new geophysical data were collected during the course of this cooperative study; however, a summary of available data is provided.

A comprehensive, descriptive summary of the mines, prospects, occurrences, and significant rock geochemical anomalies of the Iditarod quadrangle forms a critical component of this report. These descriptions are based on historical information provided in published government reports, unpublished mint records, and documented oral historical accounts given by local miners, supplemented by new geologic and geochemical data from this study. The descriptions are provided in a table format (table 1); locations are given on map A. Also summarized in the table are the new mineral occurrences discovered during the course of this work.

The metallic resource assessment, which is based on all the above data, forms the main body of this report. It departs from other resource assessments by presenting the data in two different ways. On map B, forty-six mineral resource areas are outlined on the basis of seven deposit models and assigned high, moderate, or low potential for discovery of additional deposits. This map is the basic tool for evaluating the undiscovered resources of the area and shows which areas are prospective for specific commodities. A detailed description of each of the forty-six areas is provided in the text. Another way to summarize the assessment is in terms of the total mineral endowment, that is, all metallic commodities combined (fig. 3). This view would be more useful in land-planning decisions, as it better predicts where future mining might take place.

The final section of the report is a discussion of the non-metallic resources of the quadrangle including oil and gas, coal, sand and gravel, and rip rap; however, no specific resource areas or tracts are outlined. This section includes a summary of new vitrinite data, which confirm that it is unlikely the Iditarod quadrangle holds any oil or gas reserves.

INTRODUCTION

The Iditarod quadrangle lies about 350 km west-northwest of Anchorage in west-central Alaska (fig. 1). It encompasses 17,300 km^2 and is characterized by rounded upland areas and marshy lowlands. The Kuskokwim Mountains cover a broad swath across the middle and southeast parts of the quadrangle; ridges are rounded and generally rise to 400–600 m from valley floors that average 150 m in elevation. Maximum relief (1,235 m) is found in the Beaver Mountains, a rugged, glaciated, plutonic-cored mountain range that lies in the northeast part of the study area. The western third of the quadrangle consists of wetlands and rolling hills of low relief that average 150 m in elevation. Exposures are generally poor due to a thick cover of colluvium and vegetation. The Kuskokwim River, the second longest river in Alaska, flows through the southeast corner of the quadrangle. Surface access to the study area is limited, hence nearly all field work was helicopter supported. Approximately 60 km of secondary roads are maintained in the Flat area for access to several placer mine streams. An additional

35 km of secondary roads cross the northeast part of the quadrangle and provide access via the Kuskokwim River to the abandoned town of Ophir and its surrounding placer mines (including some that lie within the Iditarod quadrangle).

Land jurisdiction of the Iditarod quadrangle is divisible into four main categories (fig. 2). Nearly half of the land area (47 percent) is State land. Roughly 11 percent, most of the northwest corner, is part of the Innoko National Wildlife Refuge. Approximately 5 percent of the quadrangle consists of Native lands. Most of the remaining area (37 percent) is Bureau of Land Management-administered Federal land, some of which will eventually be conveyed to Native corporations and the State of Alaska (Alaska Department of Natural Resources, 1995).

This report and accompanying tables and maps summarize the known deposits and evaluate the potential for undiscovered mineral resources of the Iditarod quadrangle. This work represents a multi-year cooperative effort by the U.S. Geological Survey (USGS) and Alaska Division of Geological and Geophysical Surveys (ADGGS) under the auspices of the Alaska Mineral Resource Assessment Program (AMRAP). Joint field work began in 1983 and terminated in 1989, but most of the effort was concentrated during 1984 to 1986. Additional mineral resource studies were carried out near Flat in 1988 and 1989. The studies included geologic mapping, geochemical sampling, and prospect evaluation; no new geophysical data were acquired. Information obtained from previously published reports by both state and federal agencies has also aided the resource assessment effort. The cooperative agreement allowed both agencies to maximize their resources by fully sharing data and field expenses. Each agency focused on their preferred products—the USGS was responsible for regional (1:250,000-scale) geologic and geochemical studies, and the ADGGS was responsible for the more detailed (1:63,360-scale) geologic mapping and prospect-level studies.

The Iditarod quadrangle contains the third largest placer gold district in Alaska and prospecting has occurred sporadically since the late 1800's. The quadrangle was a prime area for study because the geology and lode sources were poorly known. Since 1989, a major gold resource has been identified by private industry at Donlin Creek (Dodd, 1996), and exploration work has been carried out at Flat and in the George River drainage (Bundtzen and Miller, 1997).

The first step in evaluating the metallic resources of this area was to provide a better geologic framework within which to both understand the setting of the known mines, prospects, mineral occurrences, and rock geochemical anomalies and to better predict the unknown mineral endowment. The resulting geologic map (Miller and Bundtzen, 1994) is the primary data base for this mineral resource evaluation. The second step was an inventory of known mines, prospects, mineral occurrences, and rock geochemical anomalies from the literature and our own data bases. These 206 sites are summarized in table 1 and shown on map A. The regional data base of geochemical anomalies defined by stream-sediment, nonmagnetic heavy-mineral concentrate, and aquatic moss samples (Gray and others, 1988a, 1997a, c, and d; Bennett and others, 1988; Motooka and others, 1988; Arbogast and others, 1991; Hopkins and others, 1991) provided important information for outlining areas of possible economic mineral concentration. Detailed examinations of selected prospects (Bundtzen and others, 1986, 1988, and 1992) and analytical data from 1,601 rock samples (McGimsey and others, 1988) also assisted in understanding the known deposits and defined regional background values. The last step prior to delineating resource areas was to classify the known mineral deposits (and occurrences) into genetic models in order to better understand the ore generation setting and hence, to better predict undiscovered resources. We integrated the information into seven metallic mineral deposit models that are based on analogues summarized in Cox and Singer (1986), Rytuba and Cox (1991), Nokleberg and others (1993), and Bundtzen and Miller (1997).

This resource evaluation is summarized in two ways to satisfy different purposes. Resource areas that have high, moderate, or low potential for the seven metallic mineral deposit types are delineated on map B; the areas of high potential could easily serve as exploration targets. A more useful summary for land-planning purposes is provided in figure 3. On this figure, model-derived areas are combined to form non-overlapping land tracts that are ranked as very high, high, moderate, low, or unknown according to their overall metallic mineral resource potential. Non-metallic resources are also discussed in the text, but no resource areas were specifically delineated.

GEOLOGY

PREVIOUS INVESTIGATIONS

During the first half of the eighteenth century, Russian explorers began to investigate southwest Alaska via the Kuskokwim River. They traveled from the Bering Sea up river approximately 240 km, discovered cinnabar at the deposit now known as the Kolmakof Mine, and constructed a fort just a few kilometers away (fig. 1). The Russian reports were the first to address the mineral resources of southwest Alaska; however, the geology of the region was relatively unknown until 1898 when J.E. Spurr of the U.S. Geological Survey lead a party down the Kuskokwim River from its source in the Alaska Range. This expedition traversed part of the Iditarod quadrangle and provided the first description of rocks (Spurr, 1900) that would later be named the Kuskokwim Group (Cady and others, 1955).

The discovery of paying quantities of gold on Ganes Creek (Innoko district, fig. 4) in 1906 and on Otter Creek (Iditarod district, fig. 4) in 1908 prompted further investigations by the U.S. Geological Survey within the Iditarod quadrangle. In 1908, A.G. Maddren (1910) briefly looked at placers of the Innoko district, and in 1910 he made a geologic reconnaissance survey of the general region while investigating placer deposits in both the Innoko and Iditarod districts (Maddren, 1911). In 1912 and 1913, on a limited budget, H.M. Eakin managed to visit most of the mines between Ruby and Iditarod, further contributing to the base of knowledge (Eakin, 1913, 1914). In 1914, A.G. Maddren returned to study the gold placer deposits of the lower Kuskokwim area from Iditarod southwestward to the Tuluksak River (Russian Mission and Bethel quadrangles) and was the first to describe placer claims staked in 1909 near Crooked Creek (Maddren, 1915) in the southern Iditarod quadrangle. P.S. Smith traversed from Lake Clark to Iditarod in 1914; his descriptions of the general geology and resources (Smith, 1915, 1917) remained the most complete record of the region for the next 10–15 years. Mertie and Harrington (1924) and Mertie (1936) further expanded the knowledge of the study area—especially the relationship of placer gold to the Cretaceous plutons.

W.M. Cady of the U.S. Geological Survey headed a major geological study of the Kuskokwim area. This work began in 1941 as an outgrowth of detailed investigations of the many mercury deposits in the Sleetmute quadrangle. The published summary (Cady and others, 1955) remains a definitive work for the region to the present day. In 1942, E.J. Webber and W.M. Cady of the U.S. Geological Survey visited the DeCourcy Mountain area, site of the only mercury mine in the Iditarod quadrangle, and mapped the mine workings and the surrounding country. E.J. Webber and J.M. Hoare investigated the DeCourcy area further in 1943, and Hoare visited the area again in 1946, 1947, and 1948. B.S. Webber of the U.S. Bureau of Mines conducted an extensive trenching and sampling program at DeCourcy in 1943 (Webber and others, 1947). The DeCourcy Mountain Mine was further explored under a DMEA (Defense Minerals Exploration Administration) program between 1953 and 1957. Supplemental field work was conducted by E.M. MacKevett, Jr. and R.S. Valikanje of the U.S. Geological Survey in the years 1953 and 1957. A summary of the property was included in a study of the quicksilver deposits of the Kuskokwim region (Sainsbury and MacKevett, 1965). During the latter part of this exploratory period, Kimball (1969) and other U.S. Bureau of Mines personnel completed a detailed surface sampling investigation of gold-quartz veins on Chicken Mountain near Flat.

In the late 1970’s, the ADGGS began a detailed geologic mapping program in the northeast part of the Iditarod quadrangle. Field work between 1978 and 1984 resulted in three 1:63,360-scale geologic maps (Iditarod D–2 plus eastern D–3, D–1, and C–3) (Bundtzen and Laird, 1982, 1983; Bundtzen and others, 1988; respectively) as well as an older preliminary geologic map of the Innoko district (Bundtzen and Laird, 1980). Mapping performed jointly by the ADGGS and the USGS between 1984 and 1989 has resulted in the publication of a 1:63,360-scale map of the Iditarod B–4 and eastern B–5 quadrangles (Bundtzen and others, 1992). In addition to the mapping, known mineralized areas were studied and several new copper-silver, tin-arsenic-zinc, and mercury-antimony-gold occurrences were reported. A compilation of existing field data for the A–5 quadrangle was also published by ADGGS (Decker and others, 1984). These studies represent the most-detailed published work in the Iditarod quadrangle to date.

GEOLOGIC SETTING

Bedrock mapping in the Iditarod quadrangle is hampered by low relief, poor exposure, and a thick cover of colluvium and vegetation. The generalized geologic map of Miller and Bundtzen (1994) relied heavily upon information gathered on helicopter-supported foot traverses, a method required to obtain an accurate depiction of such poorly exposed terrain. A screened version of the Miller and Bundtzen (1994) map appears as an underlay on both maps A and B of this report. A brief summary of the geology of the Iditarod quadrangle, including comments about the associated metallic resources, follows below.

Rocks of the Iditarod quadrangle are broadly subdivided into two groups by age and tectonic history: (1) fault-bounded slivers of pre-Cretaceous rocks, and (2) Cretaceous and younger overlapping assemblages of sedimentary, volcanic, and plutonic rocks (Miller and Bundtzen, 1994). The known mines, prospects, and occurrences (table 1) are mainly associated with the latter group of rocks.

The pre-Cretaceous rocks are concentrated in a narrow northeast-trending structural belt (the Dishna River Fault zone) and are divided into four units that represent a wide range in protoliths and ages. The belt contains structural slivers of Jurassic mafic-ultramafic rocks, Mississippian and Triassic chert and volcanic rocks, and two units of regionally metamorphosed continental crustal rocks of Early Proterozoic to Paleozoic age (Miller and Bundtzen, 1994). The allochthonous slivers are probably related to similar units known elsewhere in west-central and southwest Alaska such as the mafic and ultramafic complexes of the Tozitna-Innoko belt, chert and volcanic rocks of the Innoko terrane, the greenschist facies continental crust of the Ruby terrane, and the amphibolite facies continental crust of the Early Proterozoic Idono Complex (Miller and Bundtzen, 1994).

Beginning in early Late Cretaceous time, the older terranes were eroded and partly covered by terrigenous clastic deposits that became the Kuskokwim Group. This regionally extensive unit was deposited primarily by turbidity currents into an elongate, probably strike-slip basin (Bundtzen and Gilbert, 1983; Miller and Bundtzen, 1992). Locally interbedded tuffs and volcanic flows may indicate initiation of volcanism that later culminated in widespread Late Cretaceous and early Tertiary igneous activity. Volcanic-plutonic complexes of Late Cretaceous and early Tertiary age locally overlie and intrude the Kuskokwim Group. Other Late Cretaceous and early Tertiary igneous rocks in the Iditarod quadrangle include extensive subaerial volcanic rocks, peraluminous hypabyssal granite porphyry, altered intermediate to mafic dikes, and felsic plugs and plutons (Miller and Bundtzen, 1994). Late Tertiary(?) to Quaternary surficial deposits cover over half of the Iditarod quadrangle.

The dominant deformation of the region began in Late Cretaceous time, although earlier deformational events are locally preserved in the pre-Cretaceous rocks (Miller and Bundtzen, 1994). The overlap assemblages were deformed in a right-lateral wrench fault tectonic environment that yielded north- northeast-trending en échelon folds and high-angle faults (Miller and Bundtzen, 1992). Evidence indicates at least two generations of folds. The well expressed, generally northeast-trending tight folds (F_1 amplitudes range from 0.5 to 2 km) were the earliest to form, followed by later, north-trending open folds (F_2 amplitudes range from 3 to 5 km). Numerous high-angle faults parallel both sets of folds. The wrench fault tectonic environment probably controlled (1) the Kuskokwim basin formation, (2) the folding and faulting of the region, and (3) Late Cretaceous and early Tertiary volcanism and plutonism and associated polymetallic ore formation of several deposit types (Miller and Bundtzen, 1992, 1994; Bundtzen and Miller, 1997).

DESCRIPTION OF LITHOLOGIC UNITS

Pre-accretionary, pre-Cretaceous rock belts

Fault-bounded slivers of four distinct units occur along the Dishna River Fault zone in the west-central part of the Iditarod quadrangle. Correlative units to the north are interpreted as having been assembled during pre-mid Cretaceous thrust faulting that emplaced mafic and ultramafic ophiolitic rocks over chert and volcanic rocks, that in turn were thrust over polymetamorphic rocks (Patton and Box, 1989; Patton and others, 1994a, b). Their current juxtaposition along high-angle shear zones likely reflects post-mid-Cretaceous deformation (Miller and Bundtzen, 1994).

The oldest unit (unit Xi) is a fragment of Early Proterozoic continental crust, the Idono Complex of Miller and others (1991). This assemblage of rocks includes amphibolite-grade granitic to dioritic orthogneiss, amphibolite, and metasedimentary rocks. Isotopic data suggest the Idono Complex is genetically related to the Kilbuck terrane (Box and others, 1990), which lies about 250 km to the southwest. These two assemblages constitute the oldest known rocks in Alaska (Miller and Bundtzen, 1994).

Paleozoic and possibly Proterozoic greenschist-facies meta-igneous and metasedimentary rocks (map unit PzPg) that are correlated with the Ruby terrane of Jones and others (1987) also represent metamorphosed continental crustal rocks. In the Iditarod quadrangle, mafic greenschist, lesser pelitic schist, phyllite, calcareous schist, quartzite, and minor granitic orthogneiss characterize this unit, but the exposures are extremely poor.

A weakly metamorphosed assemblage of Mississippian to Triassic age rocks (unit TRMc), which includes radiolarian chert, basalt to basaltic andesite, lithic tuff, metasiltstone, and minor limestone, correlates with the Innoko terrane (Jones and others, 1987). The main outcrop belt lies in the western half of the quadrangle, but small slivers of this unit occur along high-angle faults in the northeast map area, suggesting that rocks of the Innoko terrane may form the basement beneath the Cretaceous flysch (Miller and Bundtzen, 1994).

Jurassic mafic-ultramafic rocks (unit Jdr), which are probably ophiolitic in origin (Miller, 1990), comprise the youngest of the pre-accretionary terranes. They correlate with a large belt of similar rocks described by Patton and others (1994a) as the Tozitna-Innoko belt of mafic-ultramafic complexes.

Although a few rock geochemical anomalies are associated with the pre-Cretaceous rocks, no significant mineral occurrences are known. Three samples of metasiltstone and/or chert from the Mississippian to Triassic assemblage of chert and volcanic rocks (Innoko terrane) contain 1–2 parts per million (ppm) silver (nos. 3, 24, and 38, table 1); however, these Ag values are not significant enough to warrant consideration as potential mineral deposits. One sample of serpentinized ultramafic rock from the south end of the belt of Jurassic mafic and ultramafic rocks yielded a 30 ppm value for silver (no. 51, table 1). Although this is a relatively high amount of silver, neither the sample nor other rocks at the locality look mineralized. The serpentinites do contain high chromium, nickel, and cobalt values (McGimsey and others, 1988), but these metals are enclosed in refractory minerals like olivine and clinopyroxene and thus mirror ultramafic geochemistry.

Post-accretionary, Cretaceous and Tertiary overlap assemblages

The oldest overlap assemblage is a poorly known sandstone and siltstone unit (unit Ks) that occurs only in the western part of the study area. It is compositionally distinct from the widespread Kuskokwim Group and is Early Cretaceous in age on the basis of palynomorphs in one sample (Miller and Bundtzen, 1994). No geochemical anomalies are associated with this unit.

The Upper Cretaceous Kuskokwim Group is a regionally extensive basin-fill sequence that underlies over half of the Iditarod quadrangle. This sedimentary sequence is interpreted as predominantly deep marine turbidites (flysch), but it also includes shallow-marine and fluvial strata that were deposited along the margins of the basin (Bundtzen and Gilbert, 1983; Pacht and Wallace, 1984; Miller and Bundtzen, 1994). Minor volcanic rocks consisting of tuffs and flows are locally interbedded with the flysch (Bundtzen and Laird, 1982; Miller and Bundtzen, 1994). The Kuskokwim Group in the Iditarod quadrangle is divided into five map units—Kks, Kkq, Kkt, Kka, and Kkv (Miller and Bundtzen, 1994). Most of the rocks consist of interbedded shale, siltstone, and lithic sandstone (unit Kks), which are interpreted as basin-floor turbidites. The turbidites are successively overlapped on the western margin of the basin by quartzose sandstone, siltstone, conglomerate, and local coal-rich layers (unit Kkq) that are interpreted as shoreface, foreshore, and locally non-marine deposits. Although volumetrically minor, the remaining three map units (Kkt, Kka, and Kkv) contain volcanic tuffs and flows, indicating the occurrence of intermittent volcanism during deposition of the Kuskokwim Group. All mercury occurrences in the Iditarod quadrangle are either hosted in the Kuskokwim Group or in rocks that intrude it.

Volcanic-plutonic complexes of Late Cretaceous and early Tertiary age (Miller and Bundtzen, 1994) consist of intermediate and mafic volcanic rocks (units Kit and TKil) of the Iditarod Volcanics (Miller and Bundtzen, 1988) and comagmatic monzonite to quartz monzonite plutons (unit TKm). The tuffs and flows of the Iditarod Volcanics generally overlie and locally interfinger with sedimentary rock of the Kuskokwim Group. Hornfels aureoles up to 2 km wide surround most of the larger plutons and developed in both the clastic sedimentary and overlying volcanic rocks. Polymetallic veins containing gold, silver, and various base metals are locally hosted in the plutonic rocks and associated hornfels.

Hypabyssal-textured felsic to intermediate igneous rocks of Late Cretaceous and early Tertiary age crop out discontinuously across the quadrangle. Although of similar age, they are probably not directly related to the volcanic-plutonic complexes and instead represent melted crust (Miller and Bundtzen, 1994). The hypabyssal rocks are divided into two units (based primarily on silica content) that may be genetically related. Granite porphyry dikes, sills, and plugs (unit TKgp) show a distinctly peraluminous chemistry and commonly contain garnet phenocrysts. These bodies are generally small but are widely distributed in Kuskokwim Group flysch and frequently form mappable linear belts of dikes and small hypabyssal plutons. They are spatially related to gold-bearing vein and shear-zone deposits and to several placer gold occurrences, making them an important potential target for gold exploration. Three plugs of pilotaxitic dacite-andesite (unit TKp) are similar to the granite porphyry rocks in mineralogy and mode of occurrence but are not apparently associated with anomalous gold.

Other intrusive rocks of the Iditarod quadrangle include Tertiary and Cretaceous altered intermediate to mafic dikes (unit TKd), Tertiary and Cretaceous alkali granite (unit TKg), and a Tertiary porphyritic granodiorite plug (unit Tp); the relation between these and other intrusive units is uncertain. The dikes, which intrude Kuskokwim Group flysch, are widespread and ubiquitously altered to chlorite, calcite, and silica (or silica-carbonate altered). Mercury mineral occurrences are occasionally hosted in altered dikes as well as in the intruded flysch, but the presence of dikes does not seem to be required. Several exposures of alkali granite occur in the western part of the quadrangle, and one porphyritic granodiorite plug lies north of Flat, but neither unit is associated with geochemical anomalies.

Late Cretaceous and early Tertiary subaerial volcanic rocks referred to by Miller and Bundtzen (1994) as volcanic rocks of the Yetna River area (unit TKy) underlie much of the western part of the Iditarod quadrangle. Andesite, dacite, and rhyolite lava flows are most abundant, but rhyolitic to andesitic ash-flow tuffs are present locally, particularly in the northern part of the volcanic field. This area is low lying and very poorly exposed, but scattered rock samples yield low-level geochemical anomalies in lead, tin, and even gold. Significantly younger (about 10 Ma) basaltic andesite (unit Tb) is sparsely scattered overlying the Late Cretaceous and early Tertiary volcanic rocks near the western boundary of the quadrangle. No geochemical anomalies are associated with these younger rocks.

Cretaceous and younger rocks host all of the known mines, prospects, and occurrences, and a vast majority of the metallic geochemical anomalies. Mercury occurrences are primarily associated with Upper Cretaceous flysch. Late Cretaceous-early Tertiary intrusive rocks are particularly important for gold, silver, and base metal occurrences. Late Cretaceous-early Tertiary subaerial volcanic rocks are locally anomalous in gold, lead, and tin. Placer gold is hosted by late Tertiary(?) and Quaternary fluvial and bench deposits.

Surficial deposits

Surficial deposits, which cover at least 50 percent of the quadrangle, consist largely of colluvial, alluvial, and eolian deposits but locally include talus, silt and peat, terrace deposits, glacial deposits, and minor landslide deposits. They are primarily Quaternary in age but may also contain local Pliocene terrace deposits.

Isolated highland massif areas such as the Beaver Mountains and Granite Mountain have been glaciated at least four times in Quaternary time. Deposition of till and outwash in several streams that drain the Beaver Mountains resulted in stream piracy and drainage modification. This in turn had a major effect on the formation of gold placer deposits in the adjacent Innoko district (Bundtzen, 1980). Placer gold of the Iditarod quadrangle is hosted by three morphological types of surficial deposits: modern stream alluvium, ancestral terrace alluvium, and residual and eluvial (hilltop) placers. Cinnabar and scheelite are locally important components of modern stream placer deposits.

GEOLOGIC STRUCTURE AND HISTORY

Convergence of the lithotectonic terranes of western Alaska ended in Early Cretaceous time (Box, 1985; Patton and others, 1994b; Decker and others, 1994) and by Late Cretaceous time, the tectonic environment of the region was dominated by transcurrent or wrench faults with significant right-lateral offsets (Wallace and Engebretson, 1984; Miller and others, 2002). In the Iditarod quadrangle, the primary structural features are northeast-trending en échelon folds and subparallel high-angle faults that formed in a right-lateral wrench fault tectonic environment (Miller and Bundtzen, 1992, 1994; Miller and others, 2002). Evidence of older deformation is preserved in some of the pre-Cretaceous rocks of the quadrangle, but the current juxtaposition of these fault-bounded pre-Cretaceous units along high-angle shear zones is likely the result of the Late Cretaceous strike-slip environment.

Much of the post Early Cretaceous (or post-tectonic-assemblage) geologic history of the Iditarod quadrangle is related to this wrench-fault environment. In mid- and Late Cretaceous time, the pre-Cretaceous terranes were eroded and partly covered by terrigenous clastic rocks of the Kuskokwim Group. The sediments were deposited in an elongate, probably strike-slip basin that evidently continued to deepen while filling (Miller and Bundtzen, 1992, 1994). Wrench fault systems seldom exhibit strictly parallel movement and contractional and extensional regimes commonly alternate. The Late Cretaceous and early Tertiary volcanic and plutonic rocks that overlie and intrude the Kuskokwim Group were probably emplaced during intermittent periods of extension (Miller and Bundtzen, 1992, 1994). The overlap assemblages were both folded and faulted in the wrench fault tectonic setting to yield generally northeast-trending en échelon folds and subparallel faults.

The main wrench-fault zone in the Iditarod quadrangle is marked by the northeast-trending Iditarod-Nixon Fork Fault, which bisects the Iditarod quadrangle. This fault has had a minimum of 90 km right-lateral offset since Late Cretaceous time (Miller and Bundtzen, 1988); the fault was active into at least late Tertiary or Quaternary time (Miller and Bundtzen, 1994) and segments of the fault may still be active. Numerous other high-angle faults parallel the general northeast- to north-trending structural grain that characterizes the map area. The Yankee-Ganes Creek Fault, which lies about 8 km northwest of the Iditarod-Nixon Fork Fault, appears to be a splay of the main fault zone that has been inactive since about 77 Ma (Miller and Bundtzen, 1994). The Dishna River Fault zone in the west-central part of the quadrangle contains tectonic slivers of rocks that range from Proterozoic to Cretaceous in age. Evidence indicates that this fault, which represents the southwest extension of a 270-km long zone, was active sometime between 77 and 69 Ma, but may also have been active earlier, during deposition of the Kuskokwim Group (between about 90 and 77 Ma) (Miller and Bundtzen, 1988, 1994).

The overlap assemblages underwent at least two periods of open to isoclinal folding beginning in late Cretaceous and continuing into Tertiary time. The earlier, main folding event is marked by the northeast-trending en échelon folds mentioned above. Evidence for later folding is found in the southeastern part of the study area where the earlier folds are broadly refolded along a northerly-trending fold axis. The Late Cretaceous and early Tertiary plutons appear to crosscut the regional structure and probably post-date the earlier folding event (Miller and Bundtzen, 1992). The Iditarod Volcanics have been broadly folded into synclines and anticlines, probably during the later folding event.

All lode mineral occurrences in the Iditarod quadrangle are hosted in the Cretaceous and younger overlap assemblages. The wrench-fault tectonic environment heavily influenced, if not controlled, the post-Cretaceous geologic history of the region and therefore also affected ore generation. Most of the metallic resources—including mercury and antimony—are genetically related to the Late Cretaceous-early Tertiary plutonic rocks. Gray and others (1997b) suggested that higher heat flow associated with magmatism may have facilitated release of mercury from the sedimentary rocks into hydrothermal fluids. Regardless of the ultimate source of the mercury either from the plutonic or sedimentary rocks, deposition of cinnabar-stibnite-quartz veins appears to be structurally controlled along high-angle faults. Some mineralized rocks are offset along strike-slip faults. The granite porphyry dikes of the Ganes Creek area (east of the Beaver Mountains) are probably offset along the Iditarod-Nixon Fork Fault from a similar swarm of granite porphyry dikes and plugs in the Donlin Creek area for a distance of 90 km; similar placer gold and gold-polymetallic lode deposits occur in both belts of rocks. Also, a north-northeast-trending high-angle fault may have right laterally offset a mineralized granite porphyry dike swarm in the Julian Creek-Montana Creek area from a similar swarm in the Willow Creek-Granite Creek area, some 10 km to the northeast.

GEOCHEMICAL DATA SETS

Geochemical data played a major role in delineation of resource areas and definition of deposit types for the Iditarod quadrangle. A reconnaissance drainage basin survey consisting of systematic stream-sediment, heavy-mineral concentrate, and aquatic moss sampling was performed for this study. The results support, and in some cases are used to define, resource areas. Geochemical data from rock samples collected during this project have helped to define mineral deposit types and indicate favorable rock units. Previously existing data from sediment and water samples collected in 1981 by the U.S. Department of Energy were of limited use in defining resource areas, but provided supportive information. Each of these data sets is briefly discussed below. Their role in defining resource areas is given later in the individual area descriptions.

ROCK GEOCHEMISTRY

As part of the reconnaissance geochemical survey of the Iditarod quadrangle, primarily in conjunction with geologic mapping, 1,601 rock samples were collected and analyzed (McGimsey and others, 1988). Many of these were unmineralized grab samples collected to establish background values for different rock types in the region. However, to aid in characterizing the deposits, suites of mineralized samples were collected from known prospects and from new occurrences discovered during the course of the field work. Both background and mineralized samples were analyzed for 31 elements by semiquantitative emission spectrography, and for additional selected elements by atomic absorption spectrophotometry, specific ion, modified instrumental, and colorimetric methods. The locations, rock types, and complete analyses are reported in McGimsey and others (1988). Significant rock geochemical anomalies and new mineral occurrences defined by that data set are summarized in table 1. Rock geochemical data previously reported by Bundtzen and Laird (1982, 1983) and Bundtzen and others (1988, 1992) were also utilized during this mineral resource assessment.

RECONNAISSANCE DRAINAGE BASIN GEOCHEMICAL SURVEY

Stream-sediment, heavy-mineral-concentrate, stream-water, and aquatic-moss (bryophyte) samples were collected from active channels of perennial first- and second-order streams of the Iditarod quadrangle. The area of most drainage basins ranged from 2.6 km^2 (1 mi^2) to about 13 km^2 (5 mi^2). The stream-sediment sampling density was approximately 1 sample site per 23 km^2 (9 mi^2).

The stream-sediment samples were sieved to minus-80-mesh (0.17 mm) and chemically analyzed. The panned-concentrate samples were sieved to minus 30-mesh (0.60 mm), separated in bromoform, and then further separated magnetically to obtain a nonmagnetic, heavy-mineral-concentrate sample. These concentrates were split for separate mineralogical and geochemical analyses. Aquatic moss samples were preferably collected from boulders or dead-fall vegetation near or just above the current water level in the active stream channel. However, when moss could not be found within the active stream channel, it was collected from the channel walls or over bank. The moss and sediment trapped within the moss were collected together, and the sediment was later removed by agitating the samples in water (Arbogast and others, 1991). The moss samples were then dried, ground in a mill, ashed, and chemically analyzed.

During the course of this study, 1,151 stream-sediment samples were collected. A total of 799 heavy-mineral concentrates were collected and microscopically examined for their mineralogical content; 662 of these samples were chemically analyzed, the remainder contained insufficient material to perform the laboratory analyses. Stream-sediment and heavy-mineral-concentrate samples were analyzed for multi-element suites by semiquantitative emission spectrography (Gray and others, 1988a). Stream-sediment samples were also analyzed for selected elements by inductively coupled plasma analysis (Motooka and others, 1988) and for gold, mercury, tellurium, and thallium by atomic absorption spectrophotometry (Hopkins and others, 1991). The mineralogical contents of the nonmagnetic, heavy-mineral-concentrate samples were determined microscopically (Bennett and others, 1988).

Although searched for at every site, aquatic mosses were located and collected at only 863 of the sites. These samples were analyzed for multi-element suites by semiquantitative emission spectrography (Arbogast and others, 1991). Some 1,050 stream-water samples were collected and analyzed (Gray and others, 1988b), but these samples were determined to be an ineffective geochemical exploration medium (Gray and others, 1992) and will not be discussed further.

Three maps showing the distribution of anomalous concentrations of selected elements in stream sediment, heavy-mineral concentrate, and aquatic moss samples (Gray and others, 1997a, c, and d) were used extensively for this resource assessment. The value of the concentrations selected as anomalous generally lie between the 90th to the 95th percentile. For the map that shows the distribution of mercury, antimony, and arsenic, Gray and others (1997a) plotted locations of samples having the following concentrations: 0.80 ppm Hg and 15 ppm Sb in stream sediments; 200 ppm Sb and 1,000 ppm As in heavy-mineral concentrates; 1–5 percent visible cinnabar in concentrates; and 50 ppm Sb and 200 ppm As in moss samples. For the map that shows the distribution of gold and silver, Gray and others (1997c) plotted locations of samples having the following concentrations: 0.01 ppm Au and less than 0.5 ppm Ag in stream sediments; 20 ppm Au and 1 ppm Ag in heavy-mineral concentrates; any visible gold in concentrates; and 3 ppm Ag in moss samples. For the map that shows the distribution of copper, lead, zinc, tin, and tungsten, Gray and others (1997d) plotted locations of samples having the following concentrations: 100 ppm Cu, 70 ppm Pb, 300 ppm Zn, 10 ppm Sn in stream sediments; 300 ppm Cu, 300 ppm Pb, 1,500 ppm Zn, more than 2,000 ppm Sn in heavy-mineral concentrates; and 1–5 percent visible scheelite in concentrates.

NURE GEOCHEMICAL SURVEY

In 1981 the U.S. Department of Energy completed a reconnaissance geochemical study of the Iditarod quadrangle, as part of the National Uranium Resource Evaluation (NURE) program. During the study, 888 stream-sediment, 505 lake-sediment, and 1,410 hydrogeochemical samples were collected. Composite stream-sediment samples were collected from small first-order streams at a density of about one sample per 23 km^2 (9 mi^2). In swampy lowland areas where stream sediment is scarce, lake-sediment samples were preferentially collected. Hydrogeochemical samples were collected from as many streams and lakes as possible in the quadrangle. All samples were analyzed at the Los Alamos National Laboratory by various methods including X-ray fluorescence, fluorescence spectroscopy, plasma-source emission spectrometry, instrumental neutron-activation, arc-source emission spectrography, and delayed-neutron counting (National Uranium Resource Evaluation Project, 1983).

The NURE data were evaluated by Gray and others (1988c) using R-mode factor analysis to define the major geochemical associations in the stream-sediment and lake-sediment data sets. This technique identifies element groups (called factors) that tend to be associated with mineral deposit types or with rock lithologies. The NURE stream-sediment data best fit a six-factor model, while the lake-sediment data were best described by a five-factor model. In both cases, two of the model factors were interpreted to indicate mineral deposit types: a precious-metal factor and a base-metal factor (Gray and others, 1988c). However, as further described below, the predictive power of these factors is uncertain.

For the NURE stream-sediment data, an Fe-Mn-As factor is most consistent with geochemical favorability for precious-metal mineral occurrences. However, since no Au values above the detection limit are found in the data set, the association of Au with the Fe-Mn-As factor is not documented. Although Sb and W were eliminated from the factor analysis because most samples were below the detection limit for these elements, stream-sediment samples containing anomalous concentrations of one or both of these elements are often associated with the Fe-Mn-As factor (Gray and others, 1988c). Stream-sediment samples showing this factor are found in 11 areas (Gray and others, 1988c, fig. 1). Four of these areas coincide with known precious-metal lode or placer deposits (the Flat, Moore, Ganes, and Donlin Creek areas; nos. 107, 83, 10, and 195, respectively, map A). Of the remaining seven areas, one lies downstream from a resource area (Granite Mountain) that is outlined as potentially containing precious-metal deposits based on other data (see resource area 3i description in later section). The final six areas that show the Fe-Mn-As factor are not supported by other data as being particularly favorable for precious-metal occurrences, and probably do not constitute resource areas. These six areas lie in the eastern and southern parts of the Iditarod quadrangle; their locations may be found in Gray and others, (1988c, fig. 1).

A second element association (Cu-Cs-Ni) determined from the NURE stream-sediment data set is interpreted to be favorable for base-metal mineral occurrences. Stream-sediment samples that show the Cu-Cs-Ni factor are found in eight small areas in the Iditarod quadrangle (Gray and others, 1988c, fig. 1). Two of these coincide with known Ag-Sn-polymetallic mineralized parts of the Beaver Mountains (see resource area 3a description in later section). A third small area lies in the vicinity of another resource area outlined as potentially containing Ag-Sn-polymetallic deposits based on other data (see resource area 3g description in a later section). The remaining five small areas are difficult to explain and are not considered significant. They lie in the southern and southeastern parts of the Iditarod quadrangle; their locations may be found in Gray and others (1988c, fig. 1).

The geochemical results from lake-sediments collected during the NURE project were also examined by Gray and others (1988c) using R-mode factor analysis, and two factors (As-Mn-Fe and Pb-Cs-Cu-Ni) were interpreted as possible mineral deposit associations. The lack of proximity of the lake-sediment samples to exposed bedrock makes interpretation of these factors difficult. The As-Mn-Fe factor was judged most consistent with a precious-metal association (Gray and others, 1988c), although only one anomalous gold value (520 ppb) was reported in the NURE lake-sediment data. Gray and others (1988c, fig. 2) indicated lake-sediment samples showing the As-Mn-Fe factor are found in seven areas, two of which are near the known gold prospects near Flat (no. 107, map A). Three other areas roughly coincide with resource areas outlined in this report as potentially containing precious metal-bearing deposits based on other data (see resource area 2e, 3f, and 5b descriptions in later section). The anomalies in the remaining two areas are probably not significant. These areas lie in the southeast part of the Iditarod quadrangle; their locations may be found in Gray and others (1988c, fig. 2). The lake-sediment Pb-Cs-Cu-Ni factor was judged most consistent with a base-metal association (Gray and others, 1988c). The only area containing a significant number of lake-sediment samples that show this factor is the Beaver Mountains, where several Ag-Sn-polymetallic deposits are known (Bundtzen and Laird, 1982; this report).

Water samples were collected from streams and lakes in the Iditarod quadrangle during the NURE study, but the geochemical data from these samples are difficult to interpret. For example, stream-water samples that have anomalous concentrations of Ag (≥6 ppb) are scattered widely across the study area. Less than 40 percent of these samples cluster into specific areas and numerous single-site anomalies are distant from delineated resource areas. Also, stream-water samples containing anomalous concentrations of Cu, Zn, and F do not cluster well and are equally difficult to interpret. The NURE stream-water samples appear to be poor indicators of copper-bearing deposits. Of four areas known to contain significant copper in mineral occurrences, only two showed anomalous Cu values in the NURE stream-water data. A similar problem was observed in the data from stream-water samples collected during this study. Gray and others (1992) found that stream-water samples were less effective than stream-sediment and heavy-mineral-concentrate samples in detecting underlying mineralized rock in the Iditarod quadrangle. Lake-water samples collected during the NURE study are so unevenly distributed and heavily biased toward the western lowlands that they do not provide data useful for this study.

In summary, the NURE stream-sediment and lake-sediment data sets provided useful supportive information for assessing the mineral resources of the Iditarod quadrangle. In about a dozen cases, geochemical anomalies defined by the NURE data cluster in areas that have been delineated as resource areas in this study. However, a number of resource areas that were found during the AMRAP investigations would not have been found with the NURE data sets. In a few cases (discussed above), the NURE data indicate anomalies that have not been confirmed by the AMRAP geochemical data. These areas are difficult to reconcile, but the geological and geochemical evidence collected during this study do not support designation of these areas as favorable for mineral resources.

GEOPHYSICS

No new geophysical data were collected during this investigation. Previously published data include regional gravity and reconnaissance aeromagnetic maps. The gravity data were summarized by Barnes (1977), Barnes and others (1994), and Meyer and others (1996), but the coverage in the Iditarod quadrangle is sparse and the published maps did not provide information useful in evaluating either the metallic or nonmetallic endowment of the region. A reconnaissance magnetic survey of the Iditarod quadrangle was flown in 1979 for the National Uranium Resource Evaluation (NURE) using a broad, 6-mile, flight-line spacing. A machine-contoured total magnetic intensity anomaly map summarized this data (NURE, 1982). The raw data (Aero Service Corporation, 1980) was later reprocessed and merged with data from neighboring quadrangles (Meyer and Saltus, 1995).

Although not detailed enough to assist in outlining favorable areas for mineral deposits, the aeromagnetic data locally reinforce geologic interpretations based on field mapping and suggest the subsurface continuation of both a volcanic rock unit and a fault zone. The most prominent feature of the merged aeromagnetic map (see Meyer and Saltus, 1995, sheet 1, map B) is a change in the magnetic character from the west side to the east side of the Iditarod River in the western part of the quadrangle. A pattern of localized magnetic highs and lows characterizes the region west of the Iditarod River, an area primarily underlain by subaerial volcanic rocks (unit TKy). To the east, in an area primarily underlain by Kuskokwim Group flysch, the magnetic pattern is relatively featureless. The aeromagnetic data suggest that the volcanic rocks (and their underlying basement rocks) continue under the Yetna River swamp west of Dikeman, a conclusion consistent with the mapped geology. A major southwest-trending fault system (Miller and Bundtzen, 1994) in the north-central part of the quadrangle follows the boundary suggested by the magnetic data for half of its distance. The aeromagnetic data suggest that this fault zone continues in the subsurface to the southwest corner of the map area. Just east of this fault zone, near the northern boundary of the Iditarod quadrangle, a magnetic high (see Meyer and Saltus, 1995, sheet 1, map B) reflects the presence of mafic and ultramafic rocks (unit Jdr) of the Dishna River area (Miller, 1990; Miller and Bundtzen, 1994). This anomaly dies out to the southwest, consistent with the geologic mapping.

The available geophysical data is not detailed enough to provide definitive answers, but does offer limited support of geologic interpretation of the region. Acquisition of more detailed geophysical data, particularly magnetic data, would clarify the observed anomalies and contribute significantly to the resource evaluation.

MINES, PROSPECTS, MINERAL OCCURRENCES, AND ROCK ANOMALIES

Much of the knowledge of the mineral resources of the Iditarod quadrangle is derived from the search for, and the development of, gold and mercury prospects. About 51,700 kg (1,500 flasks) of mercury were recovered from the DeCourcy Mountain Mine (no. 184, table 1). An estimated 99.1 kg (3,185 oz) of gold was produced from two lode mines (Independence and Golden Horn, no. 16 and no. 110, respectively, table 1). The vast majority of the gold produced in the quadrangle was recovered from placer deposits. The total placer production for the Iditarod quadrangle is approximately 65,000 kg (2.1 million oz) of gold and byproducts of silver, antimony, and tungsten. This figure for gold production is 25 percent greater than the value obtained by adding individual property production numbers listed in table 1 (which total a minimum of 1,682,257 oz of gold). The discrepancy is primarily due to the nature of federal, state, and territorial production figures, which are generally complete for districts and subdistricts, but incomplete for specific stream basins or individual mines.

The study area contains parts of four placer mining districts defined by Ransome and Kerns (1954)—the Iditarod, Innoko, McGrath, and Aniak districts (fig. 4). Placer deposits were first discovered in the Innoko district in 1906, and Iditarod district in 1908. By 1917, almost all other known placer deposits had been found or were developed. Exceptions of note were the Granite Pup (of Willow Creek) and Deadwood Creek placer deposits, which were found in 1924 and 1932, respectively (nos. 142 and 56, table 1 and map A). Lode discoveries followed the placer mining developments. The Independence gold mine in the Innoko district was in production around 1912. The DeCourcy Mountain mercury mine was discovered around 1910, staked in 1919, and produced intermittently from 1921 to 1949. At the Golden Horn lode, in the heart of the Iditarod district, underground mining began in 1922; the last ore was shipped in 1937.

The earliest published mineral studies of the area included those of Maddren (1910, 1915), who reported on gold placer developments in the newly discovered camps in the Innoko district and the Donlin area of the Aniak district, and Mertie (1936) and Mertie and Harrington (1924), who described activities of the Iditarod and Innoko districts ten to twenty years after their respective discovery dates. Brooks (1916), Cady and others (1955), Kimball (1969), Bundtzen and Laird (1980), and Bundtzen and others (1988, 1992) have described various activities pertaining to the development of lode gold. A detailed summary of historical mine developments near Flat was published by Bundtzen and others (1992). Topical resource work by the ADGGS, in cooperation with this study, was focused on heavy-mineral provenance studies of placer deposits (Bundtzen and others, 1987) and individual lode and placer prospect examinations (Bundtzen and Laird, 1982, 1983; Bundtzen and others, 1985, 1986). Maloney (1962) and Sainsbury and MacKevett (1965) summarized the geology and resource potential of mercury deposits in the region, information that was important to the nation's strategic mineral assessments of previous years. White and Killeen (1953) investigated the area for radioactive deposits and also evaluated the strategic materials during the 1950's. Summaries of precious metal-bearing lodes associated with Late Cretaceous and early Tertiary igneous rocks, and antimony-mercury lodes have recently been published (Bundtzen and Miller, 1997; Gray and others, 1997b).

The locations and descriptions of known mineral deposits and occurrences, which are important for delineating resource areas, are presented in table 1 and on map A. For this report, the following definitions are used: *Mine*—any site that has recorded production, no matter how small the amount; *Prospect*—any site where there is evidence of past or current exploratory work, such as a prospect pit; *Occurrence*—ore minerals are present and the site is more significant than a single-sample anomaly; *Rock anomaly*—rock containing anomalous metal value(s); ore minerals may be present, but are not confirmed. Table 1 includes a comprehensive summary of published and unpublished data on the previously known mines and prospects. It also includes information on previously unreported prospects, new mineral occurrences found during this investigation, and rock grab samples containing anomalous metal values; also included are sites where gold was visually identified in heavy-mineral concentrate samples. The mineral deposit type that best fits each locality is also listed, using the seven metallic mineral deposit models defined for this study, which are outlined in table 2.

PROCEDURE FOR ASSESSING METALLIC MINERAL RESOURCES

METHODS OF ASSESSMENT

The assessment of the metallic mineral resources of the Iditarod quadrangle follows the technique used in many Alaska mineral resource assessments (for example Richter and others, 1975; Patton and Moll, 1983; Nelson and others, 1984; and Miller and others, 1989), wherein resource areas are defined primarily by geologic and geochemical data, but refined by mine, prospect, and mineral occurrence information. Geophysical data are normally also considered, but the reconnaissance-scale NURE data available for the Iditarod quadrangle played only a minor role in definition of resource areas.

This report departs somewhat from the probabilistic "three-part quantitative assessment" that has been utilized by the USGS in varying forms since 1975. The three parts outlined by Singer (1993) may be summarized as follows: (1) resource areas are delineated on the basis of deposit type permitted by the geology, (2) grade and tonnage models are used to estimate the potential amount of contained metal, and (3) where appropriate, probabilistic estimates are made of the number of undiscovered deposits of each type. The Iditarod assessment follows these three steps in a general way, but it is tailored to account for particulars that relate to the Iditarod quadrangle, such as the level of knowledge, the lack of outcrop exposures, the locally detailed data available, and the need for information related to both mineral resource evaluation and land planning purposes. An "unnumbered" final step (Harris and Rieber, 1993) of the three-part quantitative assessment method utilizes a computer program to combine the probabilistic estimates (part 3) with grade and tonnage data (part 2) to obtain a probability distribution for the amount of contained metal or the "gross-in-place value" (GIPV) of the mineral resource. GIPV estimates are useful for land-planning purposes (for example Brew and others, 1992), particularly when comparing and compiling the value of a variety of resources for any given land parcel. However, GIPV estimates can be misleading and, given that no specific land use decisions are currently pending in Iditarod quadrangle, none are reported here. This mineral assessment does provide probabilistic estimates of numbers of undiscovered deposits, from which GIPV estimates may be calculated. Presenting probabilistic values (without GIPV estimates) emphasizes their inherent subjective nature and uncertainty, both of which are easily ignored when a GIPV dollar value is stated.

The resource areas of the Iditarod quadrangle are defined using seven mineral deposit models deemed appropriate based on the geology and geochemistry. These deposit models generally follow definitions and concepts presented in Cox and Singer (1986), but also incorporate recently published mineral deposit model concepts presented during comparisons between Alaskan and northeast Russian metallogenic belts (Nokleberg and others, 1993, 1997). Applying the first step in the three-part assessment method, the seven deposit models guided designation of resource areas. These areas of favorability are further classified into the three-tiered hierarchy of high, moderate, or low mineral resource potential following the definitions that were first suggested by Taylor and Steven (1983), adopted by Goudarzi (1984), and later summarized by Hansen (1991)(see table 3) for use in joint USGS and U.S. Bureau of Mines mineral surveys of Federal lands. In this report, 46 prospective areas are delineated and each area is ranked as having high, moderate, or low resource potential for the occurrence of one or more of the seven model types. Areas permissible for more than one deposit type may carry multiple rankings, that is, the area may have high potential for one deposit type and moderate potential for a second deposit type.

The degree of confidence placed in ranking a resource area (as high, moderate, or low) depends on the adequacy of data available and the level of understanding of the deposit type. This report uses the level of certainty rating (defined in table 3) proposed by Voelker and others (1979) and adopted by Goudarzi (1984) and Hansen (1991) to help convey this variation. Acquisition of additional information would positively affect the assigned confidence level (become more certain), but wouldn't necessarily change the area rank of high, moderate, or low mineral resource potential.

ESTIMATES OF UNDISCOVERED RESOURCES

The final step in the assessment process was to estimate the number of undiscovered deposits of selected deposit types for the Iditarod quadrangle. These estimates were made by consensus among a committee of four consisting of the three authors (geologist, economic geologist, and geochemist) joined by an additional economic geologist, who is knowledgeable about the area and resources. This method is a variation of the "density of deposit method" discussed by Cox (1993), in which the number of undiscovered deposits is inferred for a poorly known area by comparing it to a geologically similar, well-explored area for which the density of deposits is known. Some of the deposit models formulated for description of metallogenic belts in the Iditarod quadrangle do not strictly adhere to models published by Cox and Singer (1986). In these cases, tonnage/grade curves were revised to accommodate the differences.

The committee concluded that estimating the number of undiscovered deposits would be appropriate for four of the seven deposit models (table 4). For these four models, sufficient geologic control is available and the model type is sufficiently understood (including supportive data of mines, prospects, and occurrences) to make reasonable estimates. The mean size considered for each deposit type comes from the appropriate tonnage/grade curves for that model (either Cox and Singer, 1986, or defined herein). Estimates were made at the 90, 50, and 10 percent confidence levels. The estimates given in table 4 roughly approximate probability distributions for deposits of model types 1 through 4. Probabilistic estimates of contained tons of metal were not generated for this report.

Quantitative estimates were not made for the remaining three deposit models (models 5, 6, and 7, table 2). The committee concluded that model 5 (volcanic-hosted epithermal) was unsuited to quantitative estimation in Iditarod quadrangle, because of sparse data and the model is only poorly understood as applied to the Yetna volcanic field (unit TKy). The committee also did not estimate undiscovered deposits for bedrock model 6 (mafic-ultramafic related Cr-Ni-Co). The geology of the Dishna River mafic-ultramafic belt is well defined and the model (Cox and Singer, 1986) is well understood; however, in the Iditarod quadrangle, there are no occurrences or geochemical anomalies that suggest this deposit type is present; hence, the estimated number of deposits would have been very low. Perhaps the most difficult decision among committee members was to not quantitatively estimate resources for the heavy-mineral placer deposits (model 7). Here is a well-defined model for which there is abundant data and hence great confidence in designation of areas of high potential. However, the Iditarod quadrangle has been explored for placer deposits by a dedicated group of samplers—the placer prospectors as well as our geochemical investigations. If undiscovered placer deposits exist, they would likely lie within one of the resource areas, most likely in one of the five areas that have high potential but little or no known placer development. Given the high-level of placer exploration in the quadrangle, it is not likely that any of these five areas would yield a new deposit equal to or greater than the median for the region. Instead, it is more likely that undiscovered resources will come in the form of extensions of known deposits or mining of very small deposits.

ASSESSMENT PRESENTATION

The main focus of this study was to evaluate the undiscovered mineral resources of the Iditarod quadrangle. However, given that both the assessment and the contributing data have multiple applications, the data are summarized in several ways. The descriptive text and detailed mine, prospect, and mineral occurrence table provide a comprehensive summary of the available data for general interest purposes. Delineation of the most favorable resource areas by deposit type provides key information for evaluating undiscovered resources, but may also guide mineral exploration. Resource areas derived on the basis of deposit models are presented on map B. Land planners on the other hand are not usually concerned with deposit type, but rather with the relative value of regions and the likely location of possible future mining. The data are summarized in a format more useful for land planning purposes in figure 3 where deposit models are combined to emphasize relative total mineral endowment; these composite areas are designated “land tracts.”

Resource areas—the model-based assessment

One or more resource areas are outlined for each of the seven selected mineral deposit models. Forty-six resource areas (some overlapping) are defined and shown on map B. Each resource area carries a number (1 to 7) to reflect the mineral deposit model that primarily defines it, followed by a letter to identify individual areas. Hence, the four areas described by model 1 are labeled “1a” to “1d”; the five areas defined by model 2 are labeled “2a” to “2e”; and so on (map B). Some resource areas may also contain deposits defined by other models. To help illustrate this, each deposit model is represented by a pattern (or in the case of model 7, no pattern); areas represented by more than one model will have intersecting patterns.

Information about the rank (high, moderate, or low) of each resource area with respect to deposit model is also conveyed on map B by color. Red patterns denote high mineral resource potential for that particular model; a pink pattern denotes moderate potential; and a blue pattern denotes low mineral resource potential. Areas defined by model 7 (placer) are not patterned, but instead outlined by bold black lines; all designated placer areas are considered to have high potential.

Each of the 46 resource areas is described in some detail in the following pages. The main characteristics of the 35 lode resource areas are summarized in table 5; their assigned rank (high, moderate, or low) is also listed along with the level of certainty. Table 6 presents a summary of the main characteristics, rank, and level of certainty for the 11 placer resource areas.

Land tracts—the land-based assessment

Resource areas that are delineated on the basis of mineral deposit models are grouped together into 23 land tracts on figure 3. The purpose of this summary diagram is to define and rank the tracts of land on the basis of total potentially contained metallic resources or mineral endowment. The tracts are designated by a letter followed by a number. The letters denote very high (VH), high (H), moderate (M), and low (L) total mineral endowment potential. The numbers indicate relative ranking within each of these categories. The land tracts were ranked based on numeric scores assigned according to model (and commodity) represented, weighted by their resource potential (that is high, moderate, or low). A tract showing high potential for several deposit types scored higher than a tract showing moderate potential for one deposit type; a tract showing only low potential scored zero. The acreage covered by a tract was not considered in determining its relative value. Table 7 lists for each land tract the model-derived resource areas (from map B) it contains and lists the tracts in order of decreasing overall relative endowment value. No dollar figures are attached to these tracts.

Land tracts having moderate, high, or very high mineral endowment potential are readily distinguished because they are shaded; land tracts of low potential are unshaded, but labeled (L1 or L2); the region of unknown resource potential is unshaded and not labeled. The land tracts showing moderate, high, and very high mineral endowment potential are indicated by increasingly darker shading. Future mining would most likely take place within the tracts of darkest shading.

MINERAL DEPOSIT MODELS AND AREA DESCRIPTIONS

The mineral resources of Iditarod quadrangle are described in terms of seven different mineral deposit types. Analysis of individual prospects and districts in the study area, including examination of the geochemical content of ores, the structural and bedrock geology, and elemental patterns in soil, rock, stream sediments, and heavy-mineral concentrates, and isotopic data contributed to the selection of these seven deposit types (table 2). Six of the seven types are described in some degree by models published in Cox and Singer (1986); the remaining deposit type (the peraluminous granite-porphyry-hosted gold-polymetallic) is a new deposit model type described for southwest Alaska in Bundtzen and Miller (1997).

Peraluminous granite-porphyry-hosted gold-polymetallic deposits (model 1; table 2) have geological, geochemical, trace element, and isotopic characteristics that significantly differ from standard published mineral deposit models. Although these deposits have some of the attributes of porphyry Cu-Au (Cox, 1986b, model 20c) or porphyry gold (Rytuba and Cox, 1991) deposits, they lack alteration and trace element characteristics of the published mineral deposit types. The peraluminous granite-porphyry-hosted gold-polymetallic deposit type may be most similar to the granitoid-related gold systems of Sidorov and Rozenblum (1989) or Aksenova (1990), as summarized in Nokleberg and others (1993). Bundtzen and Miller (1997) compared the peraluminous-granite-porphyry gold-polymetallic deposits of the Kuskokwim mineral belt with granite and alaskite-hosted auriferous deposits of the Mineral Ridge and Divide districts of southwest Nevada (Spurr, 1906; Bercaw and others, 1987; Prudden and Jucevic, 1988), and the Maiskoye gold deposit in northeast Russia (Sidorov and Eremin, 1995; Nokleberg and others, 1993, 1997). Laboratory and field data collected during their (and this) study suggest that mineral deposit model 1, as summarized in this analysis, contains attributes of both high- and low-temperature metallogenesis. Bundtzen and Miller (1997) proposed that the peraluminous-granite-porphyry gold-polymetallic deposits probably constitute a new subclass of granitoid-related gold deposits.

In the Iditarod quadrangle, two deposit types occur in association with volcanic-plutonic complexes: plutonic-hosted copper-gold-polymetallic stockwork and vein deposits (model 2, table 2) and the plutonic-related, boron-enriched, silver-tin-polymetallic deposits (model 3, table 2). The host plutons for the latter deposit type are generally less differentiated than the intrusions that host the former deposit type (Bundtzen and Miller, 1997). Boron metasomatism usually characterizes the silver-tin-polymetallic systems, but is sometimes associated with the copper-gold polymetallic deposits. Since these two deposit types may be spatially related, resource areas described for one model are usually also assigned a moderate potential for the other model. The plutonic-hosted copper-gold-polymetallic stockwork and vein deposits somewhat resemble the porphyry Cu-Au model of Cox (1986b, model 20c) and the polymetallic vein model of Cox (1986a, model 22c), but also are similar to the alkalic copper-gold porphyry model of Vila and Sillitoe (1991). The plutonic-related, boron enriched, silver-tin-polymetallic deposits best conform to the porphyry tin model of Reed (1986, model 20a) and to the Sn-polymetallic vein model of Togashi (1986, model 20b). Model 3 is also similar to the Russian tin silicate-sulfide deposit type described in Nokleberg and others (1993).

Epithermal deposits are widespread in the study area. Epithermal mercury-antimony (gold) deposits (model 4, table 2) hosted in rocks of the Kuskokwim Group, resemble the hot-spring mercury deposit model of Rytuba (1986, model 27a), except that the host rock is sedimentary, not volcanic. The volcanic-hosted precious and other metals deposits (model 5, table 2) resemble the hot springs Au-Ag model of Berger (1986, model 25a), but our information is not detailed enough to distinguish specific model types.

Mafic-ultramafic rocks of the quadrangle are permissible host rocks for podiform chromite (Albers, 1986, model 8a) or Limassol Forest Co-Ni (Page, 1986, model 8c) deposits. No mafic-ultramafic associated mineral occurrences are known for the study area, so any potential commodities related to these rock types are included in the Cr-Ni-Co deposit type (model 6, table 2).

The heavy mineral placer deposits of the study area (model 7, table 2) conform roughly to the placer Au-PGE deposit model of Yeend (1986, model 39a).

General descriptions of the seven mineral deposit types, accompanied by descriptions of the supportive geology, geochemistry, and known mineral occurrences for each resource area defined by that model, are provided below.

PERALUMINOUS GRANITE-PORPHYRY-HOSTED GOLD-POLYMETALLIC DEPOSITS (MODEL 1)

Gold resources associated with peraluminous granite porphyry, alaskite, and minor granodiorite sills, dikes, and small stocks have only recently been identified in the Iditarod quadrangle although their association with placer gold deposits have been known for years (Mertie, 1936; Bundtzen and Miller, 1997). These gold-bearing intrusions mainly consist of porphro-aphanitic to fine-grained phaneritic varieties of granite, alaskite, and minor granodiorite that intrude the Kuskokwim Group flysch throughout the Iditarod quadrangle in northeast-trending belts almost certainly controlled by high-angle fault zones. Usually these dike swarms contain two or more, clearly defined, intrusive events. K-Ar isotopic ages from the granite porphyry and alaskite intrusions range from 71.5 to 63.5 Ma (Miller and Bundtzen, 1994). Geochemically, the dikes and sills exhibit heavy REE depletion, are peraluminous and corundum normative, and contain high Rb/Sr ratios, all of which are consistent with their suspected origin as crustal melts in a regional zone of high heat flow within an extensional environment (Bundtzen and Swanson, 1984; Bundtzen and others, 1992; Miller and Bundtzen, 1994; Bundtzen and Miller, 1997).

Ore mineralogy consists of arsenopyrite, pyrite, stibnite, complex arsenate-sulfosalts, free gold, minor cinnabar and rare cassiterite. Sulfides and sulfosalts appear to be disseminated in the intrusive rocks and structurally localized (with quartz) in shear zones and faults, either in the intrusive rocks or in immediately adjacent Kuskokwim Group sedimentary rocks. Cinnabar, gold-arsenate, and stibnite are commonly noted as late-stage introductions in vugs or breccia zones in veins. Weathering characteristics include minor gossan and bleaching in oxidized zones. Microprobe analyses indicate that most of the gold occurs in lattice structures of pyrite and arsenopyrite, hence “refractory.” Representative elemental content from four deposits in the Kuskokwim mineral belt (Bundtzen and Miller, 1997) indicates strong correlation between gold, silver, arsenic, antimony, and mercury. The granite-porphyry-hosted gold-polymetallic deposits are depleted in copper, lead, zinc, and molybdenum.

Weak argillic, phyllic, silicic, and potassic alteration and dickite have been recognized in granite porphyry dikes in the Donlin deposits (no. 192, map A) and at Spaulding Creek (no. 11, map A). Dolomite and ankerite replacement of potassium feldspar phenocrysts has been noted at Donlin and in the Yankee Creek-Ganes Creek dike swarm (at the Independence Mine, no. 16, map A). Biotite and other mafic minerals commonly show propylitic alteration in granite porphyries of the study area; but it is unclear how much of this is due to near surface weathering or to hydrothermal alteration. Siderite-calcite vein alteration is common in the altered, mineralized dikes.

Trace elements derived from rock, moss, stream-sediment, and heavy-mineral-concentrate samples from each deposit or deposit area almost always show elevated levels of Au, Ag, As, Sb, and Hg and locally show elevated levels of B, Cu, Pb, Sn, W, and Zn (table 5).

Cumulative evidence summarized by Bundtzen and Miller (1997) suggests that the peraluminous granite-porphyry-hosted gold-polymetallic deposits formed under both mesothermal and epithermal conditions. Four mineral resource areas containing the granite porphyry-gold polymetallic model have been delineated. All are related to concentrations of felsic dikes or sills intruding Kuskokwim Group sedimentary rocks.

Resource area 1a, Yankee Creek-Ganes Creek dike swarm

Resource area 1a (map B) has a high potential (certainty level D) for containing peraluminous granite-porphyry-hosted gold-polymetallic deposits. Area 1a includes mineralized granite porphyry dikes and sills (unit TKgp) that cut Kuskokwim Group sedimentary rocks (primarily unit Kks) and slivers of Innoko terrane basement rocks (unit ŦMc) along a narrow, 50-km long, curvilinear belt from Fourth of July Creek northeastward to the upper drainage basins of Yankee and Ganes Creeks in the northern part of the quadrangle. The dike and sill swarm lies along a major fault system, the Yankee-Ganes Creek Fault (Miller and Bundtzen, 1994), which has brought up pre-Cretaceous basement rocks. This northeast-trending structural belt, referred to by Bundtzen and Miller (1997) as the Ganes-Yankee Creek dike swarm, controls the distribution of at least 35 separate bodies of granite porphyry dikes, small monzonite stocks, and altered mafic dikes. The Yankee Creek-Ganes Creek dike swarm is apparently truncated on the south by the Iditarod-Nixon Fork Fault, a major right-lateral transcurrent fault in western Alaska (Miller and Bundtzen, 1988, 1994).

Resource area 1a has yielded at least 5,042 kg (about 162,100 oz) of gold and 699 kg (about 22,500 oz) of silver from six placer mines in the Ganes Creek and Yankee Creek drainage basins (nos. 1, 10, 11, 12, 13, and 19, table 1 and map A). The highest concentration of metallic mineralized rock occurs in a zone 4 km by 0.5 km near the divide separating Yankee and Ganes Creeks. Lode mineral deposits known in the resource area include the Independence gold mine (no. 16, table 1), which produced 14.9 kg (478 oz) of gold around 1912, and the nearby Katz antimony prospect, (no. 15, table 1). Both deposits are contained in, or border on, structurally controlled granite porphyry dikes. At the Independence deposit, disseminated arsenopyrite, pyrite, cinnabar, stibnite, and stephanite occur in dike rock and altered sandstone of the Kuskokwim Group. Carbonate alteration, which is quite persistent in the deposit, is controlled by hairline fractures in wall rock and host dikes. Five other prospects, occurrences, or rock geochemical anomalies known to be related to granite porphyry intrusions or altered dikes are also are to be found in this resource area (nos. 2, 14, 17, 18, and 43, table 1). Visible gold was observed in several quartz carbonate veins in granite porphyry and in veins adjacent to dikes (nos. 17 and 18, table 1). Bundtzen and Laird (1980) believed that virtually all placer gold in the Yankee Creek and Ganes Creek drainages originated from these and similar undiscovered lode sources.

Anomalies in stream-sediment, heavy-mineral-concentrate, and aquatic moss samples help define resource area 1a. One heavy-mineral-concentrate sample collected from Spaulding Creek contains visible gold. One stream-sediment sample collected from a tributary of Ganes Creek contains 0.5 ppm Ag, 100 ppm Cu, and 70 ppm Pb. From the central part of resource area 1a, one stream-sediment sample contains 23 ppm As and another contains 12 ppm Hg. A heavy-mineral-concentrate sample from the latter site has 5–20 percent microscopically visible cinnabar; a concentrate sample from another site in central 1a has 300 ppm Pb. Central 1a also has one moss sample containing 2,000 ppm As and another containing 150 ppm Sb. The southwestern part of resource area 1a includes one stream-sediment sample containing less than 0.5 ppm Ag and one heavy-mineral-concentrate sample containing 2,000 ppm Sn and 1–5 percent cinnabar; an aquatic moss sample contains 100 ppm Sb.

Resource area 1b, Granite Creek area

Resource area 1b (map B) has a high potential (certainty level D) for containing peraluminous granite-porphyry-hosted gold-polymetallic deposits. The area is defined by peraluminous granite porphyry dikes and sills (unit TKgp) and a small monzonite stock (unit TKm) that cut Kuskokwim Group sedimentary rocks and occur in an elongate belt that extends 20 km from just south of Willow Creek, a tributary of the George River, northeastward to the upper drainage basin of Little Waldren Fork of the Takotna River. During this study, auriferous stibnite gash veins were found in granite porphyry and shale host rock at the Wyrick lode (Bundtzen and others, 1986; this study no. 143, table 1) and in two additional mineralized zones associated with small granite porphyry bodies (nos. 123 and 144, table 1). Within resource area 1b, Willow Creek and Granite Pup (no. 142, table 1) have intermittently produced modest quantities of placer gold (101 kg or 3,250 oz) since the 1920's; the granite porphyry swarm is the suspected lode source of the commercial placer deposits.

Resource area 1b is supported by local anomalies in stream-sediment, heavy-mineral-concentrate, and moss samples. One stream-sediment sample contains 0.046 ppm Au, another contains 31 ppm As, and a third contains 0.86 ppm Hg. A heavy-mineral-concentrate sample from the third site also contains 1–5 percent microscopically visible cinnabar. A heavy-mineral-concentrate sample from the gold-bearing site contains 7,000 ppm B. Another heavy-mineral-concentrate sample contains 5,000 ppm zinc, and microscopically visible cinnabar (1–5 percent), stibnite (<1 percent), cassiterite (<1 percent), and scheelite (<1 percent). An aquatic moss sample (from the site that yielded 31 ppm As in the stream-sediment sample) contains 3,000 ppm As.

Resource area 1c, Julian Creek area

Resource area 1c (map B) has a high potential (certainty level C) for containing peraluminous granite-porphyry-hosted gold-polymetallic deposits. The area includes granite porphyry dikes and small stocks (unit TKgp) that intrude Kuskokwim Group sedimentary rocks along a narrow, 35-km long, east-northeast-trending belt that extends from the North Fork of the George River through Julian Creek to about 10 km east of the George River. Three lode mineral occurrences were found in this resource area during the investigations. They include: (1) a mineralized quartz vein stockwork in granite porphyry at the head of Julian Creek (no. 159, table 1), which contains up to 10 g/tonne Ag, greater than 0.2 percent As, 11 ppm Bi, 3.3 ppm Cd, and 100 ppm Sn; (2) limonite breccias in fractured hornfels along the contact of a granite porphyry intrusion (no. 162, table 1), where grab samples contain up to 250 ppb Au, 2,000 ppm Sb, 610 ppm As, and 200 ppm W, and more than 14 ppm Hg; and (3) massive stibnite veins in brecciated hornfels near creek level east of no. 162 above, where grab samples contain up to 1 percent Sb, 200 ppm Sn, and 60 ppm As (no. 163, table 1). One additional Hg anomaly (1.6 ppm, no. 164, table 1) is associated with a granite porphyry dike within this area. Resource area 1c has yielded at least 373 kg (12,000 oz) of gold and 51.6 kg (1,660 oz) of silver from three placer deposits (nos. 160, 161, and 172, table 1). Gold and other heavy minerals found in these placer deposits are probably derived from granite porphyry bodies at the headward portion of each respective drainage.

Both the southwest limit of resource area 1b (Granite Creek area) and the northeast limit of resource area 1c (Julian Creek area) are truncated along a north-northeast-trending transcurrent fault (Miller and Bundtzen, 1994). Both areas were probably part of a single belt of mineralized granite porphyry dikes and sills that was right laterally offset 12 km along this fault.

Anomalous stream-sediment, heavy-mineral concentrate, and moss samples help define resource area 1c. One stream-sediment sample contains 0.10 ppm Au and another contains less than 0.25 ppm Au. Three other stream-sediment samples contain 89 ppm As, 1.2 ppm Hg, and 5.0 ppm Hg and 0.5 ppm Ag. One heavy-mineral-concentrate sample contains more than 2,000 ppm Sn and that sample, plus one additional sample, contain less than 1 percent microscopically visible cassiterite. Another heavy-mineral-concentrate sample contains 1–5 percent microscopically visible scheelite. One aquatic moss sample contains 200 ppm Sb.

Resource area 1d, Donlin Creek trend

Resource area 1d (map B) has a high potential (certainty level D) for containing peraluminous granite-porphyry-hosted gold-polymetallic deposits. The area is a 50-km long northeast-trending belt defined by a series of granite porphyry sills and dikes (unit TKgp) that intrude Kuskokwim Group sedimentary rocks. The belt extends from Omega Gulch in the southern part of the Iditarod quadrangle northeast to Bonanza Creek, where it is truncated by the Iditarod-Nixon Fork Fault. This structurally controlled dike and sill swarm contains the important Donlin gold polymetallic deposits (nos. 192 and 196, table 1), which have been the subject of intense mineral industry exploration in recent years (Retherford and

McAtee, 1994; Dodd, 1996; Szumigala and others, 2000). Extension of the resource area to the northeast of Donlin is supported by additional mineral occurrences and rock anomalies. At least 918 kg (29,500 oz) of placer gold has been mined from deposits (nos. 188, 191, 193–195, and 205, table 1) in this resource belt.

The Donlin deposits lie within a 2 km by 6 km area in the southwestern part of resource area 1d. Spatially associated with the deposits are at least three separate generations of granite porphyry dikes (Retherford and McAtee, 1994); although composed of distinct, cross-cutting intrusive events, the period of intrusion likely spanned no more than five million years time (Miller and Bundtzen, 1994). Eight discrete, gold-antimony arsenic-bearing mineralized zones including the Lewis/Rochelieu, Queen, Snow, 400, ACMA, Duqum, Dome, and Far Side (nos. 192 and 196, table 1) have been identified in the Donlin prospect area (Dodd, 1996; Szumigala and others, 2000). Four separate exploration programs conducted by four different mining companies during 1987–2001 have assessed the Donlin Creek lode system. On the basis of about 15,000 m of drilling conducted during 1987–1990 by Western Gold Exploration and Mining Company (supplemented by additional work by Teck Exploration Ltd. in 1993), the Donlin mineralized area was estimated to contain 3.87 million tonnes grading about 3.15 g/tonne gold or about 12,190 kg (379,110 oz) gold (Retherford and McAtee, 1994). Exploration work and drilling conducted by Placer Dome U.S. Inc. from 1995 to 1998 substantially added to the gold resource base at Donlin. This work increased the Donlin resource estimate to 61 million tonnes of 3.4 g/t gold or 207, 400 kg (6.7 M oz) gold from all reserve categories (Dodd, 1996; Placer Dome Inc., 4/27/98 press release). In 2001, NovaGold Resources took over the exploration program at Donlin and based on further definition drilling and reassessment of former drill data, they announced even higher resource estimates. As of April 2003 the Donlin deposit is reported to contain 259 million tonnes grading 3.10 g/tonne gold or 792 tonnes (25.45 M oz.) gold (Szumigala and others, 2004).

Two additional occurrences were identified in the general Donlin area during the course of our studies. Both occurrences (nos. 189 and 197, table 1) are associated with granite porphyry dikes—grab samples from one occurrence contain up to 0.9 ppm Au, 1.5 ppm Ag, 6.4 ppm Hg, and 0.2 percent As; grab samples from the other contain up to 440 ppm Zn, 200 ppm As, 2.3 ppm Hg, and trace Ag. Placer gold production from the Donlin area amounts to about 730 kg (23,430 oz) gold and 31 kg (990 oz) silver from seven creeks that drain the mineralized area.

The northern-most peraluminous granite porphyry hosted gold-polymetallic occurrences in resource area 1d lie near Prince Creek (nos. 135 and 136, table 1)—one contains 2.9 ppm Au and 1.7 ppm Hg, the other contains greater than 1 percent Sb, 1 ppm Ag, 300 ppm Pb, 120 ppm As, and trace Au. In the central part of resource area 1d grab samples of granite porphyry dikes from two sites (nos. 157 and 170, table 1) contain 50 ppb Au and up to 1.8 ppm Hg.

Within resource area 1d, four sample sites near the Donlin prospects yielded anomalous metal values from stream-sediment, heavy-mineral-concentrate, and (or) aquatic moss samples. A stream-sediment sample from American Creek (just south of the Donlin prospects) contains 0.011 ppm Au and 110 ppm As. A stream-sediment sample from Queen Gulch contains 0.035 ppm Au, 100 ppm As, 0.5 ppm Ag, and 1.6 ppm Hg; the heavy-mineral-concentrate sample from this site contains more than 2,000 ppm Sn and less than 1 percent each of microscopically visible sphalerite, scheelite, and cinnabar. A stream-sediment sample from Snow Gulch contains 41 ppm As and the heavy-mineral concentrate contains 2,000 ppm Sn. A heavy-mineral concentrate from Dome Creek (near the northern border of the Donlin prospects) contains 1,000 ppm W and less than 1 percent microscopically visible cassiterite. Aquatic moss samples from three of these four sites contain as much as 200 ppm Sb and 5,000 ppm As. In the northern part of resource area 1d one stream-sediment sample contains 0.010 ppm Au and one heavy-mineral concentrate from a different site has less than 1 percent microscopically visible cassiterite.

Although outlined primarily as a gold-bearing resource area, 1d also carries a moderate potential for epithermal Hg-Sb deposits (underlying resource area 4m). At seven localities within area 1d (nos. 134, 168, 169, 171, 185, 186, and 187, table 1), grab samples of granite porphyry dike, or of country rock spatially associated with felsic dikes, contain anomalous Hg (1.2 to 7.1 ppm) and locally up to 700 ppm As.

Resource area 1d may originally have been contiguous with resource area 1a, but was offset from its northern half along the Iditarod-Nixon Fork Fault. Miller and Bundtzen (1988) proposed a right-lateral offset solution along the Iditarod-Nixon Fork Fault of about 90 km, based mainly on the apparent matching of nearly identical volcanic sections in the DeCourcy Mountain area on the south and the Beaver Mountains-Moore Creek region on the north. This same offset solution would effectively match the trend of the Donlin Creek granite porphyry dike and sill swarm (resource area 1d) with the Yankee Creek-Ganes Creek dike swarm (resource area 1a).

PLUTONIC-HOSTED COPPER-GOLD-POLYMETALLIC STOCKWORK AND VEIN DEPOSITS (MODEL 2)

Plutonic-hosted, copper-gold-polymetallic stockwork and vein deposits are located in the volcanic-plutonic complexes of the Iditarod-Flat, Moore Creek, and

Mount Joaquin areas. The volcanic-plutonic complexes are probably remnants of strato volcanoes emplaced in a back-arc setting during Late Cretaceous and early Tertiary time. Plutons and volcanic fields have been localized along zones of trans-tension in strike-slip fault systems such as the Iditarod-Nixon Fork Fault.

The monzonitic intrusions of the Iditarod-Flat area host the best examples of the mineral deposit model 2 type (Bull, 1988; Bundtzen and others, 1992). The intrusions are ilmenite-series, magnetite-poor (I type), meta-aluminous, alkali calcic to quartz alkalic suites that petrographically exhibit a well developed olivine-orthopyroxene-diopside-biotite differentiation trend. Feldspar geothermometry data indicate shallow, epizonal emplacement depths for the intrusions in the Iditarod-Flat area (Bull, 1988). Mineralogy of the deposits includes pyrite, free gold, arsenopyrite, scheelite, stibnite, silver sulfosalts, and minor cinnabar. Also sphalerite, chalcopyrite and molybdenite are found locally, and tantalum-enriched ilmenorutile and cassiterite, although rare, have also been noted in lodes of the Iditarod district (Bundtzen and others, 1992; Bundtzen and Miller, 1997). Principle metallic elements are copper, gold, silver, arsenic, and antimony. Elevated levels of lead, tungsten, bismuth, uranium, and molybdenum also occur in this deposit type. Silver/gold ratios from five plutonic-hosted copper-gold-polymetallic stockwork and vein deposits in the Kuskokwim mineral belt average 3.3:1 (Bundtzen and Miller, 1997).

A progressive sequence of mineralization spanning the mesothermal and epithermal temperature ranges is indicated by detailed studies in the Iditarod-Flat area (Bundtzen and others, 1992; Bull, 1988). Cinnabar-stibnite veins occur in the highest levels of the deposits, whereas higher temperature base-metal-dominant assemblages (mainly chalcopyrite/molybdenite-bearing vein stockwork) occur deeper and earlier in the hydrothermal systems. Most ore bodies are tabular to steeply dipping, due to the influence of high-angle structural controls.

Alteration types, where recognized, include biotite+potassium feldspar+quartz+dolomite+ankerite in plutonic centers and propylitic (chlorite-iron oxide) alteration distal from intrusive centers. Silicic, phyllic, gypsum, and alunite-kaolin zones typical of "gold porphyry" deposits (Vila and Sillitoe, 1991; Rytuba and Cox, 1991) are absent. Secondary biotite and sericite alteration ubiquitously occur in the hornfels sedimentary rock in the contact zone and also in most plutonic phases. Bull (1988) identified dolomite breccias associated with late phases of mineralization at the Golden Horn deposit (no. 110, table 1 and map A). Overall, lodes in the Iditarod-Flat area are gold-base metal stockworks superficially similar to those found in alkalic copper-gold stockwork porphyry and vein systems described by Vila and Sillitoe (1991) and by Cox (1986b, model 20c). Associated mineralized veins and shear zones, such as the Golden Ground (no. 87, table 1 and map A) and Golden Horn deposits correspond to deposit model 22c (polymetallic veins) of Cox (1986a).

Resource area 2a, Mount Joaquin

Resource area 2a (map B) has a high potential (certainty level C) for containing plutonic-hosted copper-gold-polymetallic deposits; it also has a moderate potential (certainty level C) for the plutonic-related, boron-enriched silver-tin-polymetallic deposit type. The area includes the 12-km^2 monzonite-monzodiorite composite pluton (unit TKm) on Mount Joaquin and the surrounding hornfels sedimentary rock. One prospect near the summit of the mountain (no. 32, table 1) consists of thin, gold-bearing veins that contain cinnabar and arsenopyrite. The veinlets cut both intrusive rock and small roof pendants of calcareous sandstone of the Kuskokwim Group along a N. 10º W. to N. 10º E. fracture system. The veinlets range from 10 cm to 100 cm in width and extend along strike for about 150 m, based on limited surface trenching. Disseminated chalcopyrite occurs in a 200-m^2 area of silicified monzonite about 1 km west of the arsenopyrite-cinnabar quartz veinlets described above. Weak to moderate secondary biotite alteration envelopes both mineralized areas.

In the reconnaissance geochemistry study, samples collected within or downstream from resource area 2a provide supportive data. Four stream-sediment samples contain Au ranging from 0.011 to 0.018 ppm. Of these samples, three also contain Hg (1.3 to 22.2 ppm). Heavy-mineral concentrates collected at these latter three sites also contain microscopically visible cinnabar (1 to 20 percent), scheelite (up to 5 percent), and locally gold (<1 percent) and 1,000 ppm W. The gold-bearing site (no. 33, table 1) is downstream from the lode prospect discussed above. One additional stream-sediment sample contains 300 ppm Zn. One aquatic moss sample contains 200 ppm As.

Resource area 2b, Moore Creek

Resource area 2b (map B) has a high potential (certainty level D) for containing plutonic-hosted copper-gold-polymetallic deposits; it also has a moderate potential (certainty level C) for the plutonic-related, boron-enriched silver-tin-polymetallic deposit type. The area includes monzonite to quartz monzonite stocks (unit TKm) that intrude coeval volcanic rocks (the Iditarod Volcanics, units TKil and Kit) near Maybe, Willow, and Moore Creeks. The volcanic-plutonic complex intrudes and overlies Kuskokwim Group sedimentary rocks (unit Kks). Hornfels aureoles extend about 1 km from the contacts of the exposed intrusive rocks and local areas of gossan occur in the volcanic rocks. The stocks are aligned along a north-trending zone suggesting emplacement was structurally controlled (Bundtzen and others, 1988). West of the plutons, distinctive boron metasomatism has replaced original volcanic textures in host rocks. In effect, the plutonic-related, boron-enriched silver-tin-polymetallic deposit type is superimposed over the plutonic-hosted copper-gold-polymetallic deposit type in the Moore Creek area suggesting they are metallogenically related, perhaps through hydrothermal zonation.

Plutonic-hosted copper-gold-polymetallic type deposits and placer gold mineral occurrences are associated with the stocks and locally with hornfels in resource area 2b. The Broken Shovel prospect (no. 82, table 1), is a mesothermal, sulfide-tourmaline greisen developed in the stock near Moore Creek. Ore minerals identified include tetrahedrite, arsenopyrite, and scheelite, which collectively comprise 5–10 percent of the greisen-vein system (Bundtzen and others, 1988). Secondary biotite floods fractures and locally groundmass in hornfels and plutonic rocks. The rest of the occurrences and rock anomalies within resource area 2b are associated with volcanic or sedimentary rocks in the hornfels aureole. In the western part of the resource area, a grab sample of hornfels volcanic rock contains 0.85 ppm Ag, 200 ppm Pb, 9.5 ppm Hg, and 60 ppm As (no. 59, table 1). Also in the west, a grab sample of iron-oxide stained volcanic rock contains slightly elevated Hg (no. 57, table 1). In the northern part of resource area 2b, scattered silver-mercury-gold anomalies are associated with shear and fracture zones in the Iditarod Volcanics. One mineral occurrence (no. 62, table 1) contains up to 5.1 ppm Ag and 5 ppm Hg. Grab samples from two other sites (nos. 61 and 63, table 1) contain up to 1.4 ppm Au, 0.2 ppm Ag and more than 10 ppm Hg.

Placer deposits containing gold, silver, chromite, and cinnabar are found downslope or downstream from the exposed stocks in resource area 2b. The two placer mines in the area have together produced at least 1,723 kg (55,420 oz) gold and 391 kg (about 12,600 oz) silver. The source of gold for the placer deposit at the head of Fourth of July Creek (no. 60, table 1) is believed to be the nearby monzonite stock. All placer gold produced from Moore Creek (no. 83, table 1) is believed to be derived from the mineralized Moore Creek pluton. The placer mine concentrates from Moore Creek also contain high amounts of chromite (Bundtzen and others, 1988), but the source is uncertain. Chromite was identified from mafic phases of the Black Creek stock in the Iditarod-Flat area (Bull, 1988); such phases have not been recognized in the Moore Creek pluton, but exposure is poor. The pluton exposed near Maybe Creek is the likely source of gold panned from Maybe Creek (no. 58, table 1). The lode source for an unexploited placer deposit on Deadwood Creek (no. 56, table 1) may also be this same pluton. Two additional placer gold occurrences (St. Patrick Creek, no. 57 and Willow Creek, no. 81, table 1) also lie downstream from monzonite stocks of resource area 2b. One placer gold occurrence (no. 55, table 1) lies west of resource area 2b, but the source is uncertain.

Stream-sediment samples collected during the reconnaissance geochemical survey add additional support for designation of resource area 2b. Stream-sediment samples collected from Willow Creek locally contain up to 0.077 ppm Au and 23 ppm As; heavy-mineral concentrates from these same sites contain up to 500 ppm Pb, 1,500 ppm W, and more than 5,000 ppm B (and also have less than 1 percent microscopically visible cassiterite). A stream-sediment sample from north of VABM Willow has 0.056 ppm Au; the heavy-mineral concentrate contains 5,000 ppm W and more than 5,000 ppm B. From the head of Fourth of July Creek, one stream-sediment sample contains 0.88 ppm Hg; the heavy-mineral concentrate from that site contains 5,000 ppm Sb, 500 ppm W, and more than 2,000 ppm Sn (plus 1–5 percent microscopically visible cinnabar); a nearby heavy-mineral-concentrate sample contains 5,000 ppm B. In the northern part of resource area 2b, one stream-sediment sample contains 30 ppm As and a heavy-mineral concentrate from a different site has microscopically visible cinnabar (1–5 percent) and chalcopyrite (<1 percent), and contains more than 5,000 ppm B. In the western part of the resource area, one heavy-mineral concentrate has microscopically visible gold (no. 55, table 1, mentioned above), cinnabar (1–5 percent), and scheelite (<1 percent), and contains 300 ppm Ag and more than 1,000 ppm Au. Another heavy-mineral concentrate from a site 2 km northwest contains 50 ppm Ag, 500 ppm Au, 100 ppm Mo, and 500 ppm W. Two additional heavy-mineral concentrates from the western part of the resource area contain up to 200 ppm W. Scattered aquatic moss samples from resource area 2b contain up to 200 ppm Sb.

Resource area 2c, Fourth of July Creek area

The small resource area 2c (map B) has a moderate potential (certainty level B) for containing plutonic-hosted copper-gold-polymetallic deposits; it also has a moderate potential (certainty level B) for the plutonic-related, boron-enriched silver-tin-polymetallic deposit type. The area consists of a small monzonite intrusion (unit TKm) and the surrounding hornfels sedimentary rock near the Bonnie Creek-Fourth of July Creek divide in the vicinity of the Iditarod-Nixon Fork Fault. The monzonite hosts mineralized rock containing base metal sulfides, but the extent is uncertain. A single grab sample (86BT93; no. 64, table 1) of monzonite near hornfels contains anomalous silver (1 ppm), zinc (190 ppm), and arsenic (30 ppm). No stream-sediment samples, heavy-mineral concentrates, or aquatic moss samples were collected in this immediate area.

Resource area 2d, Iditarod-Flat area

Resource area 2d (map B) has a high potential (certainty level D) for containing plutonic-hosted copper-gold-polymetallic deposits; it also has a moderate potential (certainty level C) for the plutonic-related, boron-enriched silver-tin-polymetallic deposit type. The area includes three alkali gabbro to quartz monzonite composite stocks (unit TKm), the hornfels volcanic and sedimentary rocks they intruded (units TKil and Kks, respectively), and numerous small dikes of intermediate to mafic composition (unit TKd). The monzonitic stocks line up along a north-northeast-trending high-angle fault. Resource area 2d contains the placer gold deposits of the Iditarod-Flat area (nos. 89, 104–107, 109, 111, 112, 129, 131, and 132, table 1 and map A), which up to 1990, had produced about 45,200 kg (1,450,000 oz) of gold and about 6,100 kg (197,000 oz) of silver (Bundtzen and others, 1992). This amount of gold production is about 1,000 kg higher than the amount obtained by adding together the production figures listed in table 1; as indicated in a previous section, recorded production figures are commonly provided by district, and the numbers are difficult to restore creek by creek. The Golden Horn lode mine (no. 110, table 1) produced an additional 84.2 kg (2,707 oz) of gold, 81.5 kg (2,620 oz) of silver, 4,235 kg lead, and 296 kg of zinc.

Polymetallic-gold deposits hosted in the intrusive rocks of the Flat area have been described in detail by Bull (1988), Bundtzen and others (1992), and Bundtzen and Miller (1997) and will be briefly summarized here. Principle deposits include the Golden Horn, Chicken Mountain, Malamute Pup, and the Idaho (nos. 110, 130, 111, and 105, respectively, table 1). The best known of these are the Golden Horn and Chicken Mountain deposits. Most deposits are shallow, cupola-hosted, vein-fault and quartz stockwork concentrations of gold, silver, arsenic, antimony, mercury, and tungsten. Mineral assemblage and geothermometry estimates summarized by Bundtzen and others (1992) and Bull (1988) indicate that all mineral deposits in the Flat area represent a zoned hydrothermal system now exposed at several erosional levels. Highest temperature/pressure mineral assemblages (mesothermal) were deposited early in the deepest structural levels whereas lowest temperature/pressure mineral assemblages were subsequently deposited in high level, near-surface environments. On the basis of their own surface sampling and limited underground control (drilling) made available by private firms, Bundtzen and others (1992) estimated that the Golden Horn deposit contains inferred reserves of 2.85 million tonnes grading 1.2 g/tonne gold and 3.4 grams/tonne silver, 1.9 percent arsenic, and 2.0 percent antimony. The Chicken Mountain deposit contains about 14.5 million tonnes grading 1.2 g/tonne gold, 4.6 g/tonne silver, 0.09 percent copper, and 0.46 percent antimony (Bundtzen and Miller, 1997). Both estimates of the resource are judged to be conservative.

Three other prospects and one occurrence in resource area 2d are associated with fractured hornfels rather than directly with the exposed stocks. The Golden Ground prospect north (no. 87, table 1) and the nearby unnamed prospect (no. 88, table 1) contain gold-bearing quartz veins that cut brecciated country rock. Samples from Golden Ground contain up to 50 g/tonne gold and 2 kg/tonne silver; grab samples from the nearby prospect contain up to 1.0 ppm Au and Ag; both prospects also have anomalous Sb, As, W, and Hg. An unnamed prospect (no. 108, table 1) that lies between the Golden Horn and Chicken Mountain deposits has quartz veins in sandstone hornfels that contain 11 ppm Au and 7 ppm Ag. On the south side of Chicken Mountain, an occurrence near Prince Creek (no. 133, table 1) consists of veinlets containing 3.4 ppm Au, 10 ppm Ag, 1,380 ppm W, and visible cinnabar that cut hornfels and an intermediate dike(?).

Stream-sediment, heavy-mineral-concentrate, and locally aquatic moss samples collected during the reconnaissance geochemical survey add supportive data for resource area 2d. One sample site (I0374) near the placer workings of Black Creek (no. 109, table 1) yielded 1.55 ppm Au and 1.0 ppm Ag in the stream sediment; 500 ppm Ag, 3,000 ppm Sb, 1,500 ppm As, 2,000 ppm W, and 50 ppm Bi in the heavy-mineral concentrate; 1–5 percent microscopically visible gold and scheelite; and 2,000 ppm As and 100 ppm Sb in aquatic moss samples. Other samples collected downstream from Chicken Mountain locally contain up to 23 ppm As, 0.5 ppm Ag, 200 ppm Cu, and more than 34 ppm Hg in stream-sediment samples. One heavy-mineral concentrate collected on the south side of Chicken Mountain contains 50 ppm Ag. An aquatic moss sample from a creek draining to the north of Chicken Mountain contains 3,000 ppm As. Two sample sites from the part of resource area 2d north of Otter Creek also yielded anomalous values. A stream-sediment sample from one site contains 22.2 ppm Hg; the heavy-mineral concentrate from this site contains 70 ppm Ag, 500 ppm Au, and 1,000 ppm W and has 5–20 percent each microscopically visible cinnabar and scheelite. A heavy-mineral concentrate from the other site contains 500 ppm Sb and 200 ppm W.

Resource area 2e, Mosquito Mountain

Resource area 2e (map B), in the extreme southwest corner of the quadrangle, has a high potential (certainty level C) for containing plutonic-hosted copper-gold-polymetallic deposits; it also has a moderate potential (certainty level B) for the plutonic-related, boron-enriched silver-tin-polymetallic deposit type. The area is centered around Mosquito Mountain where several flow, tuff, and locally sill-like bodies of intermediate composition (unit Kka) are interbedded with shallow marine to nonmarine sandstone, conglomerate and shale of the Kuskokwim Group (unit Kkq). A number of thin, discontinuous, altered intermediate dikes (unit TKd) and at least one granite porphyry dike (unit TKgp) locally intrude the sedimentary rocks. Biotite from an interbedded andesite tuff yielded a K-Ar age of 77 Ma (Miller and Bundtzen, 1994); however, the hypabyssal porphyry bodies exhibit extensive hydrothermal alteration and were not isotopically dated. The sedimentary rocks locally exhibit effects of thermal metamorphism (hornfels) near many of the sill-like intrusive bodies. Whereas the geology underlying resource area 2e does not include the monzonitic intrusive rocks associated with the other areas of high potential for the plutonic-hosted copper-gold-polymetallic deposit type (2a to 2d, above), the geochemical signatures exhibited in both rock and stream-sediment samples suggest this model type.

Resource area 2e contains one mineral occurrence (no. 174, table 1) that seems to fit the plutonic-hosted copper-gold-polymetallic deposit type with the exception that it does not contain detectable gold. At this locality, grab samples of gossan in hornfels sedimentary rock contain up to 0.7 ppm Ag, 640 ppm Zn, 500 ppm Cu, 110 ppm Sb, and 6 ppm Bi. Grab samples from six other sites lend support for designation of this resource area, but their elemental suites are ambiguous with respect to model type. At five of these sites (nos. 176, 177, 178, 179, and 203, table 1), gossan zones occur in hornfels, usually in vicinity of igneous rock. Grab samples variously contain up to 0.7 ppm Au and 1.4 ppm Hg (at no. 176, table 1), up to 10 ppm Ag (at no. 203, table 1), and up to 200 ppm Zn and 400 ppm As (nos. 178 and 179, table 1). At one additional site (no. 175, table 1), a grab sample of intermediate volcanic rock interbedded with sandstone contains 34 ppm Sb.

Two heavy-mineral concentrates in resource area 2e yielded anomalous metal values. One sample from American Creek contains 200 ppm Ag, 70 ppm Bi, and more than 1,000 ppm Au; this sample also has visible gold (no. 204, table 1). Another sample from a creek draining the northwest side of Mosquito Mountain contains 20 ppm Ag and 200 ppm Au; the stream-sediment sample contains 1.1 ppm Hg.

The NURE reconnaissance lake-sediment data provide some additional support for resource area 2e. Using R-mode factor analysis, Gray and others (1988c) outlined an area that lies in the southwest corner of the Iditarod quadrangle (see their fig. 1) that fits their precious-metal related factor (As-Mn-Fe) outlined for the lake-sediment data set.

PLUTONIC-RELATED, BORON-ENRICHED, SILVER-TIN POLYMETALLIC DEPOSITS (MODEL 3)

Like the copper-gold polymetallic deposits (model 2) described above, the silver-tin-polymetallic deposits are associated with volcanic-plutonic complexes. The host composite plutons for both model types range from diorite to quartz syenite in composition and show progressive mineralogical differentiation, including early olivine, clinopyroxene, and later biotite. Hornblende is commonly found as a mineral phase in plutons associated with mineral deposit model 3, whereas it is commonly absent in the plutons associated with mineral deposit model 2. The stocks and plutons associated with the silver-tin polymetallic deposits (model 3) contain intensive boron metasomatism, which, although sometimes locally present, is not characteristic of the intrusive rocks associated with the copper-gold-polymetallic deposits. The K/Ar isotopic ages obtained from plutons associated with both deposit types range from 73 to 59 Ma (Miller and Bundtzen, 1994). Based on these limited data, there are two distinct crystallization age groups—63 to 59 Ma and 73 to 68 Ma. The older ages are associated with deposits of both model types 2 and 3, but with one exception (a mafic phase from north of Chicken Mountain), all of younger ages come from plutons associated with the boron-enriched, silver-tin-polymetallic type deposits (at Swinging Dome, Granite Mountain, and VABM Tatalina). This younger age range is the same age as the McKinley plutonic suite in the southern Alaska Range and also Sleitat Mountain, northwest of Iliamna, both of which host stanniferous, “S” type leucogranites (Reed and Lanphere, 1969; Reed and others, 1978).

The plutonic-related, boron-enriched, silver-tin-polymetallic deposits of the Iditarod quadrangle exhibit the following morphological types: (1) en echelon, stockwork-like, tourmaline-quartz (sulfide) veining in high-level plutonic cupola phases; (2) circular or dumbbell-shaped, tourmaline-axinite breccia pipes in both plutonic rocks or overlying hornfels; and (3) large tourmaline-sulfide flooding zones in hornfels and altered volcanic rocks showing extensive replacement by both tourmaline and brown to purple axinite. Accompanying the boron metasomatism are multiple phases of sulfide and metallic oxide mineralogy that includes chalcopyrite, sphalerite, galena, arsenopyrite, pyrite, and minor cassiterite, scheelite, Bi-sulfosalts, and ilmenorutile. Silver/gold ratios average about 3,000:1 from five representative deposits of this type in the Kuskokwim mineral belt (Bundtzen and Miller, 1997). In addition to silver and tin, these complex mineral deposits contain variable amounts of copper, zinc, arsenic, antimony, niobium, lead, tantalum, indium, and bismuth.

Bundtzen and Miller (1997) classified the plutonic-related, boron-enriched, silver-tin-polymetalllic deposits in the Kuskokwim mineral belt into both 20a (porphyry tin; Reed, 1986) and 20b (Sn polymetallic; Togashi, 1986) deposit models. Regardless of specific deposit correlation, the plutonic-related, boron-enriched, silver-tin-polymetallic deposits of the Iditarod quadrangle constitute an important deposit type only recently recognized in the region that may eventually prove to contain significant resources of tin, silver, and other commodities.

Resource area 3a, Beaver Mountains

Resource area 3a (map B), the Beaver Mountains, has a high potential (certainty level D) for containing plutonic-related, boron-enriched silver-tin-polymetallic deposits; it also has a moderate potential (certainty level C) for the plutonic-hosted copper-gold-polymetallic deposit type. The area is underlain by a volcanic-plutonic complex consisting of monzonite-quartz monzonite intrusive rocks (unit TKm) and coeval volcanic rocks (units TKil and Kit); hornfels is found locally in the volcanic rocks and in the surrounding Kuskokwim Group flysch (unit Kks) that the complex intrudes and overlies. The Beaver Mountains are cut by numerous high-angle faults.

Plutonic-related, boron-enriched silver-tin-polymetallic deposits occur in large zones of boron metasomatism throughout the Beaver Mountains igneous complex and adjacent hornfels. Four morphological deposit types have been recognized: (1) large and aerially extensive tourmaline-rich breccia pipes and replacement zones in cupolas of the Beaver Mountains stock (Tolstoi deposit, no. 6, table 1; Bundtzen and Laird, 1982; Bundtzen and Miller, 1997); (2) structurally controlled tourmaline-sulfide zones along faults and joints (Cirque deposit, no. 28, and nos. 27, 29, and 30, table 1; Bundtzen and Laird, 1982; Bundtzen and Miller, 1997); (3) intrusion-hosted stockworks (nos. 7 and 31, table 1); and (4) axinite-tourmaline-rich replacements in hornfels breccias or overlying altered volcanic rocks sometimes containing massive sulfides (nos. 8 and 9, table 1). Visible gold was found on Tolstoi Creek, which drains north from the Beaver Mountains (no. 5, table 1). This gold may be from a reworked auriferous terminal moraine, but was probably originally derived from the Beaver Mountains.

Intrusion-hosted mineral deposits (1–3 above) typically contain variable amounts of chalcopyrite, arsenopyrite, pyrite, and minor galena, cassiterite, and scheelite. Hornfels or volcanic-hosted occurrences can contain abundant pyrrhotite, marcasite, and minor arsenopyrite, but rarely other base metal sulfides. The Tolstoi deposit contains the largest zones of boron-sulfide metasomatism. Metal grades are erratic, but three prominent tourmaline breccia pipes total a minimum of 1.50 million tonnes of mineralized rock (Cu, Ag, Pb, and Zn). The Cirque deposit contains the best average grade data. The 159-m-long and 3-m-wide zone identified on the surface contains an inferred reserve of 175,000 tonnes grading 3.5 percent copper, 445 g/tonne silver, and containing anomalous tin, niobium, lead, and zinc. Taken as a whole, the plutonic-related, boron-enriched silver-tin-polymetallic deposits and occurrences in the Beaver Mountains contain up to 20 percent copper, 1,000 g/tonne silver, 2.0 percent arsenic, 1,000 ppm tin, 300 ppm tungsten, 0.79 percent lead, 1,000 ppm niobium, 40 ppm beryllium, and 2 g/tonne gold.

Resource area 3a contains two additional known sites of mineralized rock, but these do not appear to be of the plutonic-related, boron-enriched silver-tin-polymetallic deposit type. Near Lincoln Creek, an area of altered mafic and felsic dikes that cut Kuskokwim Group sedimentary rock adjacent to a high-angle fault has been prospected (no. 44, table 1). Fine gold was reportedly panned from prospect pits during exploratory work (Joe Degnan, oral commun., 1979). Grab samples from this study contain up to 0.15 ppm Ag and 1.3 ppm Hg. In the western Beaver Mountains grab samples from an iron-oxide stained zone in a volcanic rock roof pendant (no. 4, table 1) contain up to 200 ppm Zn and more than 10 ppm Hg.

Resource area 3a is supported by geochemical anomalies in numerous stream-sediment, heavy-mineral-concentrate, and aquatic-moss samples. In creeks draining west, north, and east from the Beaver Mountains, Au values are found in 11 stream-sediment samples (0.010–0.79 ppm) and two heavy-mineral concentrates (8 and 700 ppm). The west-draining headwaters of Billy Goat Creek include the Cirque prospect (no. 28, table 1) and two other lode localities (nos. 27 and 30, table 1). Seven sites in this area yielded anomalous samples: stream-sediments from two of the seven sites contain Au (0.010 and 0.079 ppm), and locally the seven sites contain up to 2 ppm Ag, 200 ppm Cu, 150 ppm Pb, 120 ppm As, 0.94 ppm Hg, 20 ppm Sn, and 2,000 ppm B; heavy-mineral concentrates contain up to 100 ppm Ag 500 ppm W, more than 2,000 ppm Bi, and more than 5,000 ppm B; and aquatic moss samples locally contain up to 5 ppm Ag, 1,000 ppm As, and 70 ppm Sb. In the west-draining headwaters of Windy Creek, six sites yield anomalous values: stream sediments from four of six sites contain Au (0.010 to 0.015 ppm), and locally the six sites contain up to 130 ppm As, up to 100 ppm Cu, up to 7 ppm Mo, up to 150 ppm Pb, and up to 30 ppm Sn; one heavy-mineral concentrate contains 500 ppm W; and two aquatic moss samples contain up to 7 ppm Ag and 1,000 ppm As. From drainages in the northern part of the Beaver Mountains (including the Tolstoi prospect and the Tolstoi Lake occurrence, nos. 6 and 7, table 1), seven stream sites yield anomalous values: stream sediments from two of the seven sites contain Au (0.016 and 0.027 ppm), and locally the seven sites contain up to 50 ppm Sn, 500 ppm Zn, 1.6 ppm Hg, and 2,000 ppm B; four heavy-mineral concentrates contain up to 500 ppm W, 300 ppm Pb, 1,500 ppm Sn, and more than 5,000 ppm B; one heavy-mineral concentrate contains microscopically visible gold, cinnabar, and chalcopyrite (no. 5, table 1); and one moss sample contains 200 ppm As. The east-draining creeks (Brown, Beaver, and Ganes Creeks) have ten anomalous sites between them: stream sediments from three of the ten sites contain Au (0.010–0.056 ppm), and locally the ten sites contain up to 1.5 ppm Ag, 180 ppm As, 1.5 ppm

Hg, 150 ppm Pb, 20 ppm Sn, 300 ppm Zn, and 2,000 ppm B; five heavy-mineral concentrates contain up to 300 ppm Cu, 300 ppm W, and locally more than 2,000 ppm Sn; aquatic moss locally contains up to 5 ppm Ag and 1,000 ppm As. The east-facing drainage basin that lies just south of the headwaters of Ganes Creek yielded three anomalous sample sites: a heavy-mineral concentrate from one of the three sites contains 700 ppm Au and 100 ppm Ag; stream sediments locally contain up to 1.0 ppm Ag, 75 ppm As, 70 ppm Pb, 300 ppm Zn, and 2,000 ppm B; one aquatic moss contains 5 ppm Ag. Creeks draining the south side of the Beaver Mountains yielded no Au values, but stream-sediment samples locally contain up to 21 ppm As, 6.6 ppm Hg, and 70 ppm Pb.

The NURE reconnaissance stream-sediment data provide some additional support for resource area 3a. Using R-mode factor analysis Gray and others (1988c) outlined two areas, one east and one west of the Beaver Mountains (see their fig. 1) that fits their base-metal related factor (Cu-Cs-Ni) outlined for the stream-sediment data set.

Resource area 3b, Takotna Mountain

Resource area 3b (map B), Takotna Mountain, has a high potential (certainty level C) for containing plutonic-related, boron-enriched silver-tin-polymetallic deposits; it also has a moderate potential (certainty level C) for the plutonic-hosted copper-gold-polymetallic deposit type. The area is underlain by a 16-km^2 volcanic-plutonic complex (units TKm and TKil) and the surrounding hornfels sedimentary rock (unit Kks) on the Iditarod-McGrath quadrangle boundary. Stockwork-like tourmaline-quartz veins occur in the western part of the monzodiorite pluton near the hornfels contact zone. A mineral occurrence of iron-rich hornfels and breccia containing up to 13.7 ppm Ag, 280 ppm Cu, 1,050 ppm Zn, and 0.03 ppm Au lies along the pluton's southern border (no. 23, table 1). Grab samples of monzonite cut by sulfide-bearing veins and of iron-oxide stained hornfels sandstone from the western part of the resource area (no. 22, table 1) contain up to 0.3 ppm Ag, 30 ppm As, 1.1 ppm Hg, and trace Au. Samples of altered intrusive and hornfels volcanic rock from Takotna Mountain in the McGrath quadrangle contain up to 0.6 ppm Ag, 222 ppm Cu, and 100 ppm Pb (Bundtzen and Laird, 1983).

In the reconnaissance drainage-basin study, samples collected from three sites within or downstream from resource area 3b yielded anomalous values. One stream-sediment sample from the southern part of the area contains 0.010 ppm Au. In the central part of the area a stream-sediment sample contains 35 ppm As and the heavy-mineral concentrate from the same site contains 300 ppm W, 50 ppm Mo, and more than 2,000 ppm Sn. One heavy-mineral concentrate from a creek draining the northern part of the area contains 500 ppm Pb.

Resource area 3c, VABM Tatalina area

Resource area 3c (map B), near VABM Tatalina in the eastern part of the study area, has a high potential (certainty level D) for containing plutonic-related, boron-enriched silver-tin-polymetallic deposits; it also has a moderate potential (certainty level C) for the plutonic-hosted copper-gold-polymetallic deposit type. The area includes two quartz monzonite to syenite plutons (unit TKm) and granite porphyry dikes and stocks (unit TKgp) that intrude rocks of the Kuskokwim Group (unit Kks). A 2-km aureole of hornfels surrounds the pluton underlying VABM Tatalina; the igneous-sedimentary rock contact of the other pluton is concealed. An extensive area (2 km^2) of manganese-rich, tourmaline-quartz-biotite breccia in this hornfels yields consistent values of up to 5 ppm Ag and 100 ppm Cu (no. 49, table 1). Down slope from the prospect, stream cobbles contain up to 33 ppm Ag, 0.10 ppm Au, 1,100 ppm As, and 500 ppm Pb (no. 48, table 1). In the western part of the resource area, grab samples from a sheared contact zone between a granite porphyry stock and hornfels sandstone contain up to 1 ppm Hg and 500 ppm As (no. 47, table 1).

In the reconnaissance drainage-basin study, samples collected from six sites within or downstream from resource area 3c yield anomalous values in stream sediment, heavy-mineral concentrate, or aquatic moss. Three of sample sites were collected from streams that drain the eastern part of the area, in the vicinity of VABM Tatalina. At one of these sites, an aquatic moss sample contains 50 ppm As. The other two sites, which are downslope from the prospect discussed above (no. 49, table 1), contain up to 3 ppm Ag, 120 ppm As, 200 ppm Pb, 15 ppm Sn, and 15 ppm Bi in stream-sediment samples; up to 15 ppm Ag, 1,000 ppm As, 5,000 ppm Pb, more than 2,000 ppm Bi, and more than 5,000 ppm B in heavy-mineral concentrates; and up to 3 ppm Ag in aquatic moss. A heavy-mineral concentrate collected from the same drainage during an earlier study contains 23 ppm Ag, 5,700 ppm Pb, and trace Au (no. 48, table 1; site 79BT104, Bundtzen and Laird, 1983). Heavy-mineral concentrates collected from three sites downslope from the quartz monzonite pluton in the central part of resource area 3c contain up to 2,000 ppm Sb; one of these samples also contains 1–5 percent microscopically visible cassiterite.

Resource area 3d, Camelback Mountain

Resource area 3d (map B) has a high potential (certainty level D) for containing plutonic-related, boron-enriched silver-tin-polymetallic deposits; it also has a moderate potential (certainty level C) for the plutonic-hosted copper-gold-polymetallic deposit type. The area is underlain by the Iditarod Volcanics (units TKil and Kit) and to a lesser extent by the Kuskokwim Group (unit Kks), all of which are intruded by monzonitic plutons (unit TKm).

Mineralized rock in resource area 3d occurs as: (1) sulfide-bearing zones in hornfels immediately adjacent to plutonic contacts; and (2) disseminated and vein sulfides in volcanic rocks distant from the known intrusive rocks. Grab samples of quartz-sulfide veins in hornfels sandstone just north of the Camelback pluton contain up to 12 ppm Ag, 710 ppm As, 600 ppm Zn, 500 ppm Pb, 70 ppm Sb, 35 ppm Cd, 300 ppm Ni, 4.2 ppm Hg, and more than 2,000 ppm B (no. 77, table 1). Samples of sulfide-rich fault breccia in hornfels west of the pluton contact contain up to 0.2 ppm Au, 2.9 ppm Ag, 210 ppm Cu, 349 ppm Zn, 127 ppm As, and 3 ppm Hg (no. 76, table 1). A sample from a 25-cm wide pyrrhotite pod in hornfels south of the pluton contains 2.6 ppm Ag, 891 ppm Cu, 304 ppm Zn, 1.68 percent Mn, and 28 percent Fe (no. 98, table 1). One mineral occurrence and two rock geochemical anomalies are found more distant from the monzonitic intrusives of the Camelback area. In the northern part of the resource area, a grab sample of altered mafic tuff has disseminated sulfides and contains 100 ppm Mo, 500 ppm As, 100 ppm Cu, 30 ppm Sb, 1.1 ppm Hg, and 50 ppb Ag (no. 79, table 1). At two sites elsewhere in the resource area grab samples of volcanic rock locally contain up to 1.4 ppm Hg, 50 ppm As, and 200 ppm Sb (nos. 78 and 80, table 1).

In the reconnaissance drainage-basin study, several samples containing anomalous values were collected downstream from area 3d. They include: one stream sediment containing 22 ppm As and another containing 140 ppm As and 5 ppm Mo; one heavy-mineral concentrate containing 3,000 ppm Zn and another containing 5,000 ppm B; one heavy-mineral concentrate containing 1–5 percent microscopic scheelite and another containing less than 1 percent cassiterite; and one aquatic moss containing 2,000 ppm As.

Resource area 3e, northeast of Flat

Resource area 3e (map B) has a high potential (certainty level C) for containing plutonic-related, boron-enriched silver-tin-polymetallic deposits; it also has a moderate potential (certainty level C) for the peraluminous granite-porphyry-hosted gold-polymetallic deposit type. Area 3e lies to the northeast of resource area 2d, the Iditarod-Flat area, where several monzonitic stocks and plutons (unit TKm) intrude along a generally north-trending linear zone, and which is classified as having a high potential for the plutonic-hosted copper-gold-polymetallic deposit type. Resource area 3e has no exposed monzonite, but does have a 2–3 km^2 hornfels zone in Kuskokwim Group sedimentary rock (unit Kks) that indicates the presence of underlying intrusive rock (perhaps monzonite), and also has numerous granite porphyry dikes and sills (unit TKgp) and intermediate dikes (unit TKd) that cut the sandstone country rock. As at Moore Creek (resource area 2b), plutonic-hosted copper-gold-polymetallic mineralizing systems and plutonic-related, boron-enriched silver-tin-polymetallic systems appear to overlap and may be metallogenically related. Boron metasomatism—largely absent in the stocks of the Iditarod-Flat area—is extensively developed in a pronounced hornfels in area 3e north of Granite Creek and in the small granite porphyry dikes and sills.

Four known mineral occurrences help define resource area 3e and at each locality, mineralized rock is associated with intrusive rocks (mostly dikes) and nearby sandstone hornfels. In the western part of the resource area, samples from a zone of quartz vein stringers and iron-oxide stained sandstone hornfels spatially associated with a granite porphyry dike contain up to 200 ppm Ag, 2.0 percent Pb, more than 0.2 percent Sb, 0.2 percent Zn, 200 ppm Cu, 50 ppm Sn, 0.16 percent As, 100 ppm Cd, and 18 ppm Bi (no. 90, table 1). At a locality 1.5 km to the north, extensive tourmaline alteration is found in intermediate dikes and the enclosing sandstone; samples contain up to 200 ppm Sn, 500 ppm Zn, 500 ppm Sb, 480 ppm As, 200 ppm Pb, 46 ppm Bi, 1 ppm Ag, trace Au, and more than 2,000 ppm B (no. 91, table 1). Another 2 km north, a grab sample of sandstone hornfels in the vicinity of a dike(?) contains 2 ppm Ag, 850 ppm As, 200 ppm Cu, 52 ppm Bi, 30 ppm Sn, and 50 ppb Au (no. 92, table 1). In the central part of the resource area, quartz veinlets cut sandstone, sandstone breccia, and granite porphyry dike; samples contain up to 1.2 ppm Ag, 0.2 ppm Au, 290 ppm Sb, 130 ppm As, and trace Hg (no. 93, table 1).

In the reconnaissance drainage-basin study, samples collected from ten sites within or downstream from resource area 3e yield anomalous values in stream sediment, heavy-mineral concentrate, and locally aquatic moss. Creeks that drain to the north and northwest from area 3e show the following anomalies: stream-sediment samples contain up to 1 ppm Ag, 190 ppm As, and 50 ppm Bi; two heavy-mineral concentrates contain 200 ppm Sb, one from another site contains 200 ppm Ag and more than 1,000 ppm Au, and one from a fourth site contains 2,000 ppm Sn; another heavy-mineral concentrate contains 1–5 percent microscopically visible cassiterite; one aquatic moss sample contains 5,000 ppm As. Creeks that drain to the south and southeast from area 3e show the following anomalies: one stream-sediment sample contains 30 ppm Sn and another contains less than 0.5 percent Ag; the heavy-mineral concentrate from the latter site contains 1,000 ppm W and two other concentrates contain up to 20 ppm Ag, 10,000 ppm Sb, and 2,000 ppm W.

Resource area 3f, Swinging Dome

Resource area 3f (map B) has a moderate potential (certainty level B) for containing plutonic-related, boron-enriched silver-tin-polymetallic deposits; it also has a moderate potential (certainty level B) for the plutonic-hosted copper-gold-polymetallic deposit type. The resource area is underlain by biotite-pyroxene-quartz monzonite to biotite-hornblende granodiorite (unit TKm) that intrudes a more quartz-rich facies of the Kuskokwim Group (unit Kkq, shoreline facies of Miller and Bundtzen, 1994) in the vicinity of Swinging Dome. Based on two samples, the isotopic age of this pluton is 61–60 Ma, significantly younger than other plutonic rocks in the Iditarod quadrangle, which center around 71 Ma (Miller and Bundtzen, 1994). However, in other aspects, the pluton at Swinging Dome is quite similar to other plutons in the region. It is surrounded by a locally brecciated hornfels aureole up to 1.5 km wide. Boron enrichment in the form of tourmaline is abundant although metallic anomalies in rock samples analyzed are few in number. Only one rock anomaly was detected within resource area 3f; a grab sample of hornfels from near the intrusive contact contains 20 ppm Sn, 20 ppm Sb, 40 ppm As, and 2,000 ppm B (no. 128, table 1).

From the reconnaissance drainage-basin study, only two samples collected downstream from resource area 3f show anomalous values. One stream-sediment sample from a creek that drains southwest from Swinging Dome contains less than 0.5 ppm Ag. A heavy-mineral concentrate from a creek that drains southeast from the mountain contains 1,500 ppm Sn.

The NURE reconnaissance lake-sediment data provide some additional support for resource area 3f. Gray and others (1988c) outlined an area around Swinging Dome (see their fig. 1) that fits their precious-metal related factor (As-Mn-Fe) outlined for the lake-sediment data set.

Resource area 3g, Bismarck Creek

Resource area 3g (map B) has a high potential (certainty level D) for containing plutonic-related, boron-enriched silver-tin-polymetallic deposits; it also has a moderate potential (certainty level C) for the plutonic-hosted copper-gold-polymetallic deposit type. Resource area 3g includes an elongate, east-west oriented hornfels zone approximately 10 km^2 in a prominent upland area of Kuskokwim Group flysch (unit Kks) at the head of Bismarck Creek, a tributary of the George River. No pluton was found below the hornfels cap; however, the intense hornfels strongly suggests the presence of a buried pluton.

Along the western margin of the hornfels zone, an extensive east- to northeast-trending zone of stockwork containing abundant axinite, tourmaline, quartz, and ferrigenous gossan can be traced for a distance of nearly 300 m and for widths up to 30 m wide (see geologic sketch, fig. 16 in Bundtzen and Miller, 1997). Based on surface sampling (no. 118, table 1) and geologic modeling, the Bismarck Creek deposit contains 498,000 tonnes (549,000 tons) grading 0.137 percent Sn, 47.8 g/tonne Ag, 0.016 percent Cu, 0.22 percent Zn, and highly anomalous As, Pb, and Sb (Bundtzen and Miller, 1997). Tungsten was not detected. Tin values in the Bismarck Creek deposit range from 150 ppm to 2.80 percent; cassiterite has been identified in polished sections. Sulfide minerals were found to be generally oxidized in surface samples. Other anomalous elements include Bi (up to 56 ppm), Cd (up to 14 ppm), In (118 ppm), and B (>2,000 ppm).

Other isolated patches of axinite-bearing stockwork can be found 2–3 km east of VABM 2424 (nos. 120–122, table 1). Grab samples from these three localities locally contain up to 50 ppm Ag, 1,000 ppm Sn, 7,000 ppm Zn, 130 ppm As, 72 ppm Cd, 150 ppm Cu, 60 ppm Sb, and more than 2,000 ppm B. In the southwestern part of the resource area, local gossan in fine-grained sandstone and shale contains 500 ppm Cu, 140 ppm Sb, 0.5 ppm Ag, and 20 ppm As (no. 119, table 1). In the western part of the resource area, a quartz fracture filling in sandstone contains trace Au, 14 ppm Sb, and 20 ppm As (no. 117, table 1).

In the reconnaissance drainage-basin study numerous silver and tin anomalies were identified in, and also downstream from, resource area 3g. Samples from four sites along creeks draining to the south contain anomalous values: three stream sediments contain up to 1.0 ppm Ag, 100 ppm Cu and 500 ppm Sn; two heavy-mineral concentrates each contain more than 2,000 ppm Sn and up to 10 ppm Ag, 200 ppm W, and 5,000 ppm B. Samples from seven sites along creeks draining to the west contain anomalous values: five stream sediments contain up to 1.0 ppm Ag, 45 ppm As, 100 ppm Cu, 150 ppm Sn, and 500 ppm Zn; two heavy-mineral concentrates each contain more than 2,000 ppm Sn and up to 7 ppm Ag and 300 ppm W; another heavy-mineral-concentrate sample has 5–20 percent microscopically visible scheelite. Samples from three sites along creeks draining to the north contain anomalous values: one stream sediment contains less than 0.5 ppm Ag; three heavy-mineral concentrates contain from 700 to more than 2,000 ppm Sn. Samples from seven sites along creeks draining to the east contain anomalous values: six stream-sediments contain up to 1.0 ppm Ag and 300 ppm Zn, and two of these contain Au (0.012 and 0.014 ppm); one heavy-mineral concentrate contains 500 ppm Au, 50 ppm Ag, 200 ppm W, more than 2,000 ppm Sn, 5,000 ppm B, and has 1–5 percent microscopically visible cinnabar; another heavy-mineral concentrate has more than 2,000 ppm Sn.

The NURE reconnaissance stream-sediment data provide some additional support for resource area 3g. Gray and others (1988c) outlined a small area northeast of area 3g (see their fig. 1) that fits their base-metal related factor (Cu-Cs-Ni) outlined for the stream-sediment data set.

Resource area 3h, southeast of Granite Creek

Resource area 3h (map B) has a high potential (certainty level B) for containing plutonic-related, boron-enriched silver-tin-polymetallic deposits. It overlaps part of resource area 1b so it has some potential for containing peraluminous granite-porphyry-hosted gold-polymetallic deposits as well. Resource area 3h is centered around a small monzonite stock (unit TKm) that cuts Kuskokwim Group sedimentary rocks (unit Kks) and forms a hornfels zone up to 1.5 km wide. The known rock anomalies and the single mineral occurrence are all associated with sandstone hornfels near the monzonite contact. At the occurrence, samples from a large limonite-tourmaline breccia zone in hornfels contain up to more than 1,000 ppm Sn, 1 ppm Ag, 500 ppm Cu, 350 ppm Zn, 100 ppm Pb, 160 ppm As, 54 ppm Sb, 1.2 ppm Hg, and more than 2,000 ppm B (no. 145, table 1); the nearby monzonite has fine quartz-tourmaline stockwork veins in the contact area. At two other localities within the resource area, grab samples from gossan areas in hornfels contain up to 2 ppm Ag, 860 ppm Zn, 500 ppm Cu, 460 ppm As, 10 ppm Bi, and 5.1 ppm Cd (nos. 146 and 147, table 1).

Due to the small size of the resource area, few of its drainages were sampled during the reconnaissance drainage-basin study. One stream-sediment sample contains 31 ppm As and an aquatic moss sample from the same site contains 3,000 ppm As.

Resource area 3i, Granite Mountain

Resource area 3i (map B) has a high potential (certainty level D) for containing plutonic-related, boron-enriched silver-tin-polymetallic deposits; it also has a moderate potential (certainty level C) for the plutonic-hosted copper-gold-polymetallic deposit type. The area lies near the head of the East Fork of the George River and is centered around Granite Mountain, an elongate monzonite to granite stock (unit TKm) that trends northeastward for a distance of about 10 km. Minor amounts of volcanic rock are associated with the pluton (units TKil and Kit) and an extensive hornfels aureole, developed mostly in Kuskokwim Group sedimentary rock, surrounds the stock. Hornblende is fairly abundant as a primary mafic mineral in the Granite Mountain pluton; whereas other Late Cretaceous and early Tertiary intrusions of the quadrangle have clinopyroxene and biotite as their dominant mafic phases. An isotopic age of 63–62 Ma makes the Granite Mountain pluton distinctly younger than most other plutons of the study area (which center around 71 Ma, Miller and Bundtzen, 1994), but similar in age to the pluton at Swinging Dome (resource area 3f).

Boron metasomatism is quite extensive throughout the Granite Mountain stock and in adjacent hornfels and occurs as sheeted tourmaline veins, tourmaline-cemented breccias, and tourmaline-axinite replacements of plutonic textures. The largest areas of metasomatism occur along the northwest margin of the stock where one hornfels-hosted, cylindrically shaped, tourmaline-breccia zone was estimated to be 400 m long, up to 15 m wide (no. 151, table 1); the pipe-like body may contain 5 million tonnes of boron-rich altered rock. Samples from this locality and two nearby sites of similar boron alteration (nos. 150 and 153, table 1) contain up to 7 ppm Ag, 300 ppm Sn, 500 ppm Pb, 54 ppm Sb, 100 ppm As, 54 ppm Bi, and more than 2,000 ppm B; site no. 151 also has 50 ppb Au. Visible gold was noted in a heavy-mineral concentrate from a stream that drains the southeast side of Granite Mountain. In the northern part of resource area 3i, well away from the intrusive contact, a grab sample of hematite-cemented sandstone breccia contains 450 ppm Zn, 400 ppm As, more than 10 ppm Hg, 7 ppm Bi, and 22 ppm Sb (no. 152, table 1). In the southwestern part of the resource area, in the vicinity of a monzonitic dike swarm, a grab sample of iron-stained sandstone hornfels contains 2 ppm Ag, 700 ppm Cu, 600 ppm As, 50 ppm Sb, 150 ppm Pb, and more than 2,000 ppm B (no. 165, table 1). About 1.5 km to the northeast (no. 149, table 1), chips of heavily iron-stained sandstone contain 390 ppm Sb, 850 ppm As, and 0.9 ppm Hg, indicative of an epithermal signature rather than the plutonic-related, boron-enriched silver-tin-polymetallic deposit type.

In the reconnaissance drainage-basin study, samples collected within or downstream from resource area 3i provide abundant supportive data. Samples from five sites that drain the southeast side of Granite Mountain yielded anomalous values: five stream sediments contain 0.5 to 1.0 ppm Ag, and up to 60 ppm As, 100 ppm Pb, and locally 2,000 ppm B; two heavy-mineral concentrates contain up to 2,000 ppm Sb, 2 ppm Ag, 500 ppm Pb, 700 ppm W, and more than 5,000 ppm B; one of these heavy-mineral concentrates also has microscopically visible gold (no. 154, table 1); four aquatic moss samples contain up to 7 ppm Ag, 200 ppm Sb, and more than 5,000 ppm As. Samples from three sites that drain to the north from Granite Mountain yielded anomalous values: one stream sediment contains 0.030 ppm Au and less than 0.5 ppm Ag; one heavy-mineral concentrate contains 100 ppm Bi; another heavy-mineral concentrate has less than 1 percent microscopically visible cassiterite. Creeks that drain the western and southwestern parts of resource area 3i yielded anomalous samples from six sites: four stream-sediment samples locally contain up to 0.5 ppm Ag, 73 ppm As, 2,000 ppm B, 300 ppm Zn, and 34 ppm Hg; one heavy-mineral-concentrate sample contains 100 ppm Au and three others contain 5 ppm Ag, 500 ppm W, and more than 5,000 ppm B each. The heavy-mineral-concentrate sample that accompanied the 34-ppm-Hg-bearing stream sediment contains 5–20 percent microscopically visible cinnabar; an aquatic moss sample from this site contains 1,000 ppm As.

The NURE reconnaissance stream-sediment data provide some additional support for resource area 3i. Using R-mode factor analysis Gray and others (1988c) outlined a small area southwest of Granite Mountain (see their fig. 1) that fits their precious-metal related factor (Fe-Mn-As) outlined for the stream-sediment data set.

EPITHERMAL MERCURY-ANTIMONY (GOLD) DEPOSITS (MODEL 4)

Epithermal cinnabar-stibnite-quartz deposits and occurrences in the Iditarod quadrangle are part of a well known mercury belt (Sainsbury and MacKevett, 1965) that extends about 500 km from the Red Top Mine near Bristol Bay northeast to the Wyoming lode in the Cripple Creek Mountains north of McGrath (fig. 1). Regionally, the epithermal mercury-bearing deposits are part of large metallogeny that produced ore deposits in an extensional environment associated with back-arc magmatic activity in Late Cretaceous and early Tertiary time (Bundtzen and Miller, 1997). Mercury and antimony have been recovered from a dozen deposits in this belt and approximately 90 percent of the 1.38 million kilograms (39,960 flasks) of mercury produced came from the Red Devil Mine, just south of the study area. The Red Devil deposit is zoned vertically showing pure cinnabar in near-surface positions and increasing stibnite/cinnabar ratios to 200 m below the surface, implying increasing temperatures with depth—a zoned hydrothermal conduit system. Gold anomalies have been found at the Kolmakof Mine (fig. 1) in the Sleetmute quadrangle where up to 3.5 g/tonne gold were found in chip-channel samples (Bundtzen and others, 1998).

Epithermal mercury-antimony lodes in the Iditarod quadrangle occur in two settings. In the first, deposits are structurally controlled and spatially associated with mafic dikes and sills that cut Kuskokwim Group flysch (as at the Red Devil mercury mine); in the second, deposits are spatially related to larger plutonic masses and the mercury mineralization overprints and forms halos around gold-polymetallic mineralization (for instance at the Golden Horn gold mine, no. 110, map A). The hot-spring mercury deposit model (Rytuba, 1986, deposit model 27a) fits some of the features of the first setting, whereas the clastic-sediment-hosted mercury deposit model (after Kuznetsov, 1974, and Babkin, 1975), which infers a plutonic source, better fits the deposits of the second setting. Using $^{40}Ar/^{39}Ar$ ages, stable and radiogenic isotopes, and geochemical and fluid inclusion data, Gray and others (1997b) suggested that the epithermal Hg-Sb deposits of southwestern Alaska formed in response to Late Cretaceous-early Tertiary igneous activity interacting with surrounding sedimentary wall rocks; anomalous heat flow from the igneous activity induced hydrothermal fluid flow and leached ore fluids and metals (most importantly mercury) from local sedimentary rocks.

In the Iditarod quadrangle, the two best examples of epithermal mercury-stibnite deposits spatially associated with altered mafic dikes are the DeCourcy Mountain Mine and the Yousure occurrence (nos. 184 and 156, table 1). At DeCourcy Mountain, Kuskokwim Group sandstone and shale are cut by basaltic sills and dikes that are extensively altered to tan weathered, silica-carbonate rock. Mineralized veins and vein breccias are localized along intrusive contacts and bedding surfaces—similar to the geologic/structural setting of the Red Devil Mine. Cinnabar, stibnite, pyrite, and marcasite occur in lenses, stockworks, tensional fractures, and shears and are accompanied by chalcedonic silica veins and dickite. The DeCourcy Mountain Mine produced 51,700 kg (1,500 flasks) of mercury from 2,250 tonnes of ore at an average grade of 3.0 percent Hg. Additional anomalous elements at the DeCourcy Mountain Mine include Ag (0.65 ppm), Sb (10,000 ppm), As (60 ppm), and Au (400 ppb)(table 1).

Mercury-antimony deposits in the Iditarod quadrangle are also found in association with larger plutonic bodies of Late Cretaceous and early Tertiary age. Disseminated and massive stibnite and minor cinnabar occur in late-stage, silica-carbonate veins in monzonite and syenite that postdate other base- and precious-metal deposits at the Golden Horn Mine, Chicken Mountain prospect, and on Mount Joaquin (nos. 110, 130, and 32, respectively, map A). This suggests that the cinnabar-stibnite lodes were deposited in epithermal temperature/pressure conditions distal to higher temperature/pressure environments in igneous cores (Bundtzen and Miller, 1997). This explains the Hg-Sb geochemical halos expressed in rock, stream-sediment, and heavy-mineral-concentrate samples (discussed in resource areas 4b, 4d, 4e, 4f, and 4i, below).

Resource area 4a, Hickey Creek

Resource area 4a (map B) has a high potential (certainty level C) for containing mercury-antimony (gold) deposits. The area is underlain by quartz-rich clastic rocks that represent the shoreline facies (defined by Miller and Bundtzen, 1994) of the Kuskokwim Group (unit Kkq). These rocks are deformed into a syncline, whose axis follows the central part of the resource area from northeast to southwest. No large intrusions or hornfels aureoles were mapped during this investigation, however, numerous small hornblende- and/or biotite-bearing dikes (less than 1 m wide) and sill-like intrusions (unit TKd) cut the sedimentary rocks locally, especially in the northern part of the resource area. Local zones of hematite alteration are found in the southern part of the resource area from about VABM Hickey to 15 km to the northeast.

Rock samples containing moderately elevated mercury, antimony, and arsenic values were collected at two sites within resource area 4a. In the northern part of the resource area, a grab sample of iron-oxide stained altered dike contains 2.4 ppm Hg, 14 ppm Sb, and 10 ppm As (no. 26, table 1). In the southern part of the resource area a grab sample of brecciated, iron-stained sandstone contains 0.85 ppm Hg, 50 ppm As, and 14 ppm Sb (no. 52, table 1).

The outline of resource area 4a is primarily controlled by anomalies in stream-sediment and heavy-mineral-concentrate samples. Gold was detected in samples at three sites. One stream-sediment sample from a creek draining the east side of the resource area contains 0.020 ppm Au. A stream-sediment sample from a creek draining the west side of the area contains 0.030 ppm Au; a heavy-mineral concentrate from the same site contains 1,000 ppm Cu, 2,000 ppm Pb, and 1,000 ppm W. Visible gold was identified in a heavy-mineral concentrate (no. 25, table 1) from a creek draining the north side of the resource area. This sample also contains 20–50 percent microscopically visible cinnabar and the accompanying stream-sediment sample contains 22.5 ppm Hg. Samples collected at nine other sites within resource area 4a yielded anomalous values in stream sediments, heavy-mineral concentrates, or both: stream-sediment samples locally contain up to 3.6 ppm Hg, 300 ppm Zn, and less than 0.5 ppm Ag; heavy-mineral concentrates locally contain up to 1,000 ppm Sb, 2,000 ppm W, and 5,000 ppm Zn. Microscopically visible scheelite (1–5 percent) was identified at four different sites. The heavy-mineral concentrates from these sites contain up to 1–5 percent cinnabar and less than 1 percent sphalerite.

Resource area 4b, Moore Creek Hg halo

Resource area 4b (map B) has a high potential (certainty level D) for containing mercury-antimony (gold) deposits. The area overlaps and forms an irregular halo around resource area 2b, which has a high potential for containing plutonic-hosted copper-gold-polymetallic deposits. The underlying rock units include those of resource area 2b (the volcanic-plutonic complex of the Moore Creek area and the surrounding sedimentary rock hornfels, units TKm, TKil, Kit, and Kks). Outside of area 2b, the halo part of resource area 4b contains Kuskokwim Group sedimentary rocks (both units Kks and Kkq), which are locally intruded by felsic (TKgp) and mafic to intermediate (TKd) dikes. Minor fault slivers of pre-Cretaceous rocks of the Innoko terrane (ŦMc) lie along the Yankee-Ganes Creek Fault (Miller and Bundtzen, 1994), which cuts the resource area.

Within resource area 2b, mercury values ranging from 5 to more than 10 ppm are associated with hornfels and altered volcanic rock at some of the lode localities used to outline this plutonic-related resource area (nos. 59, 61, 62, and 63, table 1 and resource area 2b description). Also, concentrates from the two gold-producing placer mines (nos. 60 and 83, table 1) and the three placer gold occurrences (nos. 55, 58, and 81, table 1) in, and downstream from, area 2b contain significant amounts of cinnabar. Outside of the boundary of resource area 2b, in the western part of resource area 4b, grab samples from three localities yield Hg anomalies: an altered mafic dike contains 3.4 ppm Hg (no. 41, table 1); iron-oxide stained sandstone in the vicinity of an altered dike contains 1.5 ppm Hg, 0.2 ppm Au, and 99 ppm As (no. 53, table 1); and iron-stained breccia in chert along the Yankee-Ganes Creek Fault contains 2.5 ppm Hg, 0.2 ppm Au, and 0.2 ppm Ag (no. 54, table 1). The final two anomalous rock localities in resource area 4b do not yield Hg values, and their relationship to epithermal mineralized rock is uncertain. From one locality in the northwestern part of area 4b, manganese, in grades up to 1.58 percent, is associated with iron-oxide stained, quartz-veined sandstone (no. 40, table 1). From the other locality, in the southeast part of resource area 4b, a sandstone grab sample contains 2 ppm Ag and 150 ppm Cu (no. 84, table 1).

Numerous samples from the reconnaissance drainage basin study contain anomalies supportive of the epithermal mercury-antimony (gold) deposit model in resource area 4b and of the plutonic-hosted copper-gold-polymetallic deposit model in resource area 2b. The anomalies supporting area 2b were discussed in a previous section, but in review, they include: stream-sediment samples containing up to 0.88 ppm Hg, 30 ppm As, and locally up to 0.77 ppm Au; heavy-mineral-concentrate samples containing up to 5,000 ppm Sb, more than 2,000 ppm Sn, 500 ppm Pb, 5,000 ppm W and locally up to 300 ppm Ag and more than 1,000 ppm Au; and microscopically visible cinnabar (1–5 percent), gold (<1 percent), and other minerals in heavy-mineral-concentrate samples locally. Outside of area 2b, but within or downstream from resource area 4b, five additional drainage sites yielded anomalous samples. Stream-sediment samples from two of these sites contain 0.90 to 7 ppm Hg; stream-sediments from two other sites contain trace Ag (<0.5 ppm); a heavy-mineral concentrate from the remaining site contains 1–5 percent microscopically visible cinnabar. Aquatic moss samples from two additional sites contain 100 ppm Sb.

Resource area 4c, Bonnie Creek area

Resource area 4c (map B) has a high potential (certainty level C) for containing mercury-antimony (gold) deposits; it also has a moderate potential (also certainty level C) for the peraluminous granite-porphyry-hosted gold-polymetallic deposit type. The area forms a narrow, elongate belt that lies several kilometers southeast of the Iditarod-Nixon Fork Fault and parallels the fault for about 30 km. The underlying rocks are primarily Kuskokwim Group sandstone and shale (unit Kks) that are locally intruded by granite porphyry dikes and small plugs (unit TKgp). The known deposits are spatially associated with granite porphyry dikes and consists of rock anomalies from two sites. In the northeast corner of resource area 4c a grab sample of iron-oxide stained granite porphyry contains more than 10 ppm Hg, 70 ppm As, and trace Au and Ag (no. 46, table 1). At another site, 3 km to the southwest, a grab sample of a granite porphyry dike shows secondary tourmaline alteration containing 2.2 ppm Hg (no. 45, table 1). This resource area may be a westerly extension of resource area 4d, which will be discussed below.

In the reconnaissance drainage-basin study, samples collected from five sites in or downstream from resource area 4c yielded anomalous values. Stream-sediment samples from two sites contain Au (0.050 and 0.065 ppm) and 0.64 ppm Hg[1]; a heavy-mineral concentrate from one of these sites contains 2,000 ppm Zn. Heavy-mineral concentrates from two other sites contain up to 1,500 ppm Sn, 1,000 ppm Cu, and 3,000 ppm Zn. Microscopically visible cinnabar (1–5 percent) was identified in the heavy-mineral concentrate from a fifth site.

Resource area 4d, VABM Tatalina Hg halo

Resource area 4d (map B) has a high potential (certainty level C) for containing mercury-antimony (gold) deposits; it also has a moderate potential (certainty level B) for the peraluminous granite-porphyry-hosted gold-polymetallic deposit type. The area overlaps and forms a partial halo around resource area 3c, which has a high potential for containing plutonic-related, boron-enriched silver-tin-polymetallic deposits. The underlying rock units include those of resource area 3c (monzonite to syenite plutons, granite porphyry dikes, and Kuskokwim Group sedimentary rocks, units TKm, TKgp, and Kks, respectively, plus hornfels around the VABM Tatalina pluton. Outside of area 3c, the halo part of resource area 4d is poorly exposed, but contains a variety of rock types, mostly covered by younger, unconsolidated surficial deposits (unit QTs). Exposed in this area are Kuskokwim Group sedimentary rocks (unit Kks), volcanic rock (unit TKil), numerous granite porphyry dikes and small intrusions (unit TKgp), and a small dacite-andesite plug at VABM Lin.

As in resource area 4c, the known mercury anomalies of resource area 4d are associated with granite porphyry rocks. Within resource area 3c, grab samples from a sheared contact zone between granite porphyry and hornfels sandstone contain up to 1 ppm Hg and 500 ppm As (no. 47, table 1 and resource area 3c description). Outside of the boundary of resource area 3c, in the southern part of resource area 4c, grab samples of iron-stained felsic dike and quartz-veined dike contain up to 1.0 percent As, more than 10 ppm Hg, 200 ppm W, 100 ppm Pb, 120 ppm Zn, and trace Ag (no. 66, table 1). Three kilometers east of that site, another grab sample of granite porphyry dike contains 2.2 ppm Hg (no. 67, table 1). In the western part of resource area 4d, a grab sample of a granite porphyry plug contains 200 ppm As, 2.2 ppm Hg, 28 ppm Sb, and trace Ag (no. 65, table 1).

Samples from the reconnaissance drainage-basin study contain anomalies that support both the epithermal mercury-antimony (gold) deposit model in resource area 4d and the plutonic-related, boron-enriched silver-tin-polymetallic deposit model in resource area 3c. The anomalies in area 3c were discussed in a previous section, but in review, they include: stream-sediment samples locally containing up to 3 ppm Ag, 120 ppm As, 200 ppm Pb, 15 ppm Sn, and 15 ppm Bi; heavy-mineral concentrates locally containing up to 23 ppm Ag, 1,000 ppm As, 5,700 ppm Pb, 2,000 ppm Sb, more than 2,000 ppm Bi, more than 5,000 ppm B, and trace Au; microscopically visible cassiterite (1–5 percent) in one heavy-mineral concentrate; and aquatic moss samples containing up to 3 ppm Ag and 50 ppm As. Outside of area 3c, but within or downstream from resource area 4d, six additional drainage sites yielded anomalous samples. A heavy-mineral concentrate collected near the quartz-veined dike occurrence mentioned above (no. 66, table 1) contains 5 ppm Ag, 7,000 ppm Sb, and 2,000 ppm W, and has microscopic cinnabar (5–20 percent) and scheelite (1–5 percent). The stream-sediment sample from this site contains 1.5 ppm Hg. Three other heavy-mineral concentrates from the southern part of resource area 4d locally contain up to 2,000 ppm Sb, 500 ppm W, and more than 2,000 ppm Sn; a heavy-mineral concentrate from a nearby site contains less than 1 percent microscopically visible cassiterite. Aquatic moss samples from three sites contain up to 1,000 ppm As.

Resource area 4e, Iditarod-Flat Hg halo

Resource area 4e (map B) has a high potential (certainty level D) for containing mercury-antimony (gold) deposits. The area overlaps and forms a broad halo around two other resource areas—area 2d, which has a high potential for containing plutonic-hosted copper-gold-polymetallic deposits, and area 3e, which has a high potential for containing plutonic-related, boron-enriched silver-tin-polymetallic deposits. The underlying rock units include those of resource area 2d (the volcanic-plutonic complex of the Chicken Mountain area, the surrounding sedimentary rock hornfels, and local dikes of mafic to intermediate composition—units TKm, TKil, Kks, and TKd) and those of resource area 3e (sedimentary rock that is locally hornfels, granite porphyry, and intermediate dikes—units Kks, TKgp, and TKd). Outside of areas 2d and 3e, the halo part of resource area 4e contains Kuskokwim Group sedimentary rocks (both units Kks and Kkq), which are intruded by numerous mafic to intermediate (TKd) dikes, and locally by granite porphyry dikes (TKgp).

The mercury-antimony (gold) signature of resource area 4e is interpreted as part of a broad, lower tempera-

[1]This Hg value is anomalous at the greater than 90th percentile; Gray and others (1997a) selected 0.80 ppm Hg, which is greater than the 95th percentile, as their anomalous value cut-off.

ture, epithermal overprint encompassing and surrounding higher temperature, pluton-hosted and pluton-related gold-polymetallic deposits of the Iditarod-Flat area. Within resource area 2d, late-stage epithermal cinnabar-stibnite zones crosscut older mesothermal gold mineralized rock at the Golden Horn Mine (no. 110, table 1), the Idaho prospect (no. 105, table 1), the Chicken Mountain prospect (no. 130, table 1), and along Malamute Gulch (no. 111, table 1). North of Flat, but still within area 2d, mineralized quartz veins that cut hornfels contain more than 10 ppm Hg along with high values of gold, silver, antimony, and other metals (nos. 87 and 88, table 1). Concentrates from eight placer mines within or downstream from area 2d have significant amounts of cinnabar (nos. 89, 104, 106, 107, 109, 129, 131, 132, table 1).

The part of resource area 4e that lies outside the boundaries of resource areas 2b and 3e has numerous localities where Hg-Sb mineralized rock is found. Iron-stained sandstone and shale of the Kuskokwim Group are common to all of these localities, and altered mafic to intermediate dikes that host ore are present at some. The Dishna River prospect (no. 74, table 1) is the most promising of the known localities and was first reported in Bundtzen and Miller (1997). Here gold-bearing quartz-sulfide-sulfosalt zones and vein breccias cut sheared shale and sandstone. Sulfide-bearing masses contain up to 25 percent stibnite and disseminated arsenopyrite is found locally. Grab samples contain up to 11 ppm Au, 10,000 ppm Sb, more than 10,000 ppm As, and more than 10 ppm Hg. The inferred reserve estimate of 92.5 kg (2,970 oz) is based on eighteen chip-channel samples along the 140-m-long mineralized zone. Three other known localities lie along the same northeast-trending ridge from 3 to 9 km to the southwest of this prospect (nos. 94, 95, and 96, table 1). At these localities, locally extensive gossan is spatially associated with altered dikes; grab samples from all three sites contain anomalous Hg (to 3.3 ppm) and As (to 1,900 ppm) and samples from one site also contain up to 0.2 ppm Au, 1 ppm Ag, 116 ppm Sb, and 300 ppm Zn. Anomalous Hg and (or) Sb values are found at four other sites in resource area 4e. In the northern part of the area, a hematite altered dike contains 740 ppm Sb, 80 ppm As, 0.68 ppm Hg, and trace Au (no. 71, table 1) and two grab samples of sandstone contain 76–92 ppm Sb (nos. 72 and 73, table 1). In the eastern part of the area, a silica-carbonate altered dike in the vicinity of gossan in sandstone contains 4 ppm Hg (no. 113, table 1).

Samples from the reconnaissance drainage-basin study contain anomalies that support both the epithermal mercury-antimony (gold) deposit model in resource area 4e and the plutonic-hosted and plutonic-related mesothermal type deposits in resource areas 2d and 3e. The anomalies supporting area 2d were discussed in a previous section, but in review, they include: stream-sediment samples locally containing up to 1.55 ppm Au, 1.0 ppm Ag, 23 ppm As, 200 ppm Cu, and more than 34 ppm Hg; heavy-mineral-concentrate samples locally containing up to 500 ppm Au, 500 ppm Ag, 3,000 ppm Sb, 1,500 ppm As, and 2,000 ppm W; microscopically visible gold, cinnabar, and scheelite in heavy-mineral concentrates locally; and aquatic moss samples containing up to 3,000 ppm As and 100 ppm Sb. The anomalies supporting area 3e were discussed in a previous section, but in review, they include: stream-sediment samples locally containing up to 1 ppm Ag, 190 ppm As, 50 ppm Bi, and 30 ppm Sn; heavy-mineral-concentrate samples locally containing up to 200 ppm Ag, 2,000 ppm Sn, 10,000 ppm Sb, 2,000 ppm W, more than 1,000 ppm Au; microscopically visible cassiterite in one heavy-mineral concentrate; and at one site aquatic moss containing 5,000 ppm As. Outside of areas 2d and 3e, but within or downstream from resource area 4e, stream-sediment and/or heavy-mineral-concentrate samples collected from 14 sites were anomalous. In the northeast corner of the resource area, where lode sites nos. 74, 94, 95, and 96 (discussed above) are located, six sites yielded anomalous samples: four stream sediments locally contain up to 33 ppm As and 300 ppm Zn; one heavy-mineral concentrate contains 500 ppm Sb; microscopically visible cassiterite was identified in another heavy-mineral concentrate. Two stream-sediment samples from creeks draining the western part of resource area 4e, west of Chicken Mountain, contain minor Au (0.015 and <0.05 ppm). Two stream-sediment samples from creeks draining the northern part of the resource area also contain Au (0.069 and 0.048 ppm); a heavy-mineral concentrate from the latter site contains 200 ppm W. Samples showing additional anomalies are scattered through the rest of resource area 4e: a stream sediment from one site contains 45 ppm As; another site has trace Ag (<0.5 ppm) in the stream sediment and 300 ppb Pb in the heavy-mineral concentrate; another heavy-mineral concentrate contains more than 2,000 ppm Sn; and microscopically visible cinnabar (5–20 percent) was identified in the concentrate from the fourth site.

Resource area 4f, Camelback Mountain Hg halo

Resource area 4f (map B) has a high potential (certainty level C) for containing epithermal mercury-antimony (gold) deposits. The area overlaps and forms a partial halo around resource area 3d, which has a high potential for containing plutonic-related, boron-enriched silver-tin-polymetallic deposits. The underlying rock units include those of resource area 3d: monzonitic plutons of the Camelback Mountain area, the Iditarod Volcanics, and Kuskokwim Group sedimentary rocks (units TKm, TKil, Kit, and Kks). The halo part of resource area 4f is underlain by Kuskokwim Group sedimentary rocks (unit Kks), which are locally intruded by intermediate dikes (unit TKd). The mercury-antimony signature observed in the part of resource area 4f that lies northwest of the Iditarod-Nixon Fork Fault, may represent a lower temperature, epithermal overprint encompassing and surrounding the higher temperature, pluton-related mineralized area of resource area 3d. The mercury-antimony signature observed in the part of resource area 4f that lies southeast of the fault, may not be directly related to the volcanic-plutonic rocks.

Six mercury- and (or) antimony-bearing lode localities (mineral occurrences and rock anomalies only) are contained in resource area 4f: five of these are also part of resource area 3d; the sixth lies within the halo northwest of the Iditarod-Nixon Fork Fault. As discussed above in the description of area 3d, anomalous values of silver (and locally gold), accompanied by up to 4.2 ppm Hg, occur in hornfels adjacent to the plutons (nos. 76 and 77, table 1 and resource area 3d description). Distant from the plutons of resource area 3d, up to 1.4 ppm Hg and locally up to 200 ppm Sb values are found in altered volcanic rocks (nos. 78, 79, and 80, table 1 and resource area 3d description). In the halo part of 4f, just west of Camelback Mountain, a grab sample of iron-stained, hydrothermally altered shale (no. 97, table 1) contained 5.1 ppm mercury and trace Ag.

Samples from the reconnaissance drainage-basin study contain anomalies that support both the epithermal mercury-antimony (gold) deposit model in resource area 4f and the plutonic-related, boron-enriched silver-tin-polymetallic deposit model in resource area 3d. The anomalies in area 3d were discussed in a previous section, but in review, they include: stream-sediment samples locally containing up to 140 ppm As and 5 ppm Mo; heavy-mineral-concentrate samples locally containing up to 3,000 ppm Zn and 5,000 ppm B; microscopically visible scheelite and cassiterite locally in heavy-mineral concentrates; and one moss sample containing 2,000 ppm As. Outside of area 3d, but within or downstream from resource area 4f, four additional drainage sites yielded anomalous samples; these sites also are all from southeast of the Iditarod-Nixon Fork Fault. One stream sediment contains 32 ppm As and another contains 0.96 ppm Hg. At another site, the stream sediment contains 0.82 ppm Hg, the heavy-mineral concentrate contains 1,500 ppm W, and microscopically visible cinnabar (1–5 percent) and scheelite (1–5 percent) were identified in the concentrate. One additional site had 5–20 percent microscopically visible cinnabar in the heavy-mineral concentrate.

Resource area 4g, Sugarloaf Mountain area

Resource area 4g (map B) was primarily defined on the basis of stream sediment and heavy-mineral concentrate geochemistry. The area is poorly exposed; 80 percent of it is covered by unconsolidated deposits (unit QTs). Although only one rock anomaly was located during the investigation, the drainage-basin geochemistry and the presence of granite porphyry dikes suggest that resource area 4g has a high potential (certainty level B) for containing epithermal mercury-antimony (gold) deposits. It also has a moderate potential (also certainty level B) for the peraluminous granite-porphyry-hosted gold-polymetallic deposit type. The area forms an elongate belt that lies about 5 km south of the placer workings of Moore Creek and trends east for almost 40 km. Beneath the unconsolidated deposit cover, the underlying rocks are primarily Kuskokwim Group sandstone and shale (unit Kks) that are locally intruded by granite porphyry dikes and small plugs (unit TKgp) and by two small dome-like bodies of pilotaxitic andesite (unit TKp). Local areas of hornfels, commonly circular in shape, occur locally in this west-trending belt. The dome-shaped exposure of hornfels on Sugarloaf Mountain is likely underlain by an unexposed plug, perhaps of granite porphyry or pilotaxitic andesite. The one rock anomaly found is from a grab sample of one of the pilotaxitic plugs, which contains 1 ppm Ag (no. 99, table 1); Hg was not analyzed in this sample.

In the reconnaissance drainage-basin study, samples from eleven sites in or downstream from resource area 4g yielded anomalous values. Three stream-sediment samples, one each from the western, northern, and eastern parts of the resource area, contain 0.010 to 0.011 ppm Au. A heavy-mineral concentrate from the eastern most site had 300 ppm Cu, but neither the concentrate nor the stream sediment had anomalous Hg. All of the Hg- or cinnabar-bearing samples came from eight sites in the western half of the resource area. At five of these eight sites, the stream-sediment sample contains from 1.4 to more than 34 ppm Hg; at all eight sites, microscopically visible cinnabar was identified in the heavy-mineral concentrate, locally comprising from 20 to 50 percent of the sample. Other anomalies identified at these eight sample sites include: up to 3 ppm Ag, 300 Cu, 2,000 ppm Sn, 1,000 ppm W, and 10,000 ppm Zn locally; and one concentrate sample contains microscopically visible scheelite and another contains cassiterite. Two additional sites in resource area 4g yielded anomalous Ag: one from a western drainage had trace Ag (<0.5 ppm) in the stream sediment; a northern drainage had 1 ppm Ag in the heavy-mineral concentrate.

Resource area 4h, the Doherty Creek area

Resource area 4h (map B) has a high potential (certainty level D) for containing epithermal mercury-antimony (gold) deposits; it also has a moderate potential (certainty level C) for the peraluminous granite-porphyry-hosted gold-polymetallic deposit type. Similar to resource areas 4c and 4g, area 4h is primarily underlain by Kuskokwim Group sedimentary rock (unit Kks) that is locally intruded by granite porphyry dikes (unit TKgp), and in addition contains altered intermediate to mafic dikes (unit TKd). Seven rock anomalies and one lode prospect are scattered throughout area 4h. In the northeast part of the resource area a grab sample of silicified breccia in sandstone contains 50 ppb Au and trace Hg (no. 114, table 1). Also in the northeast, an extensive zone of pyrolusite pods occur in sheared sedimentary rock (no. 115, table 1). Grab samples contain more than 5,000 ppm Mn and locally up to 10 ppm Mo, and trace amounts of Hg. In the central part of the resource area, grab samples from a prospect pit sunk on a quartz-calcite veined altered mafic? dike contain 54 ppm Sb, 100 ppm As, 0.9 ppm Hg, and 1,000 ppm Cr (no. 139, table 1). At three other localities in the central part of the resource area, grab samples of iron-stained sandstone or altered dike contain from 1.1 to 2.3 ppm Hg (nos. 138, 140, and 141, table 1). In the southwest part of the resource area, grab samples of altered granite porphyry dike contain 1.4 and 2.0 ppm Hg (nos. 137 and 158, table 1).

The mercury values in the lode sites are relatively low, but designation of the resource area is supported by stream-sediment and heavy-mineral concentrate samples collected from nine sites in or downstream from the resource area. Three sites yielded either gold values or visible gold: stream-sediment samples from two sites had 0.011 and 0.058 ppm Au; another site had 0.5 ppm Ag in the stream-sediment sample and visible gold in the heavy-mineral concentrate sample (no. 116, table 1). Heavy-mineral concentrate samples collected from six sites contain visible cinnabar (from 20 to 50 percent, locally) in the heavy-mineral concentrate; one of these samples had 14 ppm Hg value. Microscopically visible sphalerite and cassiterite were also identified locally in these samples.

Resource area 4i, northeast of Bismarck Creek

Resource area 4i (map B) lies northeast of resource area 1b (the Granite Creek area that has a high potential for peraluminous granite-porphyry-hosted gold-polymetallic deposits). This small resource area is not well defined and may be interpreted as a northeast extension of resource area 1b. The information available suggests it has a moderate potential (certainty level B) for containing epithermal mercury-antimony (gold) deposits. It is underlain by Kuskokwim Group flysch (unit Kks); one intermediate dike was mapped (unit TKd) within the area, but more dikes may exist. The area was primarily defined on the basis of drainage basin geochemistry, however, rock anomalies were found at two sites and one prospect pit was also noted, but not sampled. From a site near the prospect pit, quartz-healed sandstone breccia contains 20 ppm Sb, 20 ppm As, and trace Hg (no. 101, table 1). At another site, iron-stained sandstone containing secondary hematite contains 200 ppm Sb, 100 ppm As, 180 ppm Zn, and 100 ppm Ni (no. 100, table 1). A stream-sediment sample from the southern part of the area contains 0.070 ppm Au and trace silver (<0.5 ppm); the heavy-mineral concentrate from this site contains 10 ppm Ag, 200 ppm Sb, 300 ppm Pb, and more than 2,000 ppm Sn; aquatic moss contains 50 ppm Sb. One other stream-sediment sample from this resource area contains trace Ag (<0.5 ppm) and one other heavy-mineral concentrate contains more than 2,000 ppm Sn.

Resource area 4j, DeCourcy Mountain area

Resource area 4j (map B), which contains the DeCourcy Mountain mercury mine (no. 184, table 1, map A), has a high potential (certainty level D) for containing other epithermal mercury-antimony (gold) deposits. Much of the resource area is underlain by the Iditarod Volcanics (units TKil and Kit), which overlie the Kuskokwim Group sedimentary rocks (units Kks). The area is cut diagonally by the trace of the Iditarod-Nixon Fork Fault. Kuskokwim Group sedimentary rocks (units Kks and Kkq) lie northwest of the fault; rocks both northwest and southeast of the fault are locally intruded by altered intermediate to mafic (and locally felsic?) dikes (unit TKd). The specific resource area boundaries are defined by the DeCourcy Mountain mercury mine and the Yousure cinnabar occurrence (no. 156, table 1 and map A), on the southeast and north, respectively, and by five other localities containing anomalous mercury, antimony, and base metals. Data from the reconnaissance drainage-basin study support designation of the resource area.

Epithermal Hg-Sb ore at the past-productive DeCourcy Mountain mercury mine occurs near the contact between the Iditarod Volcanics and underlying Kuskokwim Group sedimentary rocks. Most of the ore is found where the Kuskokwim Group is cut by sill-like bodies or dikes of basalt, which are usually altered to tan, silica carbonate rock. The ore bodies, which exhibit ubiquitous chalcedony-dickite alteration, contain cinnabar, stibnite, arsenopyrite, marcasite, and arsenopyrite, in stockworks, tensional shears, and sheeted zones in altered sedimentary and dike rocks. Some 51,700 kg of mercury has been recovered intermittently from 1908 to 1953 from ores averaging about 3.0 percent mercury.

The previously unknown Yousure occurrence, which lies along the northern limit of mineral resource area 4j, is exposed in a cut bank along the Iditarod River. The occurrence consists of veins and fracture coatings of cinnabar and stibnite in brecciated, silicified Kuskokwim Group shale that has been intruded by mafic dikes, the latter of which are altered to silica-carbonate rock. In addition to anomalous mercury and antimony values, grab samples from the Yousure occurrence have yielded anomalous arsenic (>10,000 ppm), tungsten (50 ppm), barium (5,000 ppm), and trace silver.

At five other localities scattered throughout resource area 4j, rock samples yield anomalous Sb and Hg values. At three sites (one of which was previously prospected) altered volcanic rocks, sometimes spatially associated with an altered dike, contain up to 240 ppm Sb, 110 ppm As, and 0.92 ppm Hg, and locally 100 Cu ppm and 7 Mo ppm (nos. 166, 167, and 183, table 1). At two additional sites, altered sandstone (no. 182, table 1) and altered dike and sandstone (no. 180, table 1) contain up to 1.2 ppm Hg, 10 ppm Sb, and 20 ppm As. In the southwest corner of resource area 4j, Little Creek (no. 181, table 1) yielded small amounts of gold during prospecting and testing; mine concentrates contained significant cinnabar.

In the reconnaissance drainage-basin study, samples collected from seven sites in or downstream from resource area 4j yielded anomalous values. In the southern part of the resource area, stream sediments from five sites contain from 0.80 to 5.10 ppm Hg. Heavy-mineral concentrates from four of these sites contain microscopic cinnabar and one sample contains up to 20 percent cinnabar and some scheelite. A heavy-mineral concentrate from Little Creek (no. 181, table 1) contains 150 ppm Au and 15 ppm Ag; microscopic gold was also identified in the concentrate. A heavy-mineral concentrate from one site in the central part of the resource area contains 500 ppm W and 5,000 ppm B. An aquatic moss sample from a nearby site has 5 ppm Ag.

Resource area 4k, Twin Buttes area

Resource area 4k (map B) consists of two smaller subareas in the southern part of the Iditarod quadrangle and has a moderate potential (certainty level C) for containing epithermal mercury-antimony (gold) deposits. In this part of the quadrangle, the Kuskokwim Group has been deformed into several west-trending, shallowly plunging folds, but no intrusive rocks or hornfels aureoles were recognized.

The Twin Buttes subarea of resource area 4k is defined by weak mercury, antimony, and silver anomalies detected in grab samples of Kuskokwim Group sandstone (unit Kks). Grab samples from six sites in the Twin Buttes subarea yielded up to 4.7 ppm Hg, 110 ppm Sb, 2 ppm Ag, 20 ppm As, and 100 ppm Cu (nos. 198–202 and 206, table 1). One stream-sediment sample draining the north part of this subarea contains trace Ag (<0.5 ppm); the heavy-mineral concentrate from this site contains more than 2,000 ppm Sn.

The more southern subarea is defined by one anomalous drainage site. Stream-sediment samples from this site contain from 1.6 to more than 34 ppm Hg; a heavy-mineral concentrate contains 1–5 percent microscopic cinnabar and less than 1 percent scheelite.

Resource area 4l, VABM George area

Resource area 4l (map B) has a moderate potential (certainty level C) for containing epithermal mercury-antimony (gold) deposits. The area is underlain by Kuskokwim Group flysch (unit Kks) that is locally intruded by peraluminous granite porphyry dikes (unit TKgp). Resource area 4l forms a diffuse and irregular halo around the eastern end of resource area 1c, the latter of which has a potential for containing peraluminous granite-porphyry-hosted gold-polymetallic deposits. Grab samples from three localities in the eastern part of resource area 1c (nos. 162–164, table 1 and description of area 1c) have more than 14 ppm Hg, 10,000 ppm Sb, and 1.6 ppm Hg, respectively, suggesting the possibility of an epithermal overprint on mineralized rock at those localities. At one locality in the southern part of resource area 4l, a grab sample of granite porphyry dike contains 8 ppm Hg (no. 173, table 1).

In the reconnaissance drainage-basin study, stream-sediment samples from three sites within resource area 4l contain anomalous Hg; two of these sample sites also lie within resource area 1c. From the two sites that lie within area 1c, one has 5.0 ppm Hg and 0.5 ppm Ag in the stream sediment; the other site has 1.2 ppm in the stream sediment and microscopically visible cinnabar in the heavy-mineral concentrate. In the part of area 4l that lies outside of area 1c, a site in the western part contains 6.1 ppm Hg in the stream sediment, and microscopic cinnabar (1–5 percent) in the heavy-mineral concentrate; a heavy-mineral concentrate from the northern part contains 2,000 ppm Sn.

Resource area 4m, Kuskokwim Mountains

Resource area 4m (map B) has a moderate potential (certainty level C) for containing epithermal mercury-antimony (gold) deposits. It covers a very large region that encompasses resource areas 4a through 4l. This broad region is underlain primarily by rocks of the Kuskokwim Group (units Kks and Kkq) that are locally intruded by dikes (units TKgp and TKd). Local Hg and Au anomalies are found in rocks, stream sediments and heavy-mineral concentrates of this resource area, but the data are too diffuse to define a more specific target.

Rock samples from six localities yielded anomalous values that are consistent with epithermal mercury-antimony (gold) deposits. Two of these sites are located in area 4m between resource areas 4a and 4b. At the more northern of these sites, a silicified zone in sandstone near an altered dike contains 0.2 ppm Au and 0.28 ppm Hg (no. 39, table 1). About 13 km to the south, nearly a kilometer distant from any known intrusive rocks, a grab sample of altered sandstone and shale contains 2.9 ppm Hg (no. 75, table 1). Another gold-bearing locality lies east of resource area 4b and near area 1a. Here silicified lithic tuff contains 0.88 ppm Hg and trace Au (no. 42, table 1). The remaining three anomalous rock localities lie in the eastern part of resource area 4m, west of the Kuskokwim River. At one site (no. 102, table 1) a grab sample of sandstone contains slightly elevated values of Hg (0.46 ppm), As (30 ppm), Sb (20 ppm), and trace Ag.

Quartz veinlets in iron-stained sandstone at another site (no. 124, table 1) contain 0.5 ppm Ag, 900 ppm Zn, 150 ppm Sn, 20 ppm As. 0.96 ppm Hg, and 2,000 ppm B. The Sn and B values are not expected to occur with the epithermal mercury-antimony (gold) systems, but the Hg and As values are consistent with an epithermal overprint. A grab sample of sandstone from the last site (no. 155, table 1) contains 0.5 ppm Ag, 200 ppm Pb, 10 ppm Bi, 100 ppm As, and 12 ppm Sb; Hg was not analyzed.

In the reconnaissance drainage-basin study, numerous samples from resource area 4m locally contain anomalous Au, Hg, or other elements that support designation of the area for epithermal mercury-antimony (gold) deposits. However, the sample sites are widespread and the anomalous values of Hg and Au are difficult to relate to known geology and rock anomalies.

Gold anomalies occur in stream-sediment samples collected in the eastern, northern, southern, and central parts of resource area 4m; Hg anomalies do not occur at these sites. In the eastern part of area 4m, roughly in the area of anomalous rock sites nos. 102, 124, and 155 (mentioned above), two stream-sediment samples contain Au (0.010 and 0.071 ppm) and one heavy-mineral concentrate contains 70 ppm Au and 20 ppm Ag. Two sites in the vicinity of the quartz veinlet locality (no. 124, table 1) yield anomalous values. At one site, the stream-sediment sample contains 0.82 ppm Hg and the heavy-mineral concentrate contains 7 ppm Ag. A heavy-mineral concentrate from the other site contains 7,000 ppm Sb and 700 ppm Pb. Aquatic moss samples from four sites in the eastern part of area 4m locally contain up to 20 ppm Ag, 50 ppm Sb, and 500 ppm As. In the northern part of area 4m, one stream-sediment sample contains 0.022 ppm Au, another stream-sediment sample contains 19 ppm As, a heavy-mineral concentrate contains 300 ppm Cu, and two moss samples contain 10 ppm Ag. In the southern part of resource area 4m, two stream-sediment samples contain Au (0.010 and 0.011 ppm) and the heavy-mineral concentrate from a third site contains 1,500 ppm Zn. In the central part of resource area 4m, broadly centered around resource areas 1b, 3g, 3h, and 4i, one stream-sediment sample contains 0.018 ppm Au. Other samples in this general central area include two stream-sediment samples containing 0.78 and 18.3 ppm Hg; the heavy-mineral concentrates from these sites contain up to 20 percent microscopic cinnabar. The remaining anomalous samples from this central area are one stream sediment containing 300 ppm Zn and another containing 0.5 ppm Ag; six heavy-mineral concentrate samples locally contain up to 300 ppm Pb, 500 ppm W, 20,000 ppm Zn, and more than 2,000 ppm Sn; a concentrate from another site contains microscopically visible scheelite (5–20 percent) and galena (<1 percent).

Two other general regions within resource area 4m contain local Hg anomalies: (1) between resource areas 4a and 4b, and (2) in the general vicinity of resource area 4j (both east and west of it). Between areas 4a and 4b, samples from four sites yielded anomalous values: one heavy-mineral concentrate contains up to 5 percent microscopic cinnabar, two other concentrates each contain 200 ppm Sb and more than 2,000 ppm Sn, and one stream sediment contains 300 ppm Zn. From a site west of resource area 4j, a stream sediment contains 5.6 ppm Hg and the heavy-mineral concentrate contains microscopic cinnabar and galena. From a site east of resource area 4j, an aquatic moss sample contains 50 ppm Sb.

Resource area 4n, southeast corner of Iditarod quadrangle

Resource area 4n (map B) has a low potential (certainty level C) for containing epithermal mercury-antimony (gold) deposits. Similar to resource area 4m, area 4n is underlain primarily by rocks of the Kuskokwim Group (units Kks and Kkq), but unlike area 4m, very few dikes were noted during the regional geologic mapping and no mineral occurrences or rock anomalies are known. Cinnabar in some heavy-mineral concentrates and Au values in some stream-sediment samples indicate the area has some potential for epithermal deposits; however, these sites are scattered and diffuse. Four stream-sediment samples from this area contain gold values ranging from 0.01 to 0.11 ppm Au and one heavy-mineral concentrate contains 300 ppm Au and 50 ppm Ag. One stream-sediment sample contains 1.8 ppm Hg; the heavy-mineral concentrate from this site contains microscopic cinnabar. Four heavy-mineral concentrates locally contain up to 1,500 ppm Zn, 10,000 ppm W, and more than 2,000 ppm Sn. In addition to cinnabar at five sites, heavy mineral concentrates locally contain microscopic cassiterite and scheelite. An aquatic moss sample from one site contains 200 ppm Sb.

VOLCANIC-HOSTED PRECIOUS AND OTHER METALS DEPOSITS (MODEL 5)

Much of the western part of the Iditarod quadrangle is underlain by the Yetna River volcanic field (unit TKy), a poorly exposed sequence of subaerial volcanic rocks consisting primarily of calc-alkaline andesite and rhyolite pyroclastic and lava flows, and minor basalt flows. Silicification and larger areas of siliceous sinter are found locally, mostly in the more rhyolitic parts of the sequence. Eight K-Ar isotopic ages range from 69 to 54 Ma (Miller and Bundtzen, 1994) possibly making these subaerial volcanic rocks slightly younger than the 73 to 59 Ma volcanic-plutonic complexes to the east.

The lack of exposure and the reconnaissance level of this investigation make it difficult to assess the metallogenic significance of the Yetna River volcanic field. Anomalous values of Au, Ag, Sb, and Hg, in both rock and drainage-basin samples, are scattered over a broad part of the volcanic field. Some of the Au- and Ag-bearing rock samples are associated with chalcedonic alteration in rhyolite; others are associated with yellowish limonite, reddish goethite, and locally hematite-bearing bleached zones in rhyolite and andesite. In addition to this widespread epithermal elemental suite of Au, Ag, Sb, and Hg, a small part of the volcanic field, which is primarily underlain by rhyolite pyroclastic and lava flows, has consistently elevated values of Sn, Pb, Be, and Nb. This elemental assemblage is similar to that of the Sischu volcanic field, a Late Cretaceous and early Tertiary subaerial volcanic suite (Moll-Stalcup, 1994) in the Medfra quadrangle (Patton and Moll, 1983).

The geologic setting, silicic alteration, and epithermal elemental suite that characterize a broad part of the Yetna River volcanic field are consistent with parts of several deposit models—hot-spring Au-Ag model of Berger (1986, model 25a), Comstock epithermal veins model of Mosier and others (1986b, model 25c), and Sado epithermal veins model of Mosier and others (1986a, model 25d). In model 25a, a vertically zoned hydrothermal system is expressed by siliceous sinter deposits in near-surface conditions accompanied by gold, silver, antimony, arsenic, and mercury, progressing into deeper-level stockwork and veins accompanied by both base and precious metals. In model 25c, volcanic host rocks overlie clastic sedimentary (and equivalent metamorphic) rocks, but vertical zonation is somewhat similar. In model 25d, geothermal systems operate within bimodal volcanic rocks and associated intrusive units that overlie thick, older igneous sequences; elemental associations are Au, Ag, and some base metals. Without more detailed information it is not possible to select one of these models to describe the gold-silver anomalies of the Yetna River volcanic field. Also, the elevated values of Sn, Pb, Be, and Nb noted in one part of the field are not consistent with any of the volcanic-hosted epithermal models. This elemental suite is associated with felsic intrusions and may indicate the presence of an unexposed granitic body. Given the uncertainties, the potential deposits of the Yetna River volcanic field are described in general terms—volcanic-hosted precious and other metals deposit type.

Resource area 5a, west of Iditarod River

Resource area 5a (map B) has a high potential (certainty level B) for containing volcanic-hosted deposits. The area is underlain primarily by rhyolitic to andesitic pyroclastic flows and silicified rhyolitic domes that are part of the Yetna River volcanic field (unit TKy). Grab samples of rhyolitic rock from three sites in the northern part of the resource area (nos. 34–36, table 1) yield consistent values of Sn (50–70 ppm), Pb (100–150 ppm), Nb (50–100 ppm), and Be (10–15 ppm). Two other sites in the southern part of the resource area yielded Ag values. A grab sample of iron-stained, silicified rhyolite contains 10 ppm Ag, 500 ppm Pb, and 20 ppm Sn (no. 50, table 1). A grab sample of altered rhyolite tuff contains 5 ppm Ag and 200 ppm Pb (no. 69, table 1). Hg was not analyzed in any of these grab samples.

In the reconnaissance drainage-basin study, samples from two sites are Au-bearing and samples from an additional six sites locally contain anomalous values of Ag, As, or Sn. Two heavy-mineral concentrates contain Au (150 ppm and 300 ppm) and Ag (10 ppm and 300 ppm, respectively); the stream sediment from the former site contains 1.0 ppm Ag. Two other stream-sediment samples from this resource area contain trace silver (<0.5 ppm), stream sediments from three additional sites contain As (15–32 ppm), and two heavy-mineral concentrates contain more than 2,000 ppm Sn.

Resource area 5b, Yetna River area

Resource area 5b (map B) has a moderate potential (certainty level B) for containing volcanic-hosted epithermal deposits. The area is primarily underlain by rhyolite, dacite, andesite, and local basalt of the Yetna River volcanic field (unit TKy). One small exposure of Early Cretaceous sedimentary rock (unit Ks), which locally underlies the volcanic rocks, crops out in the southwestern part of the resource area.

Grab samples from eight sites in resource area 5b yield anomalous metal values, including up to 0.1 ppm Au at five of these sites. Samples of altered rhyolite from three sites (nos. 68, 70, and 85, table 1) contain Au and Hg (0.05 to 0.10 ppm Au and 60 ppb to 1.4 ppm Hg), and locally trace Ag, 20 ppm Sn, and 130 ppm As. A dacite sample from the southern part of resource area 5b contains 50 ppb Au and 18 ppm Sb (no. 126, table 1). A grab sample of hematite-altered sandstone from the southwestern part of the resource area contains 150 ppm As and trace amounts of Au, Ag, Hg, and Sb. Samples of welded rhyolite tuff from two sites (nos. 37 and 125, table 1) contain 2.2 and 1.2 ppm Hg, respectively. A grab sample of andesite from the southern part of the resource area contains 100 ppm Sn.

Samples collected within resource area 5b during the AMRAP reconnaissance drainage basin survey help define the outline of this resource area. Three stream-sediment samples from the northwestern side of the resource area contain 0.012 to 0.027 ppm Au; a heavy-mineral concentrate from one of these sites contains 1,000 ppm Sb and microscopic cinnabar occurs in the concentrate from another of these sites. Elsewhere in the resource area, cinnabar was identified in the concentrate from two other sites. Three stream-sediment samples contain up to 22 ppm As, and one stream-sediment sample has trace Ag (<0.5 ppm). One heavy-mineral concentrate contains 300 ppm Cu and another contains 1,000 ppm W. Galena, cassiterite, chalcopyrite, and scheelite were identified by microscope locally in five samples. One aquatic moss sample contains 5 ppm Ag.

The NURE reconnaissance lake-sediment data provide some additional support for resource area 5b. Using R-mode factor analysis Gray and others (1988c) outlined an area near the headwaters of Reindeer Creek (see their fig. 1) that fits their precious-metal related factor (As-Mn-Fe) outlined for the lake-sediment data set.

MAFIC-ULTRAMAFIC RELATED Cr-Ni-Co DEPOSITS (MODEL 6)

Mafic and ultramafic rocks of the Dishna River area crop out in an elongate, irregular belt from Moose Creek northeastward to the Iditarod quadrangle boundary immediately east of the Dishna River. Mafic rocks, which locally show mineral assemblages indicative of low-pressure, hydrothermal metamorphism to greenschist facies (Miller, 1990), and serpentinized ultramafic rocks, occur as isolated fault-bounded blocks that are almost certainly part of the Tozitna-Innoko ophiolite belt as described by Patton and others (1994a). Miller and Bundtzen (1994) assigned a Jurassic age to the belt in the Iditarod quadrangle.

Mafic-ultramafic related chromite, cobalt-nickel, and asbestos deposits (deposit models 8a and 8c, Albers, 1986, and Page, 1986, respectively) are hosted in rocks similar to the mafic and ultramafic rocks of the Dishna River area. Podiform chromite is known to occur in the Tozitna-Innoko ophiolite belt to the northeast of the study area (Roberts, 1984; Loney and Himmelberg, 1984). No ultramafic-associated mineral occurrences are known in the Dishna River mafic-ultramafic rocks.

Resource area 6, Dishna River area

Resource area 6 (map B) has a low potential (certainty level C) for containing mafic-ultramafic related Cr-Ni-Co deposits. Many grab samples of gabbro and harzburgite from the Dishna River mafic-ultramafic complex (reported in McGimsey and others, 1988) contain high values of chromium (>5,000 ppm, locally), nickel (up to 3,000 ppm), and cobalt (up to 200 ppm), but no chromite or massive sulfide concentrations have been identified in the field, and most elevated metals are believed to be derived from refractory minerals in altered ultramafic igneous lithologies. At one locality in resource area 6, a grab sample of serpentinized ultramafic rock contains 30 ppm Ag, 120 ppm As, 2,000 ppm Cr, and 2,000 ppm Ni (no. 51, table 1). The Cr-Ni values are probably related to the presence of chrome spinel and altered olivine; the source of the Ag and As is not well understood.

A few samples collected during the reconnaissance drainage-basin study in or downstream from resource area 6 yielded anomalous values. Two stream-sediment samples contain Cr (>5,000 ppm and 1,500 ppm). A heavy-mineral concentrate from the latter site contains 100 ppm Au and 20 ppm Ag; small amounts of microscopic cinnabar and scheelite were identified in this sample. Two aquatic moss samples from the west side of resource area 6 contain 5 ppm Ag.

HEAVY-MINERAL PLACER DEPOSITS (MODEL 7)

Gold from placer deposits has been the chief commercially recovered mineral resource in the Iditarod quadrangle. The quadrangle includes parts of four placer mining districts as defined by Ransome and Kerns (1954): the Aniak, McGrath, Innoko, and Iditarod districts (fig. 4). From 1910 to 1992, an estimated minimum of 65,000 kg[2] (2.1 million oz) of gold, 7,300 kg (235,000 oz) of silver, and some tungsten and mercury have been recovered from the placer deposits of the quadrangle. In comparison, only about 99 kg (3,185 oz) of gold was produced from lode mineral deposits in the quadrangle. Heavy minerals of past, current, or potential interest include gold, cinnabar, scheelite, cassiterite, ilmenorutile, magnetic chromite, platinum group elements (PGE), and stibnite.

Virtually all heavy-mineral placer deposits thus far recognized in the Iditarod quadrangle have their source in mineralized Late Cretaceous and early Tertiary intrusions and volcanic rocks that crop out throughout the study area. Three major morphological types of heavy-mineral placer deposits have been recognized in the study area and are summarized below.

(1) *Residual and hillslope (eluvial) placers* that formed directly on or near mineralized source rock occur in the Flat area of the Iditarod district and in parts of the Innoko district (fig. 4). They include deposits on Chicken Mountain (no. 105, map A and table 1) and part of the Ganes Creek and Yankee Creek drainages (nos. 10 and 19, map A and table 1). Residual and hillslope (eluvial) placers of the study area are restricted to small gullies, hillslopes, altiplanation terraces, and dike swarms crossing creek valleys. Host lithologies are unconsolidated, poorly sorted eluvial talus, immature fluvial deposits, and igneous gruss formed by disintegration and weathering of underlying plutonic rocks. Commonly placers contain large amounts of clay derived from alteration of igneous feldspars. Pay zones are generally thin and discontinuous, but locally may be quite rich; some pay zones at the head of Flat Creek (no. 106, map A) in the Iditarod district averaged 25 to 50 g/tonne gold during exploitation.

(2) *Ancestral stream channel deposits in terrace alluvium (bench placers)* are elevated fluvial deposits ancestral to modern stream channels. Bench placers are widespread throughout the study area and comprise the most important resources of placer gold remaining

[2]Recall that the total recorded production for the quadrangle is higher than the cumulative total obtained by adding individual property production figures from table 1, because early production figures were commonly reported by district or subdistrict, not by creek.

throughout the Iditarod quadrangle. In the Donlin Creek area (no. 195, map A), these deposits were the auriferous sources for gold found in the commercially exploited modern stream. A possible mechanism for formation of bench placers is that they formed by westward stream migration during asymmetrical valley formation. Solifluction due to daytime (afternoon) thawing activity is more pronounced on south- or west-facing slopes, which caused streams to migrate cross valley toward north- or east-facing buttresses. Through this long process, which began in late Tertiary time, the eastern bench levels formed on Ganes, Spaulding, and Deadwood Creeks (nos. 10, 11, and 56, respectively, map A) in the Innoko district, on Flat, Otter, Slate, Willow, Chicken, and Prince Creeks (nos. 106, 107, 112, 129, 131, and 132, respectively, map A) near Flat in the Iditarod district, and on Spruce Creek and Donlin Creek (nos. 172 and 195, map A) in the Aniak district. In a few areas, valley asymmetry is reversed and the stream migration could also be influenced by regional uplift or structural tilting due to the influence of high-angle movement along the Iditarod-Nixon Fork Fault system. For example, a major stream piracy at Donlin Creek that reversed stream direction subsequent to the formation of Donlin bench probably was influenced by regional uplift. Likewise, similar reversed valley asymmetry at Moore Creek (no. 83, map A) could be influenced in the same way.

(3) *Modern stream alluvium placers* formed in Holocene stream gravels throughout the study area; they comprise a less important but still significant portion of the total placer resources. They consist of unconsolidated, generally shallow gravel and silt deposits ranging from 1- to 3-m thick. The most significant deposits are on Yankee and Carl Creeks in the Innoko district, on Fourth of July Creek (northeast of Moore Creek), all third- and fourth-order streams in the Flat area (listed above), Omega, Snow, and Queen Gulches in the Donlin Creek area, Little, Montana, and Return Creeks in the DeCourcy Mountain area, and Granite and Julian Creeks in the George River area.

Gold in all three morphological placer deposit types consists of flattened, flakey, and rounded grains; some nuggets are very large. The third largest nugget ever found in Alaska was recovered by Magnuson Mining Company on Ganes Creek in 1985 and weighed 3,856 g (124 oz). Magnuson Mining Company previously recovered a 1,990 g (64 oz) gold nugget on Ganes Creek in 1964. In 1987, John Miscovich recovered a 28 oz (871 g) gold nugget in Otter Creek near Flat. A 606 g (19.5 oz) nugget was recovered on Moore Creek by Don Harris in 1984. Gold nuggets weighing up to 590 g (19 oz) were recovered by mine operator Toivo Rosander on Yankee Creek prior to 1968. In 1984, Spencer and Doug Lyman recovered a 280 g (9 oz) gold nugget in Snow Gulch of the Donlin Creek placer area.

Gold placers of all three morphological deposit types described above form at the base of the gravel or talus trapped by various natural riffles in bedrock such as dike contacts, bedding layers, or fractures. Such a deposit is generally referred to as a “bedrock placer”. In rare cases, heavy-mineral concentrations occur on clay horizons in gravel or talus and are referred to as a “false bedrock” placer.

Resource area 7a, Ganes Creek-Yankee Creek

Resource area 7a (map B) has a high potential (certainty level D) for containing unexploited placer gold resources. It contains two auriferous drainages that flow north into the Innoko River, a major tributary of the Yukon River. The pay streaks on Ganes Creek and Yankee Creek (nos. 10 and 19, table 1), and their tributaries have been mined nearly continuously since the early 20th century and rank second only behind pay streaks in the Iditarod-Flat resource area (7d). Cumulative production within resource area 7a is estimated to be 5,042 kg (162,114 oz) of gold and 699 kg (22,468 oz) of silver primarily from Ganes and Yankee Creeks, but also from Mackie Creek, Spaulding Creek, Glacier Gulch, and Last Chance Gulch (nos. 1, 11, 12, and 13, table 1). Open-cut mining operations are currently extracting gold on both Ganes and Yankee Creeks.

At least two ancestral paleo channels, 15 to 30 meters above the modern flood plain, have been mined on Ganes Creek. These paleo channels predate the beheading of upper Ganes Creek by Beaver Creek in mid-Quaternary time (Bundtzen, 1980); hence they are thought to be late Tertiary or Early Pleistocene in age. The younger (late Quaternary to Holocene) stream gravels of Ganes Creek valley also contain auriferous gravels. Spaulding and Yankee Creeks contain similar pay streaks of unknown age that formed at the same relative level as the modern incision. An ancestral bench level occurs only on the right limit of Yankee Creek, immediately north of the study area. Individual pay streaks on all three streams range from 10 m to 60 m-wide and average about 1.5 m thick.

The lode source for placers in all three drainages is correlated with an extensive northeast-trending granite porphyry to granodiorite (and locally mafic) dike swarm mapped by Bundtzen and Laird (1980; 1982) and referred to here as the Yankee Creek-Ganes Creek dike swarm. The Independence Mine (a peraluminous granite-porphyry hosted gold-polymetallic deposit (no. 16, table 1) is found within this swarm. Heavy minerals reported by Bundtzen and others (1987) in mine concentrates of all streams in this area include abundant magnesiochromite, scheelite, ilmenite, eckermannite (a sodic amphibole), and native silver, in addition to free gold. The abundant magnesiochromite is traced back to chromite-bearing olivine monzonite intrusions within the dike swarm. The sodic amphibole is commonly associated with alkaline igneous rocks.

Reserve estimates are difficult to ascertain due to lack of documented data. Examination of mine records (Warren Magnuson and Ron Rosander, oral communs., 1985), suggests that significant amounts of gold remain in unmined pay streaks, mostly in the lower Ganes Creek drainage. In the regional drainage basin study two samples yielded anomalous values: a stream-sediment sample collected from a tributary to Ganes Creek contains 0.5 ppm Ag; a heavy-mineral-concentrate sample from Spaulding Creek has visible gold.

Resource area 7b, Carl Creek

Resource area 7b (map B) has a high potential (certainty level C) for containing placer gold resources. In this area, a small, first-order stream draining the north side of VABM Tatalina empties into Carl Creek, an easterly flowing tributary of the Kuskokwim River. According to unpublished U.S. mint records, 0.6 kg (18 oz) of placer gold was mined from Carl Creek in the years 1917 and 1918; additional prospecting and production may have subsequently occurred. Placer tailings were not recognized on either Carl Creek or the VABM Tatalina tributary (no. 48, table 1 and map A). Bundtzen and Laird (1983) reported that a heavy-mineral-concentrate sample from the latter tributary contains 23 ppm Ag, 5,700 ppm Pb, and trace Au. Samples collected from nearly the same site during this study also yielded anomalous values. Two stream-sediment samples contained 3 ppm Ag and up to 120 ppm As. Heavy-mineral-concentrate samples from the same sites contained 15 ppm Ag, 1,000 ppm As, and up to 5,000 ppm Pb. The stock at VABM Tatalina is a potential lode source for the anomalous metal values in resource area 7b. No estimate of the placer resource is possible at this time.

Resource area 7c, Moore Creek area

Resource area 7c (map B) has a high potential (certainty level D) for containing unexploited placer gold resources and is one of the most significant placer resource areas in the quadrangle. Auriferous streams of the resource area drain an upland area that has a high potential for plutonic-hosted copper-gold-polymetallic deposits (resource area 2b). Two past productive placer mines (Fourth of July Creek and Moore Creek, nos. 60 and 83, table 1 and map A), one placer prospect (Deadwood Creek, no. 56), and three placer gold occurrences (nos. 55, 58, and 81) help define the area.

Most placer deposits on Moore Creek occur in ancestral stream channel deposits in terrace alluvium. Modern stream alluvium in the lower portions of the drainage have additional, but minor, placer concentrations. Total production from Moore Creek (and Nevada Gulch) between 1911 and 1985 is estimated to be 1,722 kg (55,370 oz) of gold and 391 kg (12,570 oz) of silver. The lode source of the Moore Creek heavy-mineral placer deposits is believed to be a deeply dissected monzonite plug that crops out on the hillside 2.5 km northwest of Moore Creek (Bundtzen and others, 1988). Much of the Moore Creek placer pay streak was worked out by efficient dragline-dozer operations prior to the 1970’s. However, a significant potential exists for discovery of ancestral bench placers. Bundtzen and others (1988) suggested that Tertiary to Quaternary placer deposits were successively offset from the lode source by right-lateral transcurrent movement on the Iditarod-Nixon Fork Fault, which forms the southern structural boundary of the Moore Creek pluton (the postulated lode source for the placer gold). Hence, potentially significant, older, unexploited and buried ancestral channels may lie southwest of the main workings.

Heavy-mineral placer deposits on Fourth of July Creek were first discovered in 1915 and intermittent development has taken place since then. The heavy-mineral placers appear to be confined to more modern Holocene alluvium; older bench deposits have not yet been recognized. Bedrock pay streaks overlie decomposed andesite tuff, which has proven to be a poor catchment surface for the placer gold. Bundtzen and others (1988) speculated that significant placer gold potential exists 2–3 km below the currently known placer resources, where the bedrock surface is Kuskokwim Group clastic rocks and the hydraulic gradient is more mature. The potential for discovery of a 2-km long, 3-m wide pay streak is considered high. The source of the placer gold in Fourth of July Creek is probably a mineralized pluton that straddles the Fourth of July Creek and Maybe Creek drainages. Placer gold was also panned on Maybe Creek (no. 58, table 1) during previous investigations (Bundtzen and others, 1988).

A large, low-grade, shallow, unexploited gold placer resource occupies a 1.5 km by 150 m area near the headward zone of Deadwood Creek (no. 56, table 1). The deposit, which was discovered in the 1930’s, consists of fine gold in shallow gravels 2–3 m thick. According to Toivo Rosander (oral commun., 1983), the deposit uniformly assays about 0.008 oz/yd^3 (or about 0.4 g/m^3). Assuming continuity of pay from the previous churn drilling program, the Deadwood Creek placer deposit contains a speculative resource of 375,000 m^3 of gravel grading 0.4 g/m^3 or 150 kg (4,820 oz) gold.

During the reconnaissance drainage-basin study samples collected from four sites in resource area 7c yielded anomalous Au values. Two stream-sediment samples contain 0.056 and 0.077 ppm Au. Visible gold was identified in a heavy-mineral concentrate from an unnamed drainage north of St. Patrick Creek (no. 55, table 1 and map A); this sample contains more than 1,000 ppm Au and 300 ppm Ag. A heavy-mineral concentrate from a nearby site contains 500 ppm Au, 50 ppm Ag, 500 ppm W, and 100 ppm Mo.

Placer chromite exists in the Moore Creek and Forth of July placer deposits. Mine concentrates from Moore and Fourth of July Creeks contain 35 percent and 24.8 percent chromite, respectively (Bundtzen and others, 1988). Bulk samples of placer gravels from both streams contained 0.28 to 2.08 percent chromium (Bundtzen and others, 1988). Although this is a significant amount of chromium, it is probably only economically viable as a byproduct.

Resource area 7d, Iditarod-Flat area

Resource area 7d (map B) has a high potential (certainty level D) for containing unexploited placer gold resources. Heavy-mineral placer deposits in this resource area have accounted for about 70 percent of all gold recovered from the Iditarod quadrangle. Gold has been mined nearly continuously since its discovery on Christmas Day in 1908; currently (1998) three mechanized mining operations recover placer gold. Through 1990, about 45,200 kg (1,450,000 oz) of gold, about 6,100 kg (197,000 oz) of silver, and minor amounts of tungsten and mercury have been recovered from the placer deposits. Over the years many workers have described the placer resources of this area. They include Smith (1915), Brooks (1912, 1914), Eakin (1913, 1914), Mertie and Harrington (1924), Mertie (1936), Williams (1950), and Bundtzen and others (1987, 1992). Most of the following brief summary is derived directly from a more comprehensive summary in Bundtzen and others (1992).

Commercially productive streams in the area include Granite, Happy, upper Flat, Flat, Otter, Black, Malamute, Slate, Willow, Chicken, and Prince Creeks (nos. 89, 104–107, 109, 111, 112, 129, 131, and 132, table 1 and map A). Two streams—Otter and Flat Creeks—have accounted for 33,500 kg (1,077,000 oz) gold from 1915 to 1990 or about 75 percent of total district production. The sources of the placer gold are auriferous veins, disseminations, and stockworks in the intrusive rocks of Chicken Mountain, in the hornfels aureole north of Otter Creek, and in mineralized bedrock within the valley of Otter Creek. The majority of production from Otter, Flat, Willow, and Chicken Creeks has come from several ancestral terrace alluvial deposits, which are consistently 2–4 times richer than modern stream gravels. Rich terrace levels of note include the “Marietta” bench of upper Flat Creek, the Willow Bench (no. 129, map A) on lower Willow Creek, prominent terraces on Prince Creek, and most of the southern limits of Otter Creek valley. Residual placers on Chicken Mountain and in the Black Creek drainage were mined almost entirely by hand prior to World War II; these deposits are now largely exhausted.

Extensive gold fineness data show a district average of 864 based on 112 weighted determinations (Smith, 1941; Bundtzen and others, 1987, 1992). All three placer deposit types—residual or eluvial, ancestral terrace alluvial or bench placers, and modern stream alluvial deposits—occur in the Iditarod-Flat resource area. This area is one of Alaska›s best examples of progressive evolution from residual to eluvial to stream heavy-mineral-placer concentrations from mineralized source rock.

Most of the present placer mine development and production activities are focused on (1) previously mined pay streaks where examination of records showed significant gold recovery losses and (2) evaluation of deeply buried ancestral channels not exploited by earlier mine operators. The following placer resource data are derived from examination of unpublished private company figures and discussions with John Miscovich, Alvin Agoff, and the late Richard Fullerton. A low-grade placer deposit below the Flat townsite was systematically evaluated using a churn drill program by the North American Dredging Company. The exploration effort indicated that a 3-km long and 0.5-km wide pay zone contained an inferred resource of 9,844,000 m^3 (12,875,000 yd^3) of pay grading about 0.4 g/m^3 (0.008 oz/yd^3) gold or 3,203 kg (103,000 oz) gold (Richard Fullerton, oral commun., 1989). Exploration work on the Willow Bench (no. 129, map A), an ancestral channel of Willow Creek (Bundtzen and others, 1992), delineated a pay streak approximately 3 km and 100–150 m wide that may contain an inferred resource of at least 1,580,200 m^3 (2,067,000 yd^3) grading 0.61 g/m^3 (0.015 oz/yd^3) gold or about 964 kg (31,000 oz) of gold. Placer gold resources remain in Prince and lower Chicken Creeks (nos. 132 and 131, map A). Most previous mining on both creeks was confined to shallow benches and modern stream alluvium. Unexploited ancestral channels and alluvial fan deposits buried by 10–12 m of overburden are found in both areas; recent exploration has shown that promising resources remain. Unmeasured, but probably significant placer gold resources also occur in Flat and Otter Creeks, where most of the area’s past district production has taken place. Modern mine operators in both areas have found economic concentrations of placer gold in fractions and along bench limits incompletely evaluated by past operators.

During the reconnaissance drainage-basin study, samples collected from four sites in resource area 7d yielded anomalous Au and (or) Ag values. Visible gold (1–5 percent) was noted in a heavy-mineral concentrate from Black Creek (no. 109, map A) that contains 500 ppm Ag, 1,500 ppm As, 2,000 ppm W, and 3,000 ppm Sb; the stream-sediment sample contains 1.55 ppm Au and 1.0 ppm Ag. A heavy-mineral concentrate collected north of the Flat town site contains 500 ppm Au, 70 ppm Ag, and 1,000 ppm W. A stream-sediment sample collected from Willow Creek, above the placer operation (no. 129, map A), contains 0.5 ppm Ag. West of the placer operation, a stream-sediment sample contains 0.015 ppm Au.

Resource area 7e, Little Waldren Fork

Resource area 7e (map B) has a high potential (certainty level B) for containing placer gold, however, it is unlikely that this would be a significant resource. The area is outlined on the basis of metallic lodes of the Bismarck Creek area (resource area 3g, map B) and scattered gold anomalies from the regional geochemical survey. In addition, placer gold was reportedly found in the Little Waldren Fork drainage basin shortly after World War II (Doug Sherrer, oral commun., 1992).

During the reconnaissance drainage-basin study, samples collected from six sites in resource area 7e yielded anomalous Au and (or) Ag values. Three of these sites are in the headwaters area of Little Waldren Fork; of three stream-sediment samples, one contains 0.014 ppm Au, another contains 0.012 ppm Au and less than 0.5 ppm Ag, the third contains 1.0 ppm Ag and 300 ppm Zn. The remaining three sites are from an unnamed creek that drains east from resource area 3g into Little Waldren Fork. Two stream-sediment samples from here contain 0.5 ppm Ag, and a third contains less than 0.5 ppm Ag. A heavy-mineral concentrate from the last site contains 500 ppm Au, 50 ppm Ag, 200 ppm W, and more than 2,000 ppm Sn.

Resource area 7f, Granite Creek and Munther Creek

Resource area 7f (map B) has a high potential (certainty level D) for containing unexploited placer gold resources. The area overlaps part of a gold-bearing lode resource area (1b, map B) and encompasses two auriferous creeks—Granite Creek and Munther Creek (nos. 142 and 148, respectively, table 1 and map A). Granite Creek, a major trunk stream of the George River, has recorded production; Munther Creek, a tributary to the East Fork of the George River, was prospected in the 1920's and 1930's (Tony Gularte, oral commun., 1986) and may have had some production. Bundtzen and others (1986) evaluated significant stibnite-quartz (gold) lodes hosted in granite porphyry dikes and sills near this property; the initial discovery was made by mine operator L.E. Wyrick during placer mine development. These lode occurrences are believed to be the source of at least part of the placer gold resources in both the Granite Creek and Munther Creek drainages.

Placer gold was discovered on Granite Creek in 1924 and intermittent underground drift development and production took place until 1935. After a long dormant period, the deposits were developed again in the early 1980's. Current mine operations have taken place continuously since about 1985. Total production is conservatively estimated at 101 kg (3,250 oz) of gold and 12 kg (400 oz) of silver from shallow gravels on the modern flood plain and from a slightly elevated terrace on the right limit of the creek. Principle heavy minerals besides gold are garnet, zircon, stibnite, and cassiterite.

Placer pay streaks 2 m thick in the Granite Creek drainage probably average about 1.0 g/m^3 (0.025 oz/yd^3). Surface sampling and limited shallow reverse circulation drilling results indicate about 350,000 m^3 of auriferous pay. Extensions of the known resources can be extrapolated from delineation of the granite porphyry and monzonitic plutons mapped within the placer resource area. These extensions include lower portions of Homestake, Bismarck, and Munther Creeks and the uppermost reaches of Granite Creek and Little Moose Creek.

From the regional drainage basin study, two stream-sediment samples within or downstream from resource area 7f yielded Au values. A sample from the lower part of Bismarck Creek contains 0.046 ppm Au. A sample from west-flowing Little Moose Creek, which drains the same headwaters area as the east-flowing Munther Creek, contains 0.018 ppm Au.

Resource area 7g, Julian Creek area

Resource area 7g (map B) has a high potential (certainty level D) for containing unexploited placer gold resources. The area overlaps part of a gold-bearing lode resource area (1c, map B) and contains three previously mined placer deposits. A granite porphyry dike swarm that underlies the area provided gold and associated heavy minerals to the placer deposits of Julian, Michigan, and Spruce Creeks (nos. 160, 161, 172, respectively, map A). As previously discussed in the description of resource area 1c, the granite-porphyry dike swarm of the Julian Creek area is inferred to be right-laterally offset 12 km from the granite-porphyry dike swarm that provided gold to placers in the Granite Creek drainage (placer resource area 7f, above).

Pay streaks in resource area 7g occur in short, second-order streams as both ancestral Late Tertiary? bench levels, 2–6 m above the modern flood plain, and in late? Quaternary alluvium. Incomplete production records show about 361 kg (11,600 oz) of gold and 51 kg (1,650 oz) of silver has been recovered from placer deposits on Julian Creek intermittently from 1911 to 1993. The remaining past production for the resource area has been from Spruce Creek (8.5 kg or 274 oz of gold) and Michigan Creek (3.9 kg or 125 oz of gold).

Much of the developed placer resources in resource area 7g are mined out. Reserves remain on Julian Creek, but the Spruce Creek and Michigan Creek pay streaks have been substantially depleted. Prospecting potential for gold placers exist in all drainages eroding the mineralized granite porphyry dike swarm, which is the source of the gold placers in formerly productive creeks. These include unnamed streams in the eastern part of the resource area that drain west and northwest into the George River. One stream-sediment sample collected from this area during the regional drainage basin study contains 0.5 ppm Ag and 5.0 ppm Hg.

Resource area 7h, American Creek

Resource area 7h (map B) has a high potential (certainty level C) for containing placer gold resources. The area includes the lower part of American Creek and several small, similarly oriented creeks, all of which drain southeast into the Iditarod River. American Creek drains the southeast side of lode resource area 2e, which has a high potential for containing plutonic-hosted copper-gold-polymetallic deposits. During this study, placer gold was identified in a heavy-mineral concentrate collected from the lower part of American Creek (no. 204, map A). This sample contains more than 1,000 ppm Au, 200 ppm Ag, and 70 ppm Bi. The hornfels and altered intrusive rocks exposed on Mosquito Mountain and in other parts of resource area 2e are a possible source of heavy-mineral placers in American Creek. This raw placer gold prospect needs additional work.

Resource area 7i, Little Creek

Resource area 7i (map B) has a high potential (certainty level C) for containing placer gold resources. Low-grade placer gold resources have been recognized in Little Creek, a small, north-flowing stream that originates in the Sleetmute quadrangle and flows into the Iditarod River. Trenching and limited churn drilling programs were initiated there mainly prior to 1960. Placer gold was found for a distance of 5 km of valley length, but in low concentrations. The deposit appears to be hosted in modern floodplain alluvium; but it is buried by overburden and vegetation. There is no record of production, but some gold may have been produced during testing.

During the reconnaissance drainage-basin study, placer gold was identified in a heavy-mineral concentrate collected on Little Creek (no. 181, table 1 and map A). This concentrate contains 150 ppm Au, and 15 ppm Ag; the stream sediment from the same site contains 1.9 ppm Hg.

Resource area 7j, Return Creek

Resource area 7j (map B) has a high potential (certainty level D) for containing placer cinnabar resources. Return Creek lies on the south side of cinnabar-stibnite lode sources in the DeCourcy Mountain area (nos. 183 and 184, map A) and placer cinnabar resources have long been recognized on this creek. A limited drill program indicated that some gold also occurs with the placer cinnabar (Spencer Lyman, oral commun., 1986). Aerial photographic observations suggest that the placer deposits may occur in both ancestral channels and modern stream alluvium.

Resource area 7k, Donlin Creek area

Resource area 7k (map B) has a high potential (certainty level D) for containing unexploited placer gold resources. The area overlaps part of a gold-bearing lode resource area (1d, map B) and contains seven previously mined placer deposits. Placers in the Donlin Creek area have been exploited intermittently since 1910; total recorded production is 918 kg (29,520 oz) of gold and about 31 kg (1,000 oz) of byproduct silver. Gold production by tributary is 188 kg (6,039 oz) in Lewis Gulch, 4.5 kg (145 oz) in Ruby Gulch, 256 kg (8,238 oz) in Snow Gulch, 61 kg (1,968 oz) in Quartz Gulch, 130 kg (4,170 oz) in Donlin Creek, and 278 kg (8,962 oz) in Crooked Creek and Omega Gulch together (nos. 188, 191, 193–195, and 205, respectively, table 1 and map A). Principle heavy minerals in the pay streak besides gold include garnet, cassiterite, scheelite, monazite, and stibnite.

Mineralized granite porphyry dikes and sills are most likely the lode sources for the placer deposits, but deposition and emplacement of the placer resource was influenced by a complex Quaternary history. Examination of 1:63,360-scale false-color infrared aerial photographs and sedimentary paleocurrents in old terrace alluvium of the ancestral Donlin Bench show that Donlin Creek flowed north into the Iditarod River probably in late Tertiary time. To date, all commercial quantities of placer gold are found where more youthful streams and gulches intersect and downcut into the ancestral Donlin Bench. Most of these more youthful gulches have their headward source in the mineralized granite porphyry dike/sill complex. The placer pay is probably created mainly by recycling and reconcentration of gold in the bench, but may be augmented by additions of heavy minerals from more youthful erosion of the granite porphyry intrusions.

In the reconnaissance drainage-basin study, samples from two creeks in resource area 7k contain Au. On Queen Gulch, a stream-sediment sample contains 0.035 ppm Au, 0.5 ppm Ag, 100 ppm As, and 1.6 ppm Hg; the heavy-mineral concentrate contains more than 2,000 ppm Sn. A stream-sediment sample from American Creek, which lies between Lewis and Omega Gulches, contains 0.011 ppm Au and 110 ppm As.

Discovery of additional placer resources in resource area 7k will probably involve systematic testing of gulches that drain upland areas underlain by granite porphyry and that intersect the ancestral Donlin Bench.

ASSESSMENT OF NON-METALLIC RESOURCES

HYDROCARBON RESOURCES

Sedimentary rocks of the Kuskokwim Group, which underlie roughly 65 percent of the Iditarod quadrangle, are considered a poor target for hydrocarbon resources due to environment of deposition, induration, and structural complications (Mull and others, 1995; Stanley, 1996). The Upper Cretaceous Kuskokwim Group in the study area is part of a regionally-extensive basin-fill sequence that consists of marine turbidites (unit Kks) that are flanked on the west by subordinate shallow-marine and fluvial strata (unit Kkq) (Miller and Bundtzen, 1994). The turbidite sandstones are matrix-rich and generally lack porosity; the shallow- to non-marine quartzose sandstones are usually cemented by secondary silica and hematite. The Kuskokwim Group was deformed in a wrench fault tectonic environment resulting in a structurally complex system of folds and faults (Miller and Bundtzen, 1994).

The flysch deposits consist of medium- to thick-bedded sandstone, siltstone, and shale and exhibit Bouma sequences (Bouma, 1962). Sandstones are usually fine to medium grained, light to medium gray, poorly sorted, locally arkosic, micaceous graywacke containing abundant clay in the matrix. Calcareous sandstone is abundant locally. Some coarse-grained, pebble-bearing sandstones are present as channel-fill deposits. Bouma sequences include massive or graded Ta, Tab, Tae, Tabcde, Tcde, Tce, and Tde. Due to poor sorting, an abundance of clay matrix, and deep post-depositional burial (resulting in significant compaction), these sandstones have low porosity and permeability.

Strata of the Kuskokwim Group interpreted as shallow marine and fluvial, consist of moderately well-sorted feldspathic to quartzose sublithic sandstone, plant-debris-bearing siltstone, and minor coal-rich layers. Locally thickened wedges of quartz-pebble conglomerate occur throughout the section, some of which may represent fluvial channels. Although lacking the abundant clay matrix that characterizes the sandstone in the marine turbidites, porosity in the shallow marine and nonmarine sandstones has evidently been reduced by the presence of a high percentage of ductile grains, mechanical compaction, and pressure solution. Low porosity values (<3 percent) have been recorded from samples of Kuskokwim Group sandstone outside the study area (Mull and others, 1995).

Petrologic studies from the Iditarod quadrangle indicate that marine turbidites contain cellulosic kerogen in the form of locally abundant carbonaceous plant debris. If present in sufficient quantities, this type of kerogen is considered to be a source for gas only; liquid hydrocarbons are not generated in any quantity by cellulosic kerogen (Tissot and Welte, 1984). Although no rocks in the Iditarod quadrangle have been analyzed for total organic carbon (TOC), Lyle and others (1982) reported TOC values for 19 shale-rich samples from the Kuskokwim Group that range from less than 0.5 percent to 1.05 percent TOC and average about 0.70 percent TOC. Four Kuskokwim Group composite shale samples from the western McGrath quadrangle (fig. 1) range from 0.59 to 0.93 percent TOC and average 0.72 percent TOC (T.K. Bundtzen, W.G. Gilbert, J.T. Kline, and E.E. Harris, unpub. data, 1998). Shales containing less than 1 percent TOC are generally considered poor potential hydrocarbon source rocks (Tissot and Welte, 1984).

Higher concentrations of organic debris occur in the non-marine strata of the Kuskokwim Group where carbonaceous siltstones and mudstones contain abundant leaf impressions and occasional thin coal seams are found. During early gold rush years, coal was mined for local use in the Iditarod-Flat area (no. 86, table 1 and map A), but total production was very modest and used exclusively by local blacksmiths. The principle coal mine near Flat was briefly investigated and found to contain only thin, friable, discontinuous 10–50 cm thick, “bone” coal seams. Mertie (1936) reported this coal to be close to anthracite in composition having a calorific value of about 8,000 and Btu value of about 14,000, but that it’s physical features (such as friable nature) were more like subbituminous lignite. Due to the local nature and small size of these coal seams, no resource area is delineated. If other coal deposits are present, they will likely occur in association with the shallow-marine to non-marine strata of the Kuskokwim Group (map unit Kkq, which is exposed on the western edge of the paleo basin). The coal would only be economically viable for near-site use.

Thermal maturity is a useful tool in evaluating the liquid and gaseous hydrocarbon potential of source rocks. Measures of thermal maturity, such as vitrinite reflectance (R_o), thermal alteration index (TAI), and color alteration index (CAI), have been calibrated to the thermal windows for oil and gas generation and preservation (for example Heroux and others, 1979; Tissot and Welte, 1984; Johnsson and others, 1993). The thermal maturity categories devised by Johnsson and others (1993) for an Alaska statewide study of thermal maturity were adopted for this study. In their scheme (table 8), which is based loosely on the hydrocarbon maturation regimes of Poole and Claypool (1984), the following terms are used: *undermature* rocks are underheated with respect to the oil window; *mature-I* rocks are within the oil-generation window; *mature-II* rocks are higher than the oil-generation window, but within the oil and wet gas preservation window; *overmature* and *supermature* are successively higher levels outside the oil windows. Vitrinite reflectance data (table 9) were obtained for 26 samples of Kuskokwim Group mudstone and shale from the central part of the Iditarod quadrangle as part of the statewide study of thermal maturity (Johnsson and others, 1992). The samples include examples from both the shallow marine and basinal rock units. The R_o values range from a low of 0.61 to a high of 5.13 percent reflectance. Six of the average R_o values are within the mature-I category, that is they lie within the oil-generation window, but the majority of the 26 samples are overmature to supermature. TAI values were determined for 12 samples as a byproduct of biostratigraphic analysis (table 10). The TAI values range from about 2.5 to 3.5; the lowest value is questionably undermature and the remaining values are in the mature-II category, that is above the oil generation window, but within the oil and wet gas preservation window. The locations and thermal maturity levels for the R_o and TAI data sites are plotted on figure 5. Extreme variations even on a local scale indicate that the thermal maturity pattern is too complex to simply be a reflection of depth of burial. Thermal patterns associated with contact metamorphic regimes show a broad range of thermal levels locally (Rejebian and others, 1987). The thermal variation in Iditarod quadrangle is likely related to plutonism, and may also reflect structurally controlled hydrothermal alteration.

The Kuskokwim Group has a low probability of containing economically recoverable oil. In the Iditarod quadrangle, it lacks an associated oil source, migration pathways, and reservoir sandstone of sufficient porosity and permeability. The contained organic material consists primarily of cellulosic kerogen (terrigenous plant debris), which is a poor oil source rock. Most of the sandstones have a poor reservoir potential due to the compaction, burial, and thermal history, and further, the only potential channels for hydrocarbon migration are faults, which are also the conduits of hydrothermal fluids. Additionally, the irregular thermal pattern and the complex structure would make it extremely difficult to target any areas of hydrocarbon potential. Some vitrinite reflectance data do indicate that restricted areas of the basin are in the thermal window for hydrocarbon generation and coarse sandstone and conglomerate of the shallow-marine to non-marine strata of the Kuskokwim Group (map unit Kkq) could exhibit satisfactory porosity and permeability characteristics, but good source rock is still lacking.

There exists a low probability for the discovery of structurally controlled gas deposits in the Kuskokwim Group of the Iditarod quadrangle. Hypothetically, the strike-slip and concurrent wrench-fault tectonics that characterize the structural deformation would permit accumulation of gas in high-angle structural settings. In 1961, Pan American Petroleum Company (now Amoco Petroleum) drilled through approximately 4,500 m (15,000 ft) of relatively undeformed Kuskokwim Group in the Napatuk Creek No. 1 well near Bethel, about 250 km (150 mi) southwest of the study area (Mull and others, 1995). A 12-m-long (40 ft) test interval from 2,856 m to 2,868 m in depth (9,368 ft to 9,406 ft) built up a good "gas blow", but then quickly died (Mull and others, 1995). This test interval also contained saline waters, which indicate that some formation fluids flowed into the well. However, subsequent test intervals yielded slight "gas blows" that quickly ended, indicating the poor porosity and permeability characteristics of the Kuskokwim Group in that area. These limited data and information collected during this study seem to suggest that the only reasonable mechanism to trap and concentrate gas in the Kuskokwim Group would be within permeable shear zones and fault structures.

PEAT

Just east of the Iditarod quadrangle, Bundtzen and Kline (1986) studied peat near the community of McGrath (fig. 1) for it's suitability as either a horticultural or energy resource. They concluded that dry peat bogs along the Kuskokwim River could yield significant energy as well as be suitable for horticultural purposes. For example, some peat samples collected from one bog yielded Btu values ranging from 6,500 to 8,000. Extensive peat resources exist in the Iditarod quadrangle. Prospective peat settings include terrace alluvium, old glacial outwash, and wetland in the Innoko and Dishna River drainages. Large peat deposits also occur adjacent to the Yetna, Iditarod, and Kuskokwim Rivers. No attempt was made to quantify the peat resources of the study area.

SAND AND GRAVEL

Sand and gravel resources exist in modern streams, terrace alluvium, glacial outwash deposits, and placer mine tailings throughout the study area. Due to the extreme remoteness of the region, sand and gravel resources were not systematically assessed because of the lack of any apparent local need for these resources. Placer mine tailings have locally been used to construct roads and airstrips near Flat, near Moore Creek, and in the Ganes and Yankee Creek areas. Because placer mine tailings are water-washed, sorted gravels and sands, they do constitute high quality material suitable for road and airstrip construction and even rip rap uses. In the Iditarod district, 12,745,900 m^3 of material were processed by three bucketline stacker dredges from 1912 to 1966 (Bundtzen and others, 1992). Bundtzen and others (1988) estimated at least 1,070,400 m^3 of washed and stacked aggregate exist at Moore Creek. An additional 6,750,000 m^3 of processed sand and gravel exist at Ganes and Yankee Creeks in the Innoko district. Extensive but unmeasured resources of sand and gravel exist on the Donlin Creek bench, on the east limit of Bonanza Creek, near Julian Creek, in the upper George River drainage, in the upper Takotna River drainage, downstream from Moore Creek, along nearly the entire length of Fourth of July Creek, and in scattered drainage basins on the Nunsatuk River.

Glacial outwash deposits form a large, significant, but unmeasured resource in tributaries draining the Beaver Mountains. The most significant deposits include those on Tolstoi, Windy, and Beaver Creeks, which have been depicted at 1:63,360-scale geologic mapping by Bundtzen (1980) and Bundtzen and Laird (1982).

These materials could be utilized for construction of roads, bridges, and airstrips if warranted.

RIPRAP AND BEDROCK AGGREGATE

Kuskokwim Group shale and sandstone has been used as an effective surfacing agent for road construction in the Flat, Takotna, and Yankee Creek areas. From an engineering standpoint, the material compacts well and has favorable Alaska T-13 degradation test characteristics, as defined by standards adopted by the Alaska Department of Transportation and Public Facilities. The Kuskokwim Group is a widespread unit in the study area and these rocks could be used as road metal and aggregate locally throughout the study area.

Rip rap potential is largely confined to igneous lithologies in the area. Bundtzen and others (1989) reported that the rocks of the Kuskokwim Group along the Kuskokwim River consistently failed tests for rip rap suitability, however, unaltered and unweathered basalt, andesite, and monzonitic plutonic rocks tested favorably. Monzonite that was grussified by weathering consistently failed rip rap tests. These tests were run on rock lithologies in the McGrath D–6 quadrangle, immediately east of the study area; material physical characteristics would probably apply equally to the rocks of the Iditarod quadrangle. In conclusion, local material use of these would require lab testing prior to field application. The quartzite and granite gneiss from the Proterozoic Idono Complex (Miller and others, 1991) might prove satisfactory for use as rip rap.

OTHER INDUSTRIAL MINERALS

The Iditarod quadrangle is underlain by extensive fields of volcanic rocks that might contain zeolite resources. However, reconnaissance petrographic study failed to reveal presence of zeolites.

SUMMARY AND CONCLUSIONS

The Iditarod quadrangle lies in a remote part of Alaska and is currently accessible only by air, river, and a limited road system. Despite the remote location, mineral deposits from the Iditarod quadrangle have yielded at least 65,000 kg (2.1 million oz) of gold from placer deposits and another 100 kg (3,200 oz) of lode gold since 1906. These same mineral deposits have also yielded byproducts of silver, antimony, tungsten, and zinc. In addition, approximately 51,700 kg (1,500 flasks) of mercury were produced from cinnabar-stibnite lodes. In this report, the potential for additional metallic resources is assessed based on new geologic mapping and sampling, a regional drainage basin survey, and a comprehensive summary of the mines, prospects, occurrences, and rock geochemical anomalies.

Despite the fact that the region has been heavily prospected for placer gold, lode resources remain to be discovered. Several significant new mineral finds were located during the course of this study: (1) a hornfels-hosted silver-tin-polymetallic deposit at the head of Bismarck Creek (no. 118, table 1 and map A), which has an inferred reserve of 498,000 tonnes grading 0.137 percent tin, 7.8 g/t silver, 0.16 percent copper, and 0.22 percent zinc; (2) a cinnabar-stibnite-gold mineralized area at the head of the Dishna River (no. 74, table 1 and map A), which has an inferred reserve of 37,600 tonnes grading 2.46 g/t gold (a prospect not previously recorded in the literature); and (3) a cinnabar-stibnite occurrence, dubbed the “Yousure” (no. 156, table 1 and map A) near the Iditarod River.

Deposit models form the basis for this resource assessment, but the results are presented with multiple uses in mind—for mineral assessment, mineral exploration, and land-use planning. Resource areas, defined by the seven metallic deposit types, are outlined on map B and ranked as having high, moderate, or low potential for containing additional deposits of that type. Areas of high potential indicate where undiscovered resources likely lie and could serve as targets for an exploration program. Also useful for exploration purposes are the detailed descriptions provided for each resource area that clearly outline what is known and what is speculated in designating these areas. For land-planning purposes, resource tracts (fig. 3) are derived by grouping model-driven resource areas and are intended to emphasize total mineral endowment. On this figure land tracts are ranked as having very high, high, moderate, or low total metallic resource potential. This diagram is intended to be used qualitatively; it shows where mining activity is most likely to take place in the future.

The Iditarod quadrangle, a frontier area in terms of mineral exploration, contains additional undiscovered or unexploited metallic mineral resources. Using seven mineral-deposit models (table 2) to guide the assessment, we outlined 35 resource areas that have a high, moderate, or low potential for discovery of metallic lode deposits. We outlined 11 resource areas that have a high potential for discovery of placer deposits. These are described in the following paragraphs.

Four resource areas (1a–1d, map B) have a high potential for containing additional gold-bearing lode deposits that fit the peraluminous granite-porphyry-hosted gold-polymetallic model type. It is inferred that at the 90th percent confidence level, three additional deposits containing at least 155 kg (5,000 oz) of gold lie within these four resource areas (table 4).

Five resource areas (2a–2e, map B) have a high or moderate potential for containing additional gold-bearing lode deposits that fit the plutonic-hosted copper-gold-polymetallic stockwork and veins model type. It is inferred that at the 90th percent confidence level, three additional deposits containing at least 155 kg (5,000 oz) of gold lie within these five resource areas (table 4).

Nine resource areas (3a–3i, map B) have a high or moderate potential for containing additional silver-tin-bearing lode deposits that fit the plutonic-related, boron-enriched, silver-tin-polymetallic model type. It is inferred that at the 90th percent confidence level, eight deposits containing at least 175,000 tonnes (193,000 tons) of ore lie within these nine resource areas (table 4).

Fourteen resource areas (4a–4n, map B) have a high or moderate potential for containing additional mercury ± gold lode deposits that fit the epithermal mercury-antimony (gold) model type. It is inferred that at the 90th percent confidence level, six additional deposits containing at least 3,450 kg (100 flasks) of mercury lie within these fourteen resource areas (table 4).

Two resource areas (5a and 5b, map B) have a high or moderate potential for containing volcanic-hosted precious and other metals lode deposits, but no estimate of the number of undiscovered deposits of this type was made, because the model is not well defined for the area and the data are sparse.

One resource area (6, map B) has a low potential for containing mafic-ultramafic related Cr-Ni-Co lode deposits. No estimate of undiscovered resources was made since the presence of economic concentrations of these commodities is unlikely.

Defined by the heavy-mineral placer model type, ten resource areas (7a–7i, and 7k, map B) have a high potential for containing additional gold placer deposits and one resource area (7j, map B) has a high potential for containing cinnabar placer deposits. No estimate of the number of undiscovered placer deposits was made even though the model type is well defined for the study area and the likelihood for additional deposits is high. Given the high-level of placer exploration in the quadrangle, it is unlikely that any new deposit equal to or greater than the median for the region has not already been discovered. Instead, it is more likely that undiscovered resources will come in the form of extensions of known deposits or mining of very small deposits. In a limited number of resource areas (7c, 7d, and 7g) there is sufficient data to conservatively estimate that 4,667 kg (150,070 oz) more gold is contained in extensions of known deposits therein.

ACKNOWLEDGMENTS

We wish to thank all of the miners in Iditarod quadrangle who provided detailed information about their properties—Alvin Agoff, John and the late Richard Fullerton, Don Harris, Spencer and Carolyn Lyman, John Miscovich, and L.E. Wyrick. Donald Grybeck of the U.S. Geological Survey provided expertise on the mercury deposits of southwestern Alaska and helped with estimating the number of undiscovered mineral deposits. William J. Keith produced the figures and map sheets for this report. The thoughtful and constructive comments of the two USGS reviewers, W.J. Nokleberg and D.H. Richter, improved the manuscript. We also appreciated the helpful comments from Mark Meyers of the Alaska Division of Oil and Gas on the oil and gas section of this report.

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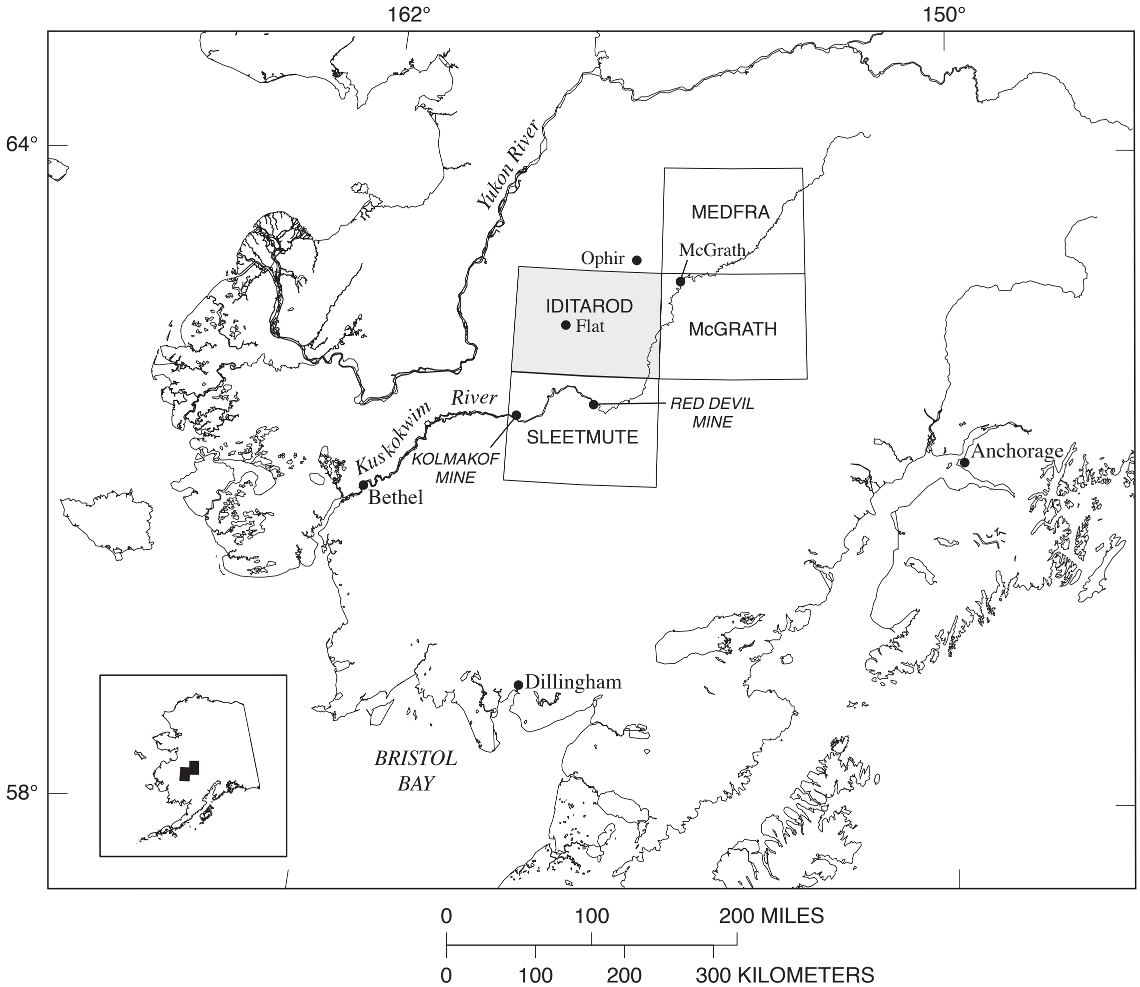

Figure 1. Location of the Iditarod quadrangle study area (shaded) in west-central Alaska. Also shown are neighboring quadrangles and other places referred to in text.

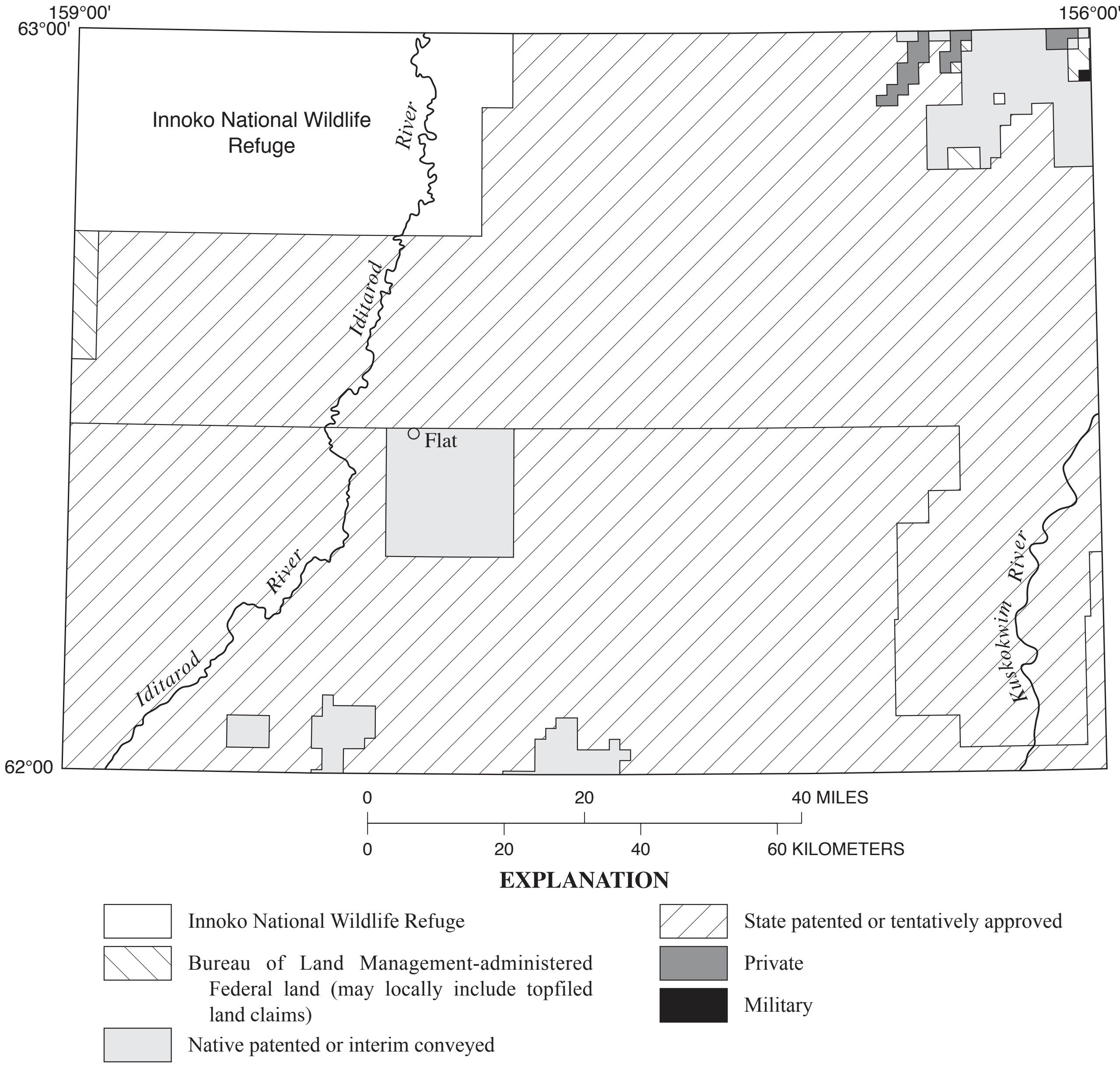

Figure 2. Map showing land jurisdiction for the Iditarod quadrangle (from Alaska Department of Natural Resources, 1995).

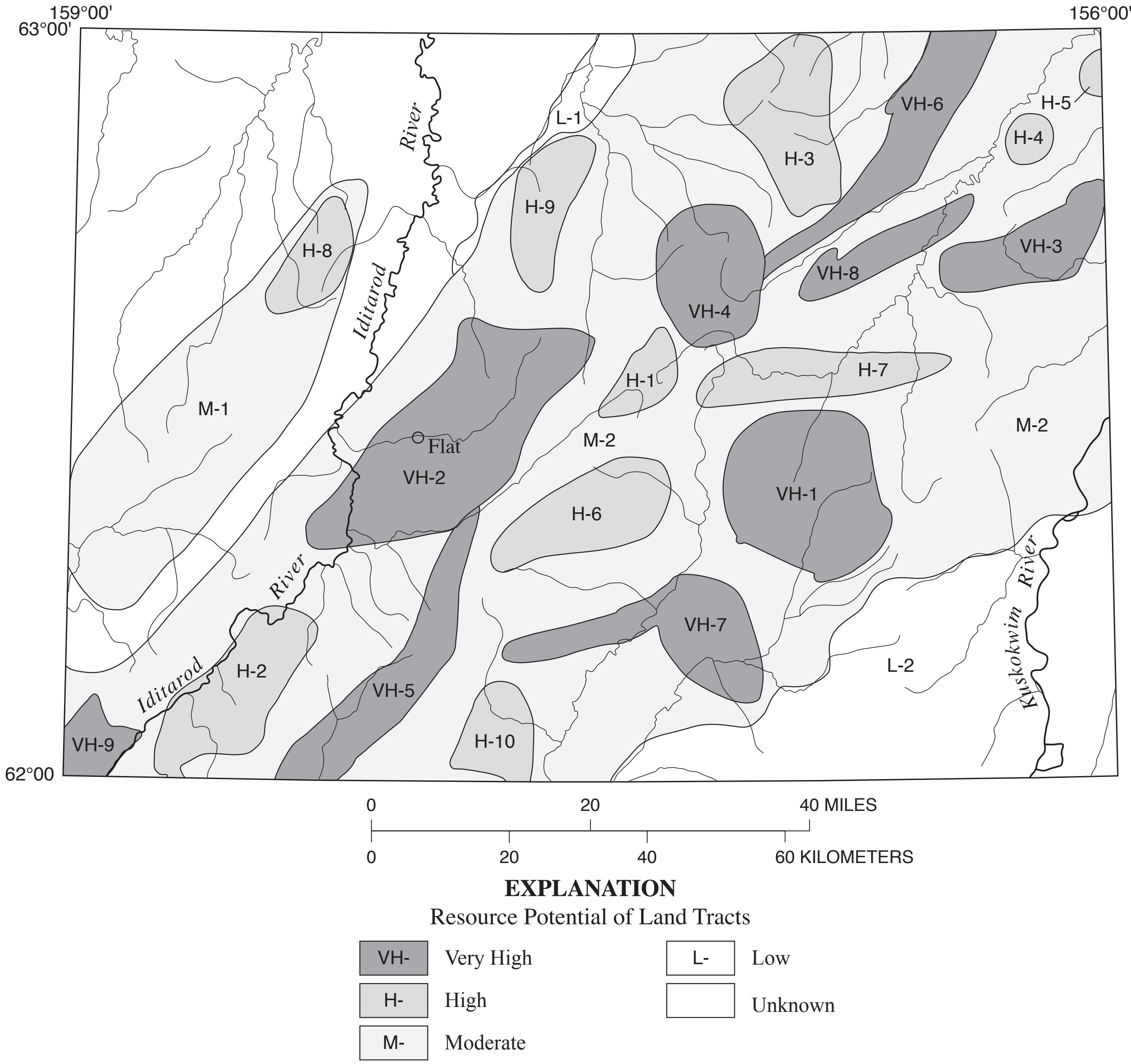

Figure 3. Map showing summary land tracts derived from model-driven resource areas of map B. Land-tract numbers correspond to table 7.

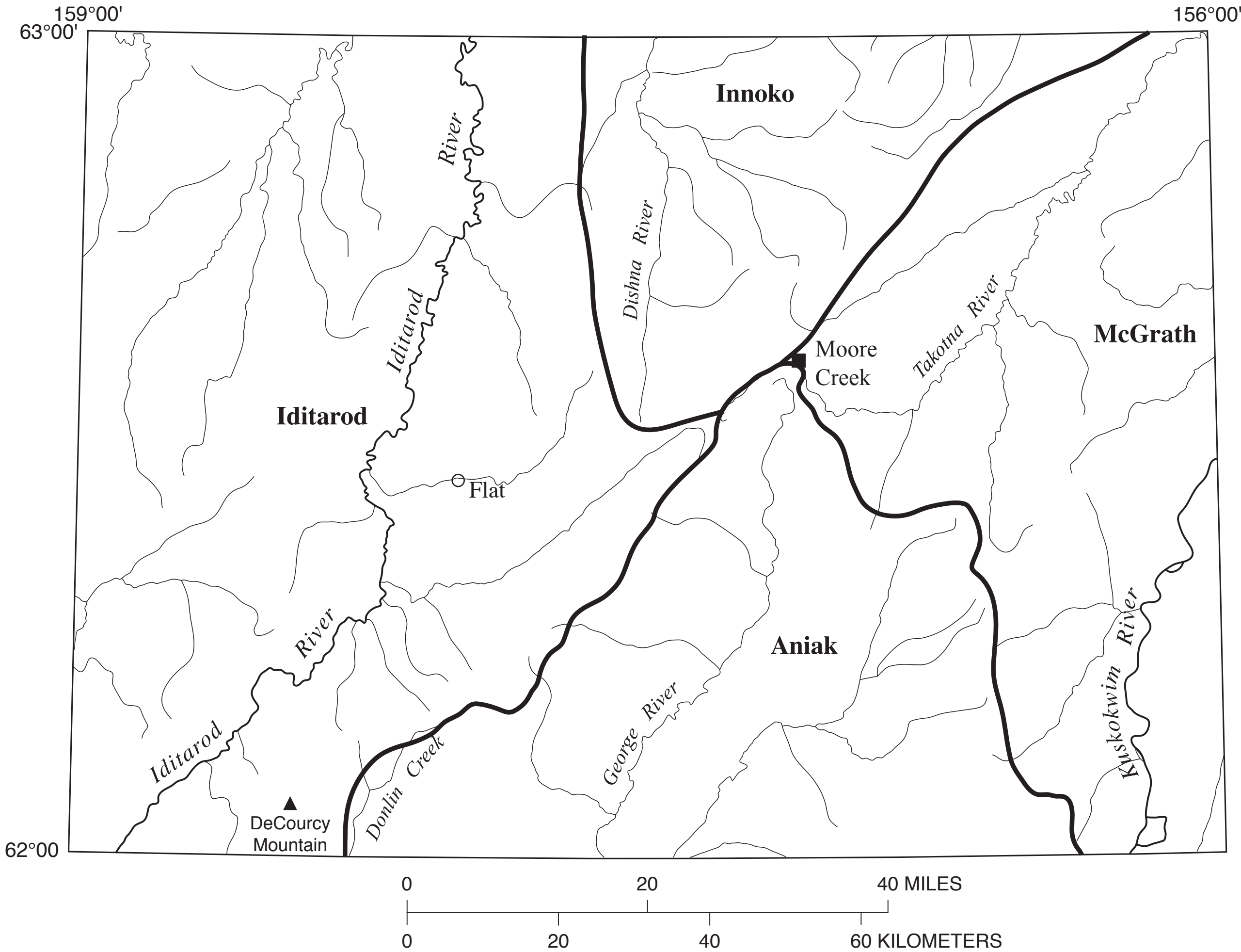

Figure 4. Map showing the placer mining districts of the Iditarod quadrangle (after Ransome and Kerns, 1954).

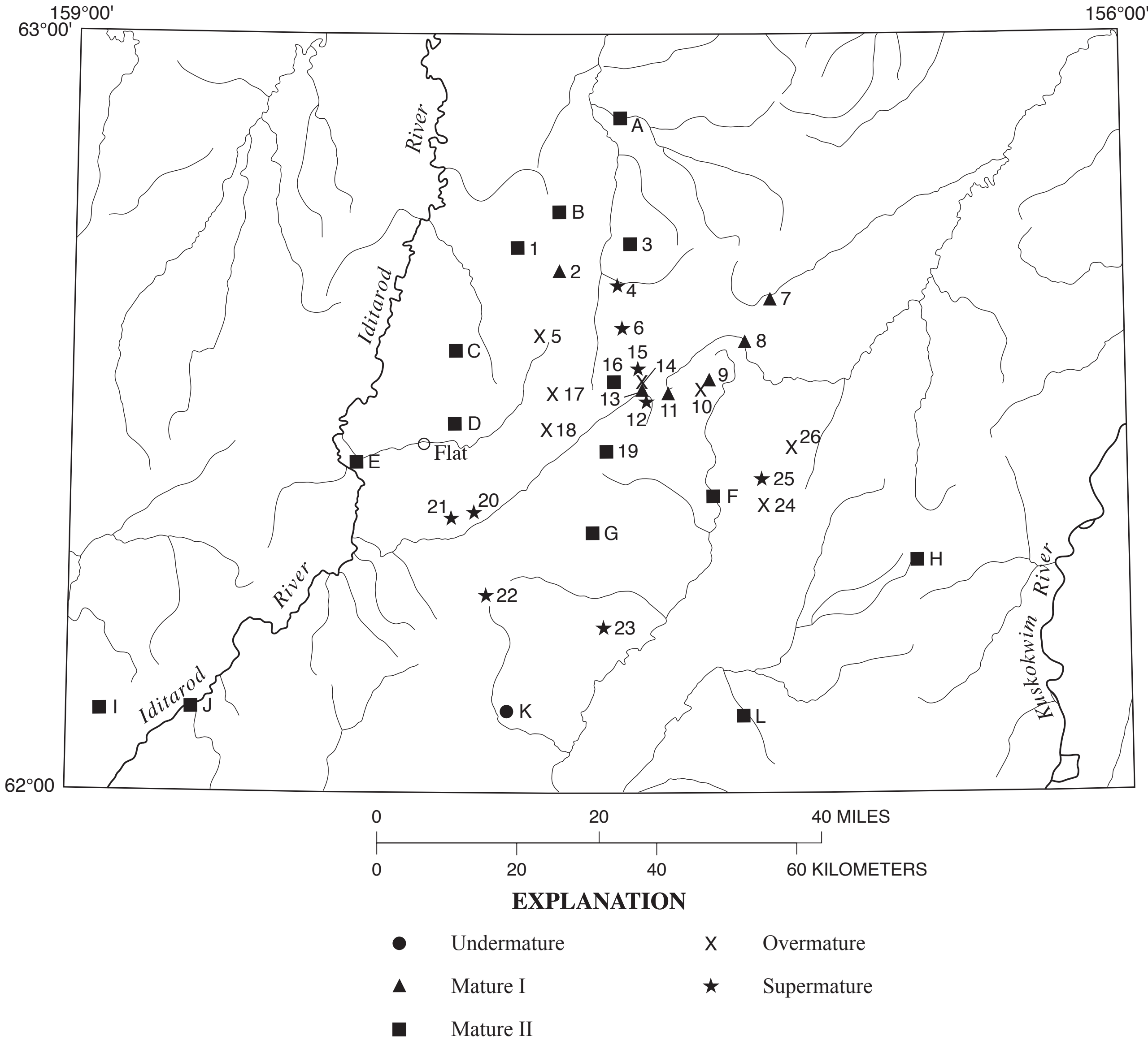

Figure 5. Map showing location of vitrinite and thermal alteration index (TAI) samples collected in the Iditarod quadrangle and levels of thermal maturity after Johnsson and others (1993). Numbers correspond to table 9; letters correspond to table 10.

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle*

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
1 T. 34 N. R. 38 W.	Mackie Creek (M)	Au (Ag) Placer	Production of 29.2 kg (940 oz) Au and 1.7 kg (54 oz) Ag between 1915 and 1938

SUMMARY: Placer concentrations of gold on bedrock surface beneath 16 m of gravel and overburden. Gulch is approximately 2 km long and 200 m wide; drains area of mineralized granite porphyry dike swarm. Most placer gold recovered near intersection of Mackie Creek and Ganes Creek. **REFERENCES:** Mertie, 1936; Smith, 1941; Bundtzen and Laird, 1980, 1983.

2 T. 34 N. R. 38 W.	Unnamed (A) [79BT16 and 79BT20]	Ag, Cr, V Deposit type uncertain	Values of up to 2,000 ppm Cr, 1,000 ppm V, and 7 ppm Ag

SUMMARY: Grab samples of iron-stained, carbonate-altered, mafic dikes that crop out discontinuously over about 1 km. High Cr, V, and Ag values characterize the numerous mafic dikes that crop out in the 40-km-long, Ganes Creek-Yankee Creek dike swarm. **REFERENCES:** Bundtzen and Laird, 1980, 1983.

3 T. 33 N. R. 44 W.	Unnamed (A) [84AAi602]	Ag (Sb) Deposit type uncertain	Sample contains up to 2 ppm Ag, 30 ppm As, 8 ppm Sb, and >5,000 ppm Ba

SUMMARY: Grab sample of iron-oxide stained, brecciated chert of Mississippian to Triassic Innoko terrane contains numerous quartz veinlets. Hg was not analyzed. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.

4 T. 33 N. R. 41 W.	Unnamed (A) [I0911 and I0912]	Hg Epithermal Hg-Sb (?)	Grab samples contain up to 200 ppm Zn and >10 ppm Hg

SUMMARY: Iron-oxide stained zone in volcanic roof pendant overlying western portion of Beaver Mountains pluton. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.

5 T. 33 N. R. 41 W.	Unnamed (O) [Tolstoi GT2]	Au (Hg, Nb) Placer	Heavy-mineral-concentrate samples contain 8 ppm Au and 218 ppm Nb

SUMMARY: Placer gold and associated heavy minerals concentrated on Kuskokwim Group bedrock and in boulder interstices. Gold may be from reworked auriferous terminal moraine thought to be of early Wisconsin age. Gold and associated minerals were probably derived from Beaver Mountains. Principal heavy minerals include fine-grained gold (891 fine), magnetite, ilmenite, cinnabar, dravite, chalcopyrite, and ilmenorutile. **REFERENCES:** Bundtzen, 1980; Bundtzen and Laird, 1982; Bundtzen and others, 1987.

1 Categories and abbreviations: M, mine (has recorded production, no matter how small); P, prospect (evidence of exploratory work such as a prospect pit present); O, occurrence (mineralized rock present); A, anomaly (rock geochemical anomaly—minor mineralized rock may be present).

2 Refers to the deposit model that best fits available data; deposit type is listed as uncertain where data are insufficient for classification into a model. Model names used in the table are abbreviated from names used in the text as follows:

1. Granite-porphyry-hosted Au-polymetallic = Peraluminous granite-porphyry-hosted gold-polymetallic
2. Plutonic-hosted Cu-Au polymetallic = Plutonic-hosted copper-gold-polymetallic stockwork and vein
3. Plutonic-related Ag-Sn polymetallic = Plutonic-related, boron-enriched, silver-tin-polymetallic
4. Epithermal Hg-Sb = Epithermal mercury-antimony (gold)
5. Volcanic hosted = Volcanic-hosted precious and other metals
6. Mafic-ultramafic = Mafic-ultramafic related Cr-Ni-Co
7. Placer = Heavy-mineral placer

3 Production was obtained from U.S. Geological Survey reports (for 1900–1930), unpublished U.S. mint records (1912–1969), State of Alaska records, and Bundtzen and others (1987).

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
6 T. 33 N. R. 41 W.	Tolstoi lode (P) [86BT350]	Cu, Ag, As, Au, Sn, Pb, Sb, Zn (Cd, Bi) Plutonic-related Ag-Sn polymetallic	Grab samples contain up to 10% Cu, 500 ppm Ag, 20,000 ppm As, 1.4 ppm Au, >2,000 ppm 10 ppm Be, 39 ppm Bi, 200 ppm Cd, >20,000 ppm Pb, 10,000 ppm Sb, 200 ppm Sn, and 2% Zn

SUMMARY: Extensive, structurally controlled, altered zone in cupola of Beaver Mountains stock shows tourmaline-axinite metasomatism and quartz-sulfide replacement deposits. Three major pipe-like tourmaline-axinite-sulfide breccia zones, 300 m long and up to 150 m wide, contain 1.50 million tonnes of mineralized rock (average grades were not determined). Tourmaline-rich "pipes" are capped by altered andesite roof pendants. An extensive area of tourmaline rosettes enclosed in potassically altered rocks lies in the westernmost part of the altered zone. Principal sulfides are chalcopyrite, pyrite, arsenopyrite, and minor galena. Silver-rich sulfosalts including stromeyerite and boulangerite are found in association with chalcopyrite. **REFERENCES:** Bundtzen and Laird, 1982; McGimsey and others, 1988; Szumigala, 1993; Bundtzen and Miller, 1997.

7 T. 33 N. R. 40 W.	Tolstoi Lake (O) [79BT403 and I0902]	Ag, As, Cu, Sb, Zn, Pb, Hg (Au) Plutonic-related Ag-Sn polymetallic	Grab samples of disseminated sulfides contain up to 33 g/t (0.96 oz/ton) Ag, 400 ppm As, >2,000 ppm B, 1,000 ppm Cu, 400 ppm Sb, 400 ppm Zn, 200 ppm Pb, >10 ppm Hg, trace Au

SUMMARY: Tourmaline rosettes, disseminated sulfides, and veins in altered monzonite of Beaver Mountains pluton. **REFERENCES:** Bundtzen and Laird, 1982; McGimsey and others, 1988.

8 T. 33 N. R. 40 W.	Unnamed (O) [79BT451]	Ag, Zn, Cu, Sb (Au) Plutonic-related Ag-Sn polymetallic	Values of 55 g/t (1.61 oz/ton) Ag, 1,000 ppm Zn, 500 ppm Cu, 100 ppm Sb, and trace Au

SUMMARY: Rubble of iron-oxide stained hornfels breccia, which contains fine veins of manganese oxide and tourmaline, is spatially associated with metasomatized andesite porphyry dikes that intrude Kuskokwim Group rocks about 2 km north of Beaver Mountains stock. **REFERENCE:** Bundtzen and Laird, 1982.

9 T. 33 N. R. 40 W.	Unnamed (O) [85BT99]	Fe, Cu, Sb (Ag) Deposit type uncertain	Values of 20.0% Fe, 200 ppm Cu, 40 ppm Sb, and 1 ppm Ag

SUMMARY: Pod of massive to disseminated pyrrhotite found in hornfels of Kuskokwim Group sedimentary rock, adjacent to eastern limit of Beaver Mountains stock.. Largest pod of pyrrhotite estimated to be 2 m thick and 30 m long. **REFERENCES:** McGimsey and others, 1988; this report.

10 T. 33–34 N. R. 38–39 W.	Ganes Creek and tributaries (M)	Au (Ag) Placer	From 1906 to 2001 produced at least 3,238 kg (104,129 oz) Au and 456 kg (14,668 oz) Ag from Iditarod quadrangle (additional production from Ophir quadrangle)

SUMMARY: Largest producer of gold in Ophir-Innoko mining district. Ganes Creek is the major stream flowing north from Beaver Mountains into Innoko River (Ophir quadrangle). Auriferous pay streaks traced for 11 km in Iditarod quadrangle—all placers confined to canyon incised into Kuskokwim Group sandstone and altered Cretaceous dike swarm. At least two ancestral paleochannels occur on both the left and right limits of Ganes Creek canyon. These bench placers are best preserved below mouth of Spaulding Creek. Paleochannels are 15–20 m above modern flood plain alluvium. They may be as old as Pliocene and predate the beheading of upper Ganes Creek by Beaver Creek, which took place in mid-Quaternary time. Ganes Creek paleochannel placers are well known for very coarse gold; two nuggets recovered in 1984 and 1963 weigh 4,012 g (129 oz) and 1,991 g (64 oz), respectively. Total gold production (see above) includes that from numerous small feeder gulches. Podisie Creek, a right-limit tributary of Ganes Creek, has yielded significant quantities of placer gold since 1994 (Doug Clark, written commun., 1997). Fineness of Ganes Creek gold ranges 817 to 874, averaging 846. Heavy minerals include magnesiochromite, scheelite, stibnite, and arsenopyrite. Most placer gold in Ganes Creek is thought to be derived or recycled from Ganes Creek-Yankee Creek granite porphyry dike swarm. Significant gold resources remain. **REFERENCES:** Smith, 1941; Cobb, 1973; Bundtzen and Laird, 1980, 1982; Bundtzen and others, 1987; this report.

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
11 T. 33 N. R. 38 W.	Spaulding Creek (M)	Au (Ag) Placer	Produced 246.5 kg (7,925 oz) Au; 49.5 kg (1,591 oz) Ag from 1909 to 1941

SUMMARY: Largest auriferous tributary of Ganes Creek (no. 10, above). Economic placer deposits found along 3 km of 9-km-long valley, mainly downstream from incision of Ganes Creek-Yankee Creek dike swarm, the probable source of gold in Spaulding Creek. Placer deposits originally covered by 1–3 m of overburden. Gold fineness ranges from 835 to 865. Heavy minerals include magnetite, ilmenite, and scheelite. **REFERENCES:** Mertie and Harrington, 1924; Smith, 1941; Bundtzen and Laird, 1980, 1982; Bundtzen and others, 1987; this study.

12 T. 33 N. R. 38 W.	Glacier Gulch (M) Placer	Au (Ag)	Minor production; included with Ganes Creek (no. 10)

SUMMARY: Small, 2-km-long, first-order tributary stream enters Ganes Creek about 0.5 km downstream from mouth of Spaulding Creek. Small amounts of gold recovered near mouth of gulch in 1908. Drainage underlain by Ganes Creek-Yankee Creek granite porphyry dike swarm. Production included with Ganes Creek (no. 10, above). **REFERENCE:** Maddren, 1910.

13 T. 33 N. R. 38 W.	Last Chance Gulch (M)	Au (Ag) Placer	Minor production; included with Ganes Creek (no. 10)

SUMMARY: Small, 1-km-long, first-order tributary stream enters Ganes Creek downstream from Glacier Gulch. Gold prospecting and development took place at stream mouth prior to 1910. Production included with Ganes Creek (no. 10). **REFERENCES:** Maddren, 1910; Eakin, 1914; Bundtzen and Laird, 1980, 1983.

14 T. 33 N. R. 38 W.	Unnamed (P) [79BT126]	Ag, Cr (Au) Deposit type uncertain	Values of 5 ppm Ag, 1,000 ppm Cr, and trace Au

SUMMARY: N. 60° E.-trending, altered mafic dike contains extensive gossan for 100 m as exposed in three prospect pits. Brecciated felsic dikes are exposed west of main mafic dike. **REFERENCES:** Bundtzen and Laird, 1983; this report.

15 T. 33 N. R. 38 W.	Katz lode (P) [79BT122 and 79BT127]	Sb, Au, Ag, As Granite-porphyry-hosted Au-polymetallic	Grab samples contain up to 1.1 ppm Au, 2 ppm Ag, and 35% Sb

SUMMARY: Stibnite-quartz-gold veins 0.1 to 0.3 m thick occur along foot wall of granite porphyry dike about 2 km southwest of Independence mine (no. 16). Veins strike N. 30° E. and dip 75° SE. and run subparallel to the dike for about 300 m in direction of Independence mine. Stibnite and minor disseminated arsenopyrite also found in parts of granite porphyry dike. **REFERENCES:** Mertie and Harrington, 1924; Bundtzen and Laird, 1983; this report.

16 T. 33 N. R. 38 W.	Independence mine (M) [I1424, 83AM122, and 86AM419]	Au, As, Sb, Ag, Pb, Sn, Hg Granite-porphyry-hosted Au-polymetallic	Produced 14.9 kg (478 oz) Au from 499 t (550 tons) ore around 1912. Grab samples contain up to 13 ppm Ag, 2.1% As, 180 ppm Au, 20 ppm Bi, >10 ppm Hg, 1,500 ppm Pb, 0.56% Sb, and 300 ppm Sn

SUMMARY: Auriferous quartz-carbonate-sulfide vein deposit 0.5 m thick on hanging wall of granite porphyry dike, which strikes N. 55–70° E. and dips steeply southeast. Granite porphyry dike averages 10 m wide and can be traced along strike for at least 300 m. Disseminated sulfides found in both quartz carbonate veins and dike rock and consist of 1–5% (by volume) arsenopyrite, pyrite, stibnite, stephanite, and trace cinnabar. Veinlets of siderite and calcite cut both dike and host sedimentary rocks of Kuskokwim Group. Mine developed underground by two tunnels totaling about 150 m in length (caved in 1979). Placer Dome Exploration completed a diamond-drilling program in 1997. Grab samples collected during this study contain up to 13 g/t Ag and 180 g/t Au. **REFERENCES:** Eakin, 1914; Mertie and Harrington, 1924; Mertie, 1936; Bundtzen and Laird, 1980, 1983; McGimsey and others, 1988; Nokleberg and others, 1993; Bundtzen and Miller, 1997; this study.

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
17 T. 33 N. R. 38 W.	Unnamed (P) [79BT102–104]	Au, Ag Granite-porphyry-hosted Au-polymetallic	Values up to 0.73 ppm Au and 5 ppm Ag; free gold observed in hand samples
SUMMARY: Quartz breccia and vug-veins developed along both hanging wall and footwall of several granite porphyry dikes. Sheeted veins also occur in Kuskokwim Group sandstone near the dikes. Free gold, jamesonite, and arsenopyrite found in two prospect pits. Gossan well developed; can be traced in N. 30° E. direction for at least 200 m. Geologically similar to Independence mine (no. 16). **REFERENCES:** Bundtzen and Laird, 1983; this report.			
18 T. 33 N. R. 38 W.	Unnamed (O) [79GL61 and 79GL62]	Au Granite-porphyry-hosted Au-polymetallic	Assay of 7g/t (0.21 oz/ton) Au; free gold in hand samples
SUMMARY: Iron-oxide stained quartz vein near dikes in Ganes Creek-Yankee Creek dike swarm; free gold found in quartz. **REFERENCE:** Bundtzen and Laird, 1983.			
19 T. 33–34 N. R. 38 W.	Yankee Creek (M)	Au, Ag (W, Cr) Placer	From 1909 to 1992 produced at least 1,808 kg (58,120 oz) Au and 233.4 kg (7,505 oz) Ag from Iditarod quadrangle (additional production from Ophir quadrangle)
SUMMARY: Major placer deposit in Innoko-Ophir district. Production derived from third-order stream system that flows north from the Iditarod quadrangle into the Ophir quadrangle. About 75% of total gold production is from Iditarod quadrangle. Small, first- and second-order streams such as Marten and Skookum Gulches also contributed to production, mainly at their intersections with Yankee Creek. Auriferous pay streak occurs in single distributary channel 11 km long and 15–80 m wide. Ancestral paleochannel benches only developed on left limit near Iditarod-Ophir quadrangle boundary. Most gold occurs at the intersection of the small gulches and second-order streams with Yankee Creek. Gulches are deriving gold from Ganes Creek-Yankee Creek dike swarm. Gold fineness ranges from 850 to 886. Considerable placer scheelite found near head of drainage. Additional heavy minerals include abundant magnesiochromite, ilmenite, anatase, eckermannite, and trace hidalgoite (lead arsenic sulfate). Mined continuously from 1909–1968 and again from 1981–1992. **REFERENCES:** Eakin, 1914; Mertie and Harrington, 1924; Mertie, 1936; Smith, 1941; Toivo Rosander, oral commun., 1978; Bundtzen and Laird, 1980, 1983; Bundtzen and others, 1987; this report.			
20 T. 33 N. R. 36 W.	Unnamed (A) [79BT194]	Ag (Cr, Au) Deposit type uncertain	Grab sample contains 5 ppm Ag, 1,000 ppm Cr, and trace Au
SUMMARY: Small northeast-trending altered porphyritic mafic dike locally contains quartz vugs in gossan. Minor pyrrhotite recognized. **REFERENCES:** Bundtzen and Laird, 1983; this report.			
21 T. 33 N. R. 36 W.	Unnamed (A) [79BT205]	Cu, Ag (Au) Deposit type uncertain	Sample contains 700 ppm Cu, 5 ppm Ag, and trace Au
SUMMARY: Grab sample of small, northeast-trending, siderite-quartz vein intrudes Kuskokwim Group sandstone. **REFERENCE:** Bundtzen and Laird, 1983.			
22 T. 33 N. R. 36 W.	Unnamed (A) [I1019]	(Ag, Au, Hg) Deposit type uncertain	Samples contain up to 0.3 ppm Ag, 30 ppm As, 1.1 ppm Hg, and trace Au
SUMMARY: Grab samples of (1) iron-oxide stained hornfels sandstone containing minor disseminated pyrite and small quartz veins, and (2) monzonite cut by sulfide-bearing veins. **REFERENCES:** McGimsey and others, 1988; this report.			
23 T. 33 N. R. 36 W.	Unnamed (O) [77BT249]	Ag, Zn, Cu (Au) Plutonic-related Ag-Sn polymetallic	Values up to 13.7 ppm Ag, 280 ppm Cu, 1,050 ppm Zn, and 0.03 ppm Au
SUMMARY: Iron-stained hornfels and breccia zone near border phase of Takotna Mountain monzonite pluton. Breccia zone is at least 2 m thick in rubble. **REFERENCE:** Bundtzen and Laird, 1983.			

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

<table>
<tr><th>Site no.
Township
Range
(Seward Meridian)</th><th>Name
(Category[1])
[Station no(s).]</th><th>Significant metals
(minor metals)
Deposit type[2]</th><th>Production, grade/
tonnage, and/or
analytical data[3]</th></tr>
<tr><td>24
T. 32 N.
R. 45 W.</td><td>Unnamed (A)
[85AM137]</td><td>Sb (Ag)
Deposit type uncertain</td><td>Sample contains 1.5 ppm Ag, 100 ppm Sb, and 40 ppm As</td></tr>
<tr><td colspan="4">SUMMARY: Grab sample of siltstone (part of the Mississippian to Triassic Innoko terrane) in a shear zone. Sample contains elevated values of Ag, Sb, and As; Hg was not analyzed. REFERENCES: McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.</td></tr>
<tr><td>25
T. 32 N.
R. 44 W.</td><td>Unnamed (O)
[I0241]</td><td>Au
Placer</td><td>Visible gold in heavy-mineral-concentrate sample</td></tr>
<tr><td colspan="4">SUMMARY: Visible gold (<1%) and cinnabar (20–50%) found in nonmagnetic, heavy-mineral-concentrate sample. Stream drains shoreline facies of Kuskokwim Group; section is intruded by mafic dike swarm to the east. Occurrence also lies near faulted contact with Dishna River ophiolitic rocks. REFERENCES: Bennett and others, 1988; Miller and Bundtzen, 1994; this report.</td></tr>
<tr><td>26
T. 32 N.
R. 44 W.</td><td>Unnamed (A)
[86AM128]</td><td>Hg (Sb)
Epithermal Hg-Sb</td><td>Sample contains 2.4 ppm Hg, 14 ppm Sb, and 10 ppm As</td></tr>
<tr><td colspan="4">SUMMARY: Grab sample of iron-oxide stained, altered dike; part of large northeast-trending dike swarm that lies east of VABM Cabin. REFERENCES: McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.</td></tr>
<tr><td>27
T. 32 N.
R. 41 W.</td><td>Unnamed (O)
[79GL321]</td><td>Ag, Cu, Pb, Zn (Bi, Sb, Sn)
Plutonic-related Ag-Sn polymetallic</td><td>Values up to 55.3 g/t (16.1 oz/ton) Ag, 0.5% Cu, 0.7% Pb, 900 ppm Zn, 100 ppm Bi, 200 ppm Sb, and 60 ppm Sn</td></tr>
<tr><td colspan="4">SUMMARY: Disseminated chalcopyrite in a N. 70° E.-trending fracture in andesitic volcanic roof pendant overlying cupola level of Beaver Mountains pluton. REFERENCE: Bundtzen and Laird, 1982.</td></tr>
<tr><td>28
T. 32 N.
R. 41 W.</td><td>Cirque (P)
[81BT501, 83AM103, and 86AGe43]</td><td>Ag, Cu, Pb, Zn, Sb, Sn (Bi, Au)
Plutonic-related Ag-Sn polymetallic</td><td>Inferred resource of 175,000 t (193,000 tons) grading 3.5% Cu and 445 g/t (13.0 oz/ton) Ag</td></tr>
<tr><td colspan="4">SUMMARY: Parallel tourmaline-axinite-sulfide fracture fillings in monzonite and quartz syenite of Beaver Mountains stock. Main fracture strikes N. 75° E., dips almost vertically, and is discontinuously exposed for nearly 3 km; may trend into occurrence no. 30. Cirque deposit may be part of a larger, laterally zoned, sulfide system. Most intensely mineralized rock lies in cirque headwall where nearly massive chalcopyrite, 1 m wide, is exposed for almost 20 m. Lesser amounts of galena, pyrite, sphalerite, and Pb-Sb-Bi(?) sulfosalt are found in gangue of tourmaline, fluorite, and quartz. Axinite is also abundant in hanging wall. Main zone is about 150 m long, 3 m wide, and up to 250 m deep. This is one of the best exposed lode mineral deposits in Iditarod quadrangle. Samples contain up to 32.3 oz/ton Ag, >2,000 ppm As, 1.8 ppm Au, >2,000 ppm B, 570 ppm Bi, 60 ppm Cd, 21% Cu, >20,000 ppm Pb, 7,000 ppm Sb, 200 ppm Sn, 100 ppm W, and 5,000 ppm Zn. REFERENCES: Bundtzen and Laird, 1982; Szumigala, 1993, 1995; Nokleberg and others, 1993; Bundtzen and Miller, 1997; this report.</td></tr>
<tr><td>29
T. 32 N.
R. 41 W.</td><td>Unnamed (O)
[79GL318]</td><td>Ag, Cu, (Au, W)
Plutonic-related Ag-Sn polymetallic</td><td>Grades of up to 2.0% Cu, 110 g/t (3.2 oz/ton) Ag, 0.7 g/t (0.02 oz/ton) Au, and 300 ppm W</td></tr>
<tr><td colspan="4">SUMMARY: Sulfide minerals associated with tourmaline breccia near major N. 20° E.-trending high-angle fault in Beaver Mountains stock. REFERENCE: Bundtzen and Laird, 1982.</td></tr>
<tr><td>30
T. 32 N.
R. 41 W.</td><td>Unnamed (O)
[81BT503]</td><td>Ag, Cu (Sb, Sn)
Plutonic-related Ag-Sn polymetallic</td><td>Grab sample contains 332 g/t (9.67 oz/ton) Ag, 8.0% Cu, 100 ppm Sb, and 100 ppm Sn</td></tr>
<tr><td colspan="4">SUMMARY: Tourmaline-axinite-sulfide fracture system in andesitic volcanic rocks strikes N. 75–80° E.; may be an extension of the Cirque deposit (no. 28). REFERENCE: Bundtzen and Laird, 1982.</td></tr>
</table>

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
31 T. 32 N. R. 41 W.	Unnamed (A) [I0916]	Cu, Pb (Ag, Hg) Deposit type uncertain	Sample contains 1 ppm Ag, >2,000 ppm B, 300 ppm Cu, 100 ppm Pb, and 0.32 ppm Hg
SUMMARY: Grab sample from iron-oxide stained fracture zone in monzonite. **REFERENCES:** McGimsey and others, 1988; this report.			
32 T. 32 N. R. 37 W.	Joaquin (P)	Hg (Au, Ag, As) Plutonic-hosted Cu-Au polymetallic (?)	Sample from ore dump contains 2.0% Hg, 0.24 ppm Au, 0.8 ppm Ag, and 2% As
SUMMARY: Thin quartz veinlets in Mount Joaquin pluton contain arsenopyrite and cinnabar. Exposed for about 30 m of strike over an average 0.5 m width. Property staked in 1957, but no production reported. **REFERENCES:** Malone, 1962; Bundtzen and Laird, 1983; this report.			
33 T. 32 N. R. 37 W.	Unnamed (O) [I1016]	Au Placer	Visible gold in heavy-mineral-concentrate sample
SUMMARY: Visible gold (<1%), cinnabar (1–5%), and scheelite (1–5%) in nonmagnetic, heavy-mineral-concentrate sample from stream draining east side of pluton at Mount Joaquin near lode prospect no. 32. **REFERENCES:** Bennett and others, 1988; Miller and Bundtzen, 1994; this report.			
34 T. 31 N. R. 48 W.	Unnamed (A) [84AAi503]	Pb, Sn (Nb) Deposit type uncertain	Sample contains 100 ppm Nb, 150 ppm Pb, 50 ppm Sn, and 15 ppm Be
SUMMARY: Grab samples of rhyolite tuff from the Yetna River volcanic field; no sulfides recognized. Hg was not analyzed. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.			
35 T. 31 N. R. 48 W.	Unnamed (A) [84AAi504]	Pb, Sn (Nb) Deposit type uncertain	Sample contains 100 ppm Nb, 100 ppm Pb, 70 ppm Sn, and 15 ppm Be
SUMMARY: Grab sample of altered felsic volcanic rock from the Yetna River volcanic field; no sulfides recognized. Hg was not analyzed. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.			
36 T. 31 N. R. 48 W.	Unnamed (A) [84AAi506]	Pb (Sn) Deposit type uncertain	Sample contains 100 ppm Pb, 50 ppm Sn, 50 ppm Nb, and 10 ppm Be
SUMMARY: Grab sample of welded rhyolite tuff from the Yetna River volcanic field. Hg was not analyzed. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.			
37 T. 31 N. R. 47 W.	Unnamed (A) [85AM164]	Hg Volcanic hosted	Sample contains 2.2 ppm Hg
SUMMARY: Grab sample of altered, welded rhyolite from the Yetna River volcanic field; no sulfides recognized. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.			
38 T. 31 N. R. 46 W.	Unnamed (A) [84AM283]	(Ag, Cu) Deposit type uncertain	Sample contains 1 ppm Ag and 100 ppm Cu
SUMMARY: Grab sample of slightly iron-stained silty metachert from the Mississippian to Triassic aged Innoko terrane; no sulfides recognized. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.			

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
39 T. 31 N. R. 44 W.	Unnamed (A) [83BT9]	(Au, Hg) Epithermal Hg-Sb (?)	Grab sample contains 0.2 ppm Au and 0.28 ppm Hg
SUMMARY: Silicified zone near altered dike that intrudes shoreline facies of Kuskokwim Group. **REFERENCE:** Bundtzen and others, 1988.			
40 T. 31 N. R. 43 W.	Unnamed (A) [83GL3]	Mn Deposit type uncertain	Grades 1.58% Mn
SUMMARY: Iron-oxide stained, pyrolusite-bearing quartz vein cuts Kuskokwim Group sandstone near altered dike. **REFERENCE:** Bundtzen and others, 1988.			
41 T. 31 N. R. 43 W.	Unnamed (A) [83GL10]	Hg Epithermal Hg-Sb	Sample contains 3.4 ppm Hg
SUMMARY: Grab sample of altered mafic dike that trends N. 50° E. near crest of anticline in Kuskokwim Group. **REFERENCE:** Bundtzen and others, 1988.			
42 T. 31 N. R. 41 W.	Unnamed (A) [86AMc43]	(Hg, Au) Epithermal Hg-Sb	Grab sample contains 0.88 ppm Hg and trace Au
SUMMARY: Silicified lithic tuff of the Iditarod Volcanics. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.			
43 T. 31 N. R. 40 W.	Unnamed (A) [83AM113]	(Ag, Hg) Granite-porphyry-hosted Au-polymetallic (?)	Sample contains 1 ppm Ag and 0.12 ppm Hg
SUMMARY: Grab sample of granite porphyry that intrudes Kuskokwim Group sedimentary rock; hornfels developed in sedimentary rocks near intrusive contact to west of locality. **REFERENCES:** McGimsey and others, 1988; this report.			
44 T. 31 N. R. 40 W.	Lincoln Creek (P) [I0308 and 86AM420]	Au (Ag, Hg) Deposit type uncertain	Fine gold panned from pits; grab samples contain up to 0.15 ppm Ag and 1.3 ppm Hg
SUMMARY: Altered mafic and felsic dikes cutting Kuskokwim Group sandstone are exposed in trenches for about 300 m; prospect is adjacent to a significant fault system. Gold panned from pits during exploratory work. **REFERENCES:** Joe Degnan, oral commun., 1979; Bundtzen and Laird, 1982; McGimsey and others, 1988.			
45 T. 31 N. R. 38 W.	Unnamed (A) [86AM422]	Hg Epithermal Hg-Sb	Sample contains 2.2 ppm Hg
SUMMARY: Grab sample of granite porphyry intrusion; rock has secondary tourmaline. The sample location was incorrectly shown in McGimsey and others (1988) to be 16 km north of the actual collection site. **REFERENCES:** McGimsey and others, 1988; this report.			
46 T. 31 N. R. 38 W.	Unnamed (A) [86AM421 and I1214]	Hg (As, Au, Ag)	Samples contain >10 ppm Hg, 70 ppm As, trace Au, and trace Ag Epithermal Hg-Sb
SUMMARY: Iron-oxide stained grab samples of granite porphyry intrusion. **REFERENCES:** McGimsey and others, 1988; this report.			

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
47 T. 31 N. R. 37 W.	Unnamed (A) [86AM401 and 86AM403]	As (Hg) Epithermal Hg-Sb (?)	Grab samples contain up to 1 ppm Hg and 500 ppm As

SUMMARY: Sheared contact zone between granite porphyry intrusion and hornfels sandstone of the Kuskokwim Group; grab samples of both contain elevated Hg values. A labeled sample wrapped in orange flagging found at locality was presumably left by exploration firm. Samples 86AM403 were collected 1.5 km east of indicated locality, but lie along same faulted contact. **REFERENCES:** McGimsey and others, 1988; this report.

48 T. 31 N. R. 36 W.	Tributary to Carl Creek (O) [79BT104 and I1275-cobble]	Ag, Au (Pb) Placer	Heavy-mineral-concentrate sample contains 23 ppm Ag, 5,700 ppm Pb, and trace Au. Stream cobble contains up to 33 ppm Ag, 0.10 ppm Au, 1,100 ppm As, >2,000 ppm B, and 500 ppm Pb

SUMMARY: First-order tributary stream drains south into Carl Creek. U.S. mint records show Carl Creek was prospected in 1917 and 1918, producing 18 oz gold. Heavy-mineral-concentrate sample contains elevated values of silver, lead, and trace gold. Mineralized stream cobbles probably come from hornfels near the Tatalina pluton. **REFERENCES:** Wimmler, 1926; Bundtzen and Laird, 1983; Bundtzen and others, 1987; McGimsey and others, 1988; this report.

49 T. 31 N. R. 36 W.	Tatalina (P) [79BT267]	Ag (Cu, V) Plutonic-related Ag-Sn polymetallic (?)	Consistent values of up to 5 ppm Ag, 100 ppm Cu, and 1,000 V

SUMMARY: Extensive zone of tourmaline-manganese breccia in hornfels aureole overlying Tatalina pluton. At least 200 m by 200 m in dimension. Old prospect pits along ridge top. Mineralized rocks similar to float observed at no. 48. **REFERENCES:** Bundtzen and Laird, 1983; this report.

50 T. 30 N. R. 48 W.	Unnamed (A) [I0002]	Ag , Pb (Sn) Deposit type uncertain	Samples contain up to 10 ppm Ag, 500 ppm Pb, and 20 ppm Sn

SUMMARY: Iron-oxide stained, vuggy silicified zone in rhyolite of Yetna River volcanic field. Grab sample contains anomalous values of Ag and Pb, and slightly elevated Sn; Hg was not analyzed. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.

51 T. 30 N. R. 46 W.	Unnamed (A) [85AM111]	Ag (Cr, Ni) Mafic-ultramafic	Grab samples contain up to 30 ppm Ag, 120 ppm As, 2,000 ppm Cr,

SUMMARY: Serpentinized ultramafic rocks of Dishna River ophiolite containing abundant chrome spinel and magnetite. Cr-Ni values probably in the spinel and silicate minerals. Source of Ag and As is not known. **REFERENCES:** McGimsey and others, 1988; Miller, 1990; Miller and Bundtzen, 1994; this report.

52 T. 30 N. R. 45 W.	Unnamed (A) [86AMc225]	Hg, As, Sb Epithermal Hg-Sb	Grab sample contains 0.85 ppm Hg, 50 ppm As, and 14 ppm Sb

SUMMARY: Brecciated, iron-stained, and veined Kuskokwim Group sandstone contains slightly elevated Hg, As, and Sb values. Nearby sample of sandstone (84BT264) contains 70 ppm Sb. **REFERENCES:** McGimsey and others, 1988; this report.

53 T. 30 N. R. 43 W.	Unnamed (A) [83BT4]	Au, Hg, As Epithermal Hg-Sb (?)	Grab sample contains 0.2 ppm Au, 1.5 ppm Hg, and 99 ppm As

SUMMARY: Iron-oxide veined sandstone near contact with N. 50° E.-trending altered mafic(?) dike. **REFERENCES:** Bundtzen and others, 1988; this report.

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

<table>
<tr><th>Site no.
Township
Range
(Seward Meridian)</th><th>Name
(Category[1])
[Station no(s).]</th><th>Significant metals
(minor metals)
Deposit type[2]</th><th>Production, grade/
tonnage, and/or
analytical data[3]</th></tr>
<tr><td>54
T. 30 N.
R. 43 W.</td><td>Unnamed (A)
[83BT20]</td><td>Au, Hg (Ag)
Epithermal Hg-Sb (?)</td><td>Grab sample contains 0.2 ppm Au, 0.2 ppm Ag, and 2.5 ppm Hg</td></tr>
<tr><td colspan="4">SUMMARY: Iron-stained breccia in chert, possibly a fault sliver of Innoko terrane. Extensive shear zone contains minor pyrite. REFERENCES: Bundtzen and others, 1988; Miller and Bundtzen, 1994; this report.</td></tr>
<tr><td>55
T. 30 N.
R. 42–43 W.</td><td>Unnamed (O)
[I1532]</td><td>Au
Placer</td><td>Visible gold in heavy-mineral-concentrate sample</td></tr>
<tr><td colspan="4">SUMMARY: Visible gold (<1%), cinnabar (1–5%), and scheelite (<1%) in nonmagnetic, heavy-mineral-concentrate sample. Stream drains area of volcanic and sedimentary rocks that are locally intruded by small stocks. REFERENCES: Bennett others, 1988; this report.</td></tr>
<tr><td>56
T. 30 N.
R. 42–43 W.</td><td>Deadwood Creek (P)</td><td>Au (Ag)
Placer</td><td>1.5 km by 150 m area contains low-grade placer Au resource</td></tr>
<tr><td colspan="4">SUMMARY: Shallow, unexploited placer gold resource near head of Deadwood Creek drainage. Discovered in 1932, but never mined. Fine-grained gold occurs in 1–3 m of gravel, which is covered by 2–3 m of overburden. Placer pay streak as drilled underlies a 1.5 km by 150 m area; probably in youthful (late Quaternary) stream alluvium. Anomalous gold also found in stream drainages immediately east of Deadwood Creek. Lode source of gold problematical—possibly from Maybe Creek pluton about 6 km to the southeast. REFERENCES: Toivo Rosander, oral commun., 1983; Don Harris, oral commun., 1983; Bundtzen and others, 1988; this report.</td></tr>
<tr><td>57
T. 30 N.
R. 42 W.</td><td>St. Patrick Creek (A)
[I0638]</td><td>(Hg; Au)
Deposit type uncertain</td><td>Grab sample contains slightly elevated Hg (0.50 ppm); placer gold reported near headwaters</td></tr>
<tr><td colspan="4">SUMMARY: Iron-oxide stained mafic volcanic rock from the Iditarod Volcanics southwest of the Beaver Mountains. Placer gold reportedly obtained from a cut at the head of St. Patrick Creek. REFERENCES: Don Harris, oral commun., 1982; McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.</td></tr>
<tr><td>58
T. 30 N.
R. 42 W.</td><td>Maybe Creek (O)
[82BT401]</td><td>Au
Placer</td><td>Gold consistently panned from creek</td></tr>
<tr><td colspan="4">SUMMARY: Fine gold (10–20 grains) consistently panned from shallow coarse gravels along 1 km of Maybe Creek between 1,500 and 1,800 foot elevations; creek drains monzonite pluton. Principal heavy minerals include chromite, magnesiochromite, cinnabar, scheelite, and polybasite(?). REFERENCES: Bundtzen and others, 1987; Bundtzen and others, 1988; this report.</td></tr>
<tr><td>59
T. 30 N.
R. 42 W.</td><td>Unnamed (A)
[I0644]</td><td>Pb, Hg (Ag, As)
Plutonic-related Ag-Sn polymetallic (?)</td><td>Grab sample contains 0.85 ppm Ag, 200 ppm Pb, 9.5 ppm Hg, and 60 ppm As</td></tr>
<tr><td colspan="4">SUMMARY: Float sample of hornfels from near monzonite contact contains disseminated sulfides. REFERENCES: McGimsey and others, 1988; this report.</td></tr>
<tr><td>60
T. 30 N.
R. 42 W.</td><td>Fourth of July Creek (M)</td><td>Au (Ag, Cr, Hg)
Placer</td><td>About 1.4 kg (45 oz) Au produced in 1982–83. Amount of earlier production (1915–20?) unknown. One heavy-mineral concentrate contained 24.8% Cr_2O_3</td></tr>
<tr><td colspan="4">SUMMARY: First discovered about 1911, but saw only intermittent development. Test mined in 1982–1983. Heavy-mineral placers occur along 4 km of Fourth of July Creek from 1,500 ft elevation to canyon breakout at 1,200 ft elevation. Bedrock pay streak lies on altered dacite tuff at upper end and on Kuskokwim Group at lower end. Coarse float predominates. Principal heavy minerals are magnetite, chromite, native mercury, cinnabar, scheelite, native silver, tetrahedrite, and polybasite. Gold fineness values range from 853 to 899. Has potential for discovery of new reserves. REFERENCES: Brooks, 1912; Bundtzen and others, 1987; Bundtzen and others, 1988; this report.</td></tr>
</table>

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
61 T. 30 N. R. 42W.	Unnamed (A) [I1230]	Au, Ag, Hg Plutonic-hosted Cu-Au polymetallic (?)	Grab samples contain up to 1.4 ppm Au, 0.2 ppm Ag, and >10 ppm Hg
SUMMARY: Veined and altered volcanic rocks of the Iditarod Volcanics; no visible sulfides. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.			
62 T. 30 N. R. 42 W.	Unnamed (O) [82BT404]	Ag, Pb, Hg Deposit type uncertain	Grab samples contain up to 5.1 ppm Ag, 76 ppm Pb, and 5 ppm Hg
SUMMARY: Extensive gossan and chalcedonic alteration in tuffaceous basal portion of the Iditarod Volcanics, south of the Beaver Mountains. **REFERENCES:** Bundtzen and others, 1988; Miller and Bundtzen, 1994.			
63 T. 30 N. R. 42 W.	Unnamed (A) [82BT385 and I1483]	Hg, As, Sb (Ag, Au) Deposit type uncertain	Samples contain up to 0.2 ppm Ag, 7 ppm Hg, 110 ppm As, 32 ppm Sb, and trace Au
SUMMARY: Grab samples of (1) iron-oxide stained breccia in volcanic rock of the Iditarod Volcanics and (2) quartz veined sandstone float. **REFERENCES:** Bundtzen and others, 1988; McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.			
64 T. 30 N. R. 40 W.	Unnamed (A) [86BT93]	(Zn, Ag, As) Plutonic-hosted Cu-Au polymetallic (?)	Grab sample contains slightly elevated Ag (1 ppm), 190 ppm Zn, and 30 ppm As
SUMMARY: Grab sample of quartz monzonite near hornfels contact. **REFERENCES:** McGimsey and others, 1988; this report.			
65 T. 30 N. R. 38 W.	Unnamed (A) [84MSL137]	As, Hg, Sb Epithermal Hg-Sb (?)	Sample contains 200 ppm As, 28 ppm Sb, 2.2 ppm Hg, and trace Ag
SUMMARY: Grab sample of granite porphyry intrusion; collector noted possible mercury oxides. **REFERENCES:** McGimsey and others, 1988; this report.			
66 T. 30 N. R. 37 W.	Unnamed (O) [86AM423]	Hg, As (Pb, W, Zn) Deposit type uncertain	Samples contain up to 1.0% As, >10 ppm Hg, 200 ppm W, 100 ppm Pb, 1,000 ppm Cr, 120 ppm Zn, and trace Ag
SUMMARY: Grab samples of iron-stained altered felsic dike; one sample has subparallel quartz veinlets and stringers. **REFERENCES:** McGimsey and others, 1988; this report.			
67 T. 30 N. R. 37 W.	Unnamed (A) [84AM245]	Hg Epithermal Hg-Sb (?)	Sample contains 2.2 ppm Hg
SUMMARY: Grab sample of iron-stained granite porphyry dike contains elevated Hg value. **REFERENCES:** McGimsey and others, 1988; this report.			
68 T. 29 N. R. 49 W.	Unnamed (A) [85BT60]	Au (Hg) Volcanic hosted	Sample contains 0.1 ppm Au and 60 ppb Hg
SUMMARY: Grab sample of bleached rhyolite from the Yetna River volcanic field; may have chalcedonic alteration. **REFERENCES:** McGimsey and others, 1988; this report.			
69 T. 29 N. R. 49 W.	Unnamed (A) [I0027]	Ag (Pb) Deposit type uncertain	Sample contains 5.0 ppm Ag and 200 ppm Pb
SUMMARY: Grab sample of altered rhyolite tuff from the Yetna River volcanic field contains anomalous Ag and Pb; Hg was not analyzed. **REFERENCES:** McGimsey and others, 1988; this report.			

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

<table>
<tr><th>Site no.
Township
Range
(Seward Meridian)</th><th>Name
(Category[1])
[Station no(s).]</th><th>Significant metals
(minor metals)
Deposit type[2]</th><th>Production, grade/
tonnage, and/or
analytical data[3]</th></tr>
<tr><td>70
T. 29 N.
R. 48 W.</td><td>Unnamed (A)
[84AM 180]</td><td>As, Hg (Au)
Volcanic hosted</td><td>Sample contains 130 ppm As, 1.4 ppm Hg, 0.05 ppm Au, 20 ppm Sn, and trace Ag</td></tr>
<tr><td colspan="4">SUMMARY: Grab sample of potassic altered rhyolite of Yetna River volcanic field collected near contact with Lower Proterozoic Idono Complex. REFERENCES: McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.</td></tr>
<tr><td>71
T. 29 N.
R. 46 W.</td><td>Unnamed (O)
[85AM323]</td><td>Sb, As (Hg, Au)
Epithermal Hg-Sb (?)</td><td>Sample contains 740 ppm Sb, 80 ppm As, 0.68 ppm Hg, and trace Au</td></tr>
<tr><td colspan="4">SUMMARY: Highly altered, iron-oxide stained, porphyritic dike cuts shoreline facies sandstone of the Kuskokwim Group. Sample has visible secondary hematite. REFERENCES: McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.</td></tr>
<tr><td>72
T. 29 N.
R. 45 W.</td><td>Unnamed (A)
[86AMc203]</td><td>Sb
Epithermal Hg-Sb (?)</td><td>Sample contains 76 ppm Sb</td></tr>
<tr><td colspan="4">SUMMARY: Grab sample of moderately well sorted Kuskokwim Group sandstone contains anomalous Sb; Hg was not analyzed. REFERENCES: McGimsey and others, 1988; this report.</td></tr>
<tr><td>73
T. 29 N.
R. 45 W.</td><td>Unnamed (A)
[86AMc207]</td><td>Sb
Epithermal Hg-Sb (?)</td><td>Sample contains 92 ppm Sb and 20 ppm As</td></tr>
<tr><td colspan="4">SUMMARY: Grab sample of Kuskokwim Group sandstone collected for background. REFERENCES: McGimsey and others, 1988; this report.</td></tr>
<tr><td>74
T. 29 N.
R. 44 W.</td><td>Dishna River (P)
[86BT365,
86AMc201, and
I0184]</td><td>Au, Sb, As (Ag, Hg)
Epithermal Hg-Sb</td><td>Inferred reserve of 37,600 t grading 2.46 g/t Au, 0.52% Sb, and 0.45% As</td></tr>
<tr><td colspan="4">SUMMARY: Mineralized quartz-sulfide-sulfosalt zones and vein breccias cut sheared shale and sandstone of the Kuskokwim Group. Extensive slickensides developed in sedimentary host rocks. Veins trend N. 5° W. to N. 5° E. and dip steeply to vertically. Prospect consists of sulfide-bearing masses locally containing 15–25% stibnite up to 25 cm thick; disseminated arsenopyrite also found. Prospect pits indicate development in previous years. At least three distinct mineralized veins identified. Eighteen chip-channel samples collected at uniform intervals along 140 m of largest vein form basis of reserve estimate. Samples contain up to 11 ppm Au, 1% Sb, >1% As, >10 ppm Hg, and 1 ppm Ag. Reference has been made to placer gold found in headward part of Dishna River. REFERENCES: Don Harris, oral commun., 1983; McGimsey and others, 1988; Bundtzen and Miller, 1997; this report.</td></tr>
<tr><td>75
T. 29 N.
R. 44 W.</td><td>Unnamed (A)
[83GL28a]</td><td>Hg
Epithermal Hg-Sb</td><td>Sample contains 2.9 ppm Hg</td></tr>
<tr><td colspan="4">SUMMARY: Sample of altered sandstone and shale of the Kuskokwim Group contains elevated Hg. Sample site is 1 km south of a small, northeast-trending felsic dike. REFERENCE: Bundtzen and others, 1988.</td></tr>
<tr><td>76
T. 29 N.
R. 43 W.</td><td>Unnamed (O)
[83GL53]</td><td>Ag, Au, Cu, Zn, As (Hg)
Deposit type uncertain</td><td>Samples contain up to 0.2 ppm Au, 2.9 ppm Ag, 210 ppm Cu, 349 ppm Zn, 127 ppm As, and 3 ppm Hg</td></tr>
<tr><td colspan="4">SUMMARY: Grab samples of sulfide-rich fault breccia near monzonite-sandstone contact. REFERENCE: Bundtzen and others, 1988.</td></tr>
</table>

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
77 T. 29 N. R. 43 W.	Unnamed (O) [I1484]	Ag, As, Zn, Pb, Sb, Hg, Cd, Ni, Fe Plutonic-related Ag-Sn polymetallic (?)	Grab samples contain up to 12 ppm Ag, 15% Fe, 710 ppm As, >2,000 ppm B, 600 ppm Zn, 500 ppm Pb, 70 ppm Sb, 4.2 ppm Hg, 35 ppm Cd, and 300 ppm Ni
SUMMARY: Quartz-sulfide veins in iron-oxide stained Kuskokwim Group sandstone hornfels near monzonite contact. **REFERENCES:** McGimsey and others, 1988; this report.			
78 T. 29 N. R. 43 W.	Unnamed (A) [I1485 and I1535]	Hg, As Epithermal Hg-Sb (?)	Slightly elevated values of Hg (up to 1.4 ppm) and As (up to 50 ppm)
SUMMARY: Grab samples of volcanic rock (of the Iditarod Volcanics) containing disseminated pyrite. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.			
79 T. 29 N. R. 43 W.	Unnamed (O) [I0196]	Mo, As, Cu, (Hg, Ag, Sb) Plutonic-related Ag-Sn polymetallic (?)	Grab sample contains 100 ppm Mo, 500 ppm As, 100 ppm Cu, 1.1 ppm Hg, 50 ppb Ag, 30 ppm Sb, 1,000 ppm Cr, and 1,000 ppm Ni
SUMMARY: Iron-oxide stained, altered mafic tuff from basal portion of Iditarod Volcanics contains disseminated sulfides. Elevated Cr and Ni values likely related to presence of olivine. **REFERENCES:** Bundtzen and others, 1988; McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.			
80 T. 29 N. R. 43 W.	Unnamed (A) [84BT277]	Sb Deposit type uncertain	Contains 200 ppm Sb
SUMMARY: Small N. 20° E.-trending quartz vein in fresh olivine basalt of the Iditarod Volcanics contains 200 ppm Sb; Hg was not analyzed. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.			
81 T. 29 N. R. 42 W.	Willow Creek (O)	Au Placer	Placer gold in panned concentrates
SUMMARY: Placer gold found in stream alluvium on Willow Creek and on hillslopes of VABM Willow. The latter may be a residual placer directly on a mineralized quartz monzonite pluton near VABM Willow. Principal heavy minerals include chromite, magnetite, and cinnabar. **REFERENCES:** Bundtzen and others, 1988; this report.			
82 T. 29 N. R. 42 W.	Broken Shovel (P)	Ag, Pb, Sb, Cu, As (Au) Plutonic-hosted Cu-Au polymetallic (?)	Estimated inferred reserve of 14,500 t (16,000 tons) grading 149 g/t (4.35 oz/ton) Ag, 0.15% Pb, 0.15% Sb, 0.17% As, 0.13% Cu; samples also contain elevated Au, Bi, W, and Zn
SUMMARY: Tourmaline-sulfide-quartz vein that averages about 1.5 m in thickness and strikes N. 20° E. can be traced for about 200 m cutting the Moore Creek pluton. Ore minerals include arsenopyrite, scheelite, tetrahedrite, and Pb-Sb sulfosalts. Traces of Au recognized in microprobe work. Sericite alteration encloses vein system. **REFERENCES:** Bundtzen and others, 1988; Nokleberg and others, 1993; Bundtzen and Miller, 1997; this report.			

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
83 T. 29 N. R. 42 W.	Moore Creek (M)	Au (Ag, Cr) Placer	Moore Creek produced 1,679 kg (53,990 oz) Au and 389.1 kg (12,510 oz) Ag from 1913–1985. Nevada Gulch produced 43 kg (1,383 oz) Au and 2.0 kg (64 oz) Ag from 1911–1929

SUMMARY: Significant placer deposit mined from both ancestral bench alluvium and modern stream alluvium. Pay streak about 3 km long and 100–400 m wide. Pay gravels were 2 m thick and covered by 3 m of overburden. Source of gold thought to be the mineralized pluton that lies northwest of the placer workings. Originally mined by hand methods in Nevada Gulch as early as 1911; large-scale mechanized operation has exhausted much of known pay streak. Principal heavy minerals include magnetite, chromite, zircon, cinnabar, scheelite, native silver, and tetrahedrite. Mine concentrates contain up to 35.0% Cr_2O_3 making the placer deposit a low-grade chrome resource. Gold fineness averages 758; nuggets to 591 g (19 oz) recently recovered. The Iditarod-Nixon Fork fault forms southern structural boundary of mineralized Moore Creek pluton, therefore, Tertiary(?) to Quaternary Moore Creek placer deposits may have been successively offset right laterally by transcurrent fault movement. If true, old unexploited buried channels would lie southwest of main workings. **REFERENCES:** Brooks, 1912; Smith 1941; Don Harris, oral commun., 1982; Bundtzen and others, 1987; Bundtzen and others, 1988.

84 T. 29 N. R. 42 W.	Unnamed (A) [83AM109]	Ag, Cu Deposit type uncertain	Sample contains 2 ppm Ag and 150 ppm Cu

SUMMARY: Sandstone grab sample from well-exposed section of Kuskokwim Group; no sulfides recognized. **REFERENCES:** McGimsey and others, 1988; this report.

85 T. 28 N. R. 51 W.	Unnamed (A) [85BT64 and 86AMc230]	Au, Hg Volcanic hosted	Samples contain up to 0.1 ppm Au, 0.14 ppm Hg, and trace Ag

SUMMARY: Grab samples of devitrified, silicified, felsic volcanic rocks of Yetna River volcanic field. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.

86 T. 28 N. R. 47 W.	Flat Coal (M)	Coal	Mined during period of 1910 to 1920

SUMMARY: Subbituminous to anthracite coal 0.3 to 0.8 m thick strikes N. 60° E. and 50° SE. Average calorific values of 7,983 and average BTU value of 14,369. Most exposures found in shallow-marine to nonmarine facies of Kuskokwim Group. Mined for blacksmithing purposes during early gold rush years at Flat. **REFERENCES:** Brooks, 1914; Mertie, 1936; Bundtzen and others, 1992.

87 T. 28 N. R. 47 W.	Golden Ground and Neilson (P) [84BT300, 86AGe32, and 86AGe33]	Au, Ag, Pb, Sb, Cu, W, Zn, As, Cd, Bi, Hg Plutonic-hosted Cu-Au polymetallic	Samples contain up to 50 g/t (1.5 oz/ton) Au, 2 kg/t (58 oz/ton) Ag, 2.0% Pb, 1% Sb, 0.5% Cu, 0.2% W, 0.1% Zn, >1% As, 300 ppm Cd, 40 ppm Bi, and >10 ppm Hg

SUMMARY: Two adits in close proximity—the more northern one is the Golden Ground prospect; the more southern one is the Neilson prospect. Deposit consists of 1–5 cm thick quartz-sulfide-tourmaline(?) veins that cut olivine basalt. Iron-oxide stained quartz rubble sampled. Arsenopyrite, galena, and scheelite recognized in field. Developed by short 15–20 m drifts. **REFERENCES:** Holzheimer, 1926; McGimsey and others, 1988; Bundtzen and others, 1992; this report.

88 T. 28 N. R. 47 W.	Unnamed (P) [86AGe34 and 86AGe35]	Au, Ag, Sb, As (Hg, W) Plutonic-hosted Cu-Au polymetallic	Samples contain up to 1.0 ppm Au, 1.0 ppm Ag, 2,000 ppm B, 650 ppm Sb, >0.2% As, 50 ppm W, and >10 ppm Hg

SUMMARY: Up to 5 cm thick quartz veins in iron-oxide stained, brecciated sandstone hornfels; no visible sulfides in samples collected. Locality has been trenched. **REFERENCES:** McGimsey and others, 1988; this report.

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
89 T. 27–28 N. R. 47 W.	Granite Creek (M)	Au (Ag) Placer	Produced 148 kg (4,750 oz) Au and 19.8 kg (636 oz) Ag from about 1913–1956 and 1980–1985
SUMMARY: Small, 2.5-km-long stream draining mineralized volcanic and plutonic rocks north of Otter Creek drainage. Paystreaks are covered by shallow overburden. Heavy minerals recovered include scheelite, cinnabar, arsenopyrite, and ilmenite. Gold fineness is 854. **REFERENCES:** Mertie, 1936; Smith, 1941; Bundtzen and others, 1987; Bundtzen and others, 1992; this report.			
90 T. 28 N. R. 46 W.	Unnamed (O) [86AGe38 and 86AGe39]	Ag, Pb, Sb, Zn (As, Cu, Sn, Cd, Bi) Plutonic-related Ag-Sn polymetallic (?)	Samples contain up to 200 ppm Ag, 2.0% Pb, >0.2% Sb, 0.2% Zn, 200 ppm Cu, 50 ppm Sn, 0.16% As, 100 ppm Cd, and 18 ppm Bi
SUMMARY: Quartz vein stringers and heavily iron-oxide stained sandstone spatially associated with granite porphyry dike. **REFERENCES:** McGimsey and others, 1988; Bundtzen and others, 1992; this report.			
91 T. 28 N. R. 46 W.	Unnamed (O) [85AM268, 269 and 86AGe41]	Sn, Zn, Sb, As, Pb, Bi (Ag, Au) Plutonic-related Ag-Sn polymetallic (?)	Grab samples contain up to 200 ppm Sn, 500 ppm Zn, 500 ppm Sb, 480 ppm As, 200 ppm Pb, 46 ppm Bi, >2,000 ppm B, 1 ppm Ag, and trace Au
SUMMARY: Extensive secondary tourmaline in calcite-chlorite altered intermediate dikes and in the Kuskokwim Group sandstone they intrude. **REFERENCES:** McGimsey and others, 1988; this report.			
92 T. 28 N. R. 46 W.	Unnamed (O) [86BT419]	Ag, As (Cu, Bi, Sn, Au) Plutonic-related Ag-Sn polymetallic	Grab sample contains 2 ppm Ag, 850 ppm As, 200 ppm Cu, 52 ppm Bi, 30 ppm Sn, and 50 ppb Au
SUMMARY: Iron-oxide stained hornfels near biotite-bearing, fine-grained intrusion. **REFERENCES:** McGimsey and others, 1988; this report.			
93 T. 28 N. R. 46 W.	Unnamed (O) [86AM370, 371 and I1495]	Ag, Au, Sb, As Granite-porphyry-hosted Au-polymetallic (?)	Grab samples contain up to 1.2 ppm Ag, 0.2 ppm Au, 290 ppm Sb, 130 ppm As, 50 ppm Nb, and trace Hg
SUMMARY: Iron-oxide stained quartz veinlets in sandstone, in quartz-healed sandstone breccia, and in granite porphyry dike; some sulfides present locally. **REFERENCES:** McGimsey and others, 1988; this report.			
94 T. 28 N. R. 45 W.	Unnamed (A) [86BT363]	As (Hg) Epithermal Hg-Sb	Sample contains 470 ppm As and 0.82 ppm Hg
SUMMARY: Grab sample of altered dike that cuts calcareous sandstone. **REFERENCES:** McGimsey and others, 1988; this report.			
95 T. 28 N. R. 45 W.	Unnamed (P) [86BT359, 86AGe46, and I0185]	(Hg, As, Ag) Epithermal Hg-Sb (?)	Samples contain up to 0.34 ppm Hg, 60 ppm As, 100 ppm Cu, and trace Ag
SUMMARY: Some gossan areas are spatially associated with silica-carbonate altered dikes that cut sandstone. Several prospect pits in area, but values we obtained are only slightly elevated. **REFERENCES:** McGimsey and others, 1988; this report.			
96 T. 28 N. R. 45 W.	Unnamed (O) [86BT351, 352, 84AAi572, and 84MSL136]	Au, Ag, Sb, As, Hg, Zn Epithermal Hg-Sb (?)	Samples contain up to 0.2 ppm Au, 1.0 ppm Ag, 0.19% As, 3.3 ppm Hg, 116 ppm Sb, and 300 ppm Zn
SUMMARY: Extensive gossan zone (estimated to be 2 km^2) in Kuskokwim Group sandstone. Iron-oxide stained quartz veinlets, sandstone breccia, and silica-carbonate altered dike are present. **REFERENCES:** McGimsey and others, 1988; this report.			

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
97 T. 28 N. R. 44 W.	Unnamed (A) [83GL69]	Hg Epithermal Hg-Sb	Sample contains 5.1 ppm Hg (and 0.1 ppm Ag)
SUMMARY: Grab sample of iron-oxide stained shale. **REFERENCE:** Bundtzen and others, 1988.			
98 T. 28 N. R. 44 W.	Unnamed (O) [83GL59]	Ag, Cu, Zn, Mn, Fe Deposit type uncertain	Sample contains 2.6 ppm Ag, 891 ppm Cu, 1.68% Mn, 304 ppm Zn, and 28% Fe
SUMMARY: Massive pyrrhotite vein, 25 cm wide, in hornfels near contact with Camelback Mountain monzonite. **REFERENCE:** Bundtzen and others, 1988.			
99 T. 28 N. R. 42 W.	Unnamed (A) [83AM110]	Ag Deposit type uncertain	Sample contains 1 ppm Ag
SUMMARY: Grab sample of hypabyssal, pilotaxiitic, andesite plug contains slightly elevated Ag; Hg was not analyzed. **REFERENCES:** McGimsey and others, 1988; this report.			
100 T. 28 N. R. 41 W.	Unnamed (A) [86AM116]	Sb, As, Fe (Zn) Deposit type uncertain	Sample contains >20% Fe, 200 ppm Sb, 100 ppm As, 180 ppm Zn, and 100 ppm Ni
SUMMARY: Grab sample of heavily iron-oxide stained altered sandstone containing secondary hematite; iron-stained rock is very minor at locality. **REFERENCES:** McGimsey and others, 1988; this report.			
101 T. 28 N. R. 40 W.	Unnamed (A) [86AM112]	Hg, Sb, As Epithermal Hg-Sb	Sample contains 0.42 ppm Hg, 20 ppm Sb, and 20 ppm As
SUMMARY: Grab sample of iron-oxide stained sandstone breccia that is locally healed by quartz. A small prospect pit on similar quartz-healed sandstone breccia was noted by another worker 1 km east of this location, but no samples were collected there. **REFERENCES:** McGimsey and others, 1988; this report.			
102 T. 28 N. R. 38 W.	Unnamed (A) [I1529]	Hg, As, Sb (Ag) Epithermal Hg-Sb	Sample contains 0.46 ppm Hg, 30 ppm As, 20 ppm Sb, and 0.1 ppm Ag
SUMMARY: Grab sample of Kuskokwim Group sandstone; no alteration or sulfides noted, but rock contains slightly elevated values. **REFERENCES:** McGimsey and others, 1988; this report.			
103 T. 27 N. R. 52 W.	Unnamed (A) [85AM216 and 85AAi709]	As (Hg, Sb, Au, Ag) Volcanic-hosted	Samples contain up to 150 ppm As, 4 ppm Sb, and locally trace Hg, Ag, and Au
SUMMARY: Grab samples of iron-oxide stained Early Cretaceous sandstone; secondary hematite noted. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.			
104 T. 27 N. R. 47 W.	Happy Creek (and upper Willow Cr) (M)	Au (Ag) Placer	Produced at least 3,965 kg (127,486 oz) Au and 535.2 kg (17,210 oz) Ag from 1910–1984
SUMMARY: Ancestral bench and modern stream alluvial placers form 6-km-long system of pay streaks in Happy Creek and upper part of Willow Creek. Uppermost Happy Creek alluvial placers are transitional to residual type placers at Alpha, Upgrade, and Trail deposits on slope of Chicken Mountain. Principal heavy minerals include zircon, magnetite, ilmenite, chromite, cinnabar, and fluorapatite. (Zircon contains up to 0.14% equivalent U.) Mineralized stockworks on Chicken Mountain are the lode source. Gold fineness ranges from 862–884. Placer deposit largely mined out. **REFERENCES:** Mertie, 1936; Smith, 1941; White and Killeen, 1953; John Fullerton, oral commun., 1983, 1985; Bundtzen and others, 1987; Bundtzen and others, 1992; this report.			

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

<table>
<tr><th>Site no.
Township
Range
(Seward Meridian)</th><th>Name
(Category[1])
[Station no(s).]</th><th>Significant metals
(minor metals)
Deposit type[2]</th><th>Production, grade/
tonnage, and/or
analytical data[3]</th></tr>
<tr><td>105
T. 27 N.
R. 47 W.</td><td>Idaho (P); Alpha, Trail Upgrade (M)</td><td>Au (Ag)
Plutonic-hosted Cu-Au polymetallic; and Placer (Residual)</td><td>Collectively produced about 2,376 kg (76,400 oz) Au during early gold rush years from 1910–1930</td></tr>
<tr><td colspan="4">SUMMARY: Classic residual placer and alluvial heavy mineral placers near or on bedrock. Pay streaks found in weathered monzonite grus usually between boulders and also in joint fractures. Heavy minerals include zircon, black pyroxene, scheelite, and cinnabar. Some heavy mineral sands were composed of up to 40% by volume zircon. Gold fineness at Idaho ranges from 854 to 901 and averages 861. REFERENCES: Eakin, 1914; Mertie and Harrington, 1924; Mertie, 1936; Bundtzen and others, 1987; Bundtzen and others, 1992.</td></tr>
<tr><td>106
T. 27 N.
R. 47 W.</td><td>Flat Creek (M)</td><td>Au (Ag)
Placer</td><td>Official recorded production of 14,837 kg (477,039 oz) Au; additional 11,017 kg (354,210 oz) Au produced from Otter and Flat Creeks combined</td></tr>
<tr><td colspan="4">SUMMARY: Largest producer of gold in Iditarod quadrangle and one of Alaska's richest placer pay streaks. Stream flows 7 km from slopes of Chicken Mountain north to confluence with Otter Creek. Placer deposits consist of (1) rich ancestral pay channels on left limit of main stream and in Marietta Bench; (2) limited but rich eluvial placer deposits on steep slopes at head of creek; and (3) lower grade but more extensive modern stream alluvium that reaches Otter Creek. The 2–3 m thick pay gravels are covered by 3–4 m of overburden. Heavy minerals include zircon, scheelite, cinnabar, and stibnite. Gold fineness averages 864. Average grade of 3.67 million m^3 of pay worked by Yukon Gold dredge (1912–1918) was 2.23 g/m^3 Au. Large nuggets typically weighed about 50 g (1.6 oz). Lode source is mineralized stockwork on Chicken Mountain (no. 130). Worked by dredges, opencut hydraulic, and mechanized tractor operations from 1910 to present. REFERENCES: Maddren, 1911; Eakin 1914; Mertie and Harrington, 1924; Mertie, 1936; Smith, 1941; Bundtzen and others, 1987; Richard, John, and Tad Fullerton, oral commun., 1988; Bundtzen and others, 1992; this report.</td></tr>
<tr><td>107
T. 27 N.
R. 47 W.</td><td>Otter Creek (M)</td><td>Au (Ag, W)
Placer</td><td>Official production of 7,332 kg (235,721 oz) Au and 952.6 kg (30,628 oz) Ag from 1910–1986. Additional 11,017 kg (354,210 oz) Au produced from Flat and Otter Creeks combined. Glenn Gulch produced 324 kg (10,421 oz) Au</td></tr>
<tr><td colspan="4">SUMMARY: Second largest producer of gold in Iditarod quadrangle behind Flat Creek (no. 106). Large, mature placer pay streak 6–7 km long and up to 1 km wide. Both terrace and modern stream alluvial placers recognized; some semi-residual type may occur near mouth of Black Creek (near Glenn and Minnie Gulches). Worked extensively by two bucketline stacker dredges from 1914–1966. The system of pay streaks is very complicated. Extensive mine activities also include opencut mining methods. Principal heavy minerals include gold, scheelite, cinnabar, stibnite, arsenopyrite, magnesiochromite, and cassiterite. Gold fineness ranges from 822–891. Large nuggets, up to 870 g (28 oz), found in area of Glenn and Minnie Gulches. REFERENCES: Maddren, 1911; Eakin, 1914; Mertie and Harrington, 1924; Mertie, 1936; Smith 1941; Bundtzen and others, 1987; John Miscovich, written commun., 1989; Bundtzen and others, 1992; this report.</td></tr>
<tr><td>108
T. 27 N.
R. 47 W.</td><td>Unnamed (P)
[86BT422]</td><td>Au, Ag (As, W)
Plutonic-hosted Cu-Au polymetallic</td><td>Sample contains 11 ppm Au, 7 ppm Ag, 340 ppm As, 50 ppm W, and 0.14 ppm Hg</td></tr>
<tr><td colspan="4">SUMMARY: Iron-oxide stained quartz vein in sandstone hornfels explored by small pit; caved drift. Quartz float indicates vein is up to 20 cm thick; no sulfides recognized. Perhaps 20 tons of rock in dump. REFERENCES: McGimsey and others, 1988; Bundtzen and others, 1992; this report.</td></tr>
</table>

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
109 T. 27 N. R. 47 W.	Black Creek (M)	Au, Ag (W) Placer	Produced at least 868.5 kg (27,925 oz) Au from 1911–1981
SUMMARY: Drainage is a 2.5-km-long second-order stream that enters Otter Creek valley. Dissects mineralized Black Creek monzonitic pluton, which is the lode source of much of placer gold in Otter Creek. Dredge operated from 1916–1918; mined by opencut methods intermittently to 1981. Principal heavy minerals include magnetite, ilmenite, cinnabar, chromite, scheelite, zircon, cassiterite, ilmenorutile, and argentopyrite. Platinum metals found within gold grains (1.3 ppm). Gold fineness is 819 (one analysis). **REFERENCES:** Brooks, 1912; Eakin, 1914; John Miscovich, oral commun., 1986; Bundtzen and others, 1987; Bundtzen and others, 1992.			
110 T. 27 N. R. 47 W.	Golden Horn (M)	Au, Ag, Pb, Zn (W, Sb, Hg) Plutonic-hosted Cu-Au polymetallic	Produced 84.2 kg (2,707 oz) Au, 81.5 kg (2,620 oz) Ag, 4,235 kg Pb, and 296 kg Zn from 1922–1937. Estimated resource of about 2.85 Mt (3.15 M tons) grading 1.2 g/t (0.035 oz/ton) Au, 3.4 g/t (0.1 oz/ton) Ag, and containing credits of W and Sb
SUMMARY: Deposit consists of quartz-tourmaline-calcite veins containing stibnite, cinnabar, scheelite, sphalerite, Pb-Sb sulfosalts, and chalcopyrite. Stibnite and cinnabar crosscut arsenopyrite, scheelite, and silver sulfosalt. Veins occur in irregularly distributed, quartz-filled shear zones in the Late Cretaceous Otter Creek pluton (monzonite), or near intrusive contacts. Vein system from 3 to 30 m wide and at least 1 km in length; occurs along 3-km-long fault zone on eastern side of pluton. Pluton intrudes graywacke and shale of Cretaceous Kuskokwim Group. Mined by underground workings beginning in 1922. Pumps were removed in 1935; last ore was shipped in 1937. Private diamond-drill programs were conducted during 1978–1981 and 1997–1998. **REFERENCES:** Maloney, 1962; Bundtzen and Gilbert, 1983; Bull, 1988; Bundtzen and others, 1992; Nokleberg and others, 1993; Bundtzen and Miller, 1997.			
111 T. 27 N. R. 47 W.	Malamute Gulch or Pup; lode (P), placer (M)	Au, Ag Plutonic-hosted Cu-Au polymetallic, and Placer	Placer yielded 59.3 kg (1,907 oz) Au and 7.5 kg (241 oz) Ag from 1912–1952
SUMMARY: Lode prospect located about 122 m (400 ft) west of the mouth of Malamute Gulch. Consists of 21 m (70 ft) long adit (now caved) reportedly made on quartz-calcite veins containing arsenopyrite and cinnabar; said to have carried considerable gold. The nearby drainage—Malamute Gulch or Pup—was mined intermittently between 1912 and 1952. Gold fineness averages 832 (7 determinations). **REFERENCES:** Mertie, 1936; Smith, 1941; Maloney, 1962; Bundtzen and others, 1987; Bundtzen and others, 1992; this study.			
112 T. 27 N. R. 47 W.	Slate Creek (M)	Au, Ag Placer	Produced at least 108.3 kg (3,483 oz) Au and 18.4 kg (592 oz) Ag from 1915–1951
SUMMARY: Modern stream alluvium has placer pay streak 2–3 km long. Gold irregularly distributed and pay zones are erratic. Mining ceased in 1951 due to lack of economic values. Gold fineness is 855. **REFERENCES:** Mertie, 1936; Metz and Hawkins, 1981; Bundtzen and others, 1987; Bundtzen and others, 1992; this report.			
113 T. 27 N. R. 46 W.	Unnamed (A) [84GL14 and 84BT11]	Hg Epithermal Hg-Sb (?)	Samples contain up to 4 ppm Hg
SUMMARY: Silica-carbonate(?) altered mafic dike contains 4 ppm Hg (84GL14). Gossan in sandstone breccia about 0.5 km to NE contains 1.7 ppm Hg (84BT11). **REFERENCES:** McGimsey and others, 1988; Bundtzen and others, 1992; this report.			
114 T. 27 N. R. 44 W.	Unnamed (A) [84BT223]	(Hg, Au) Epithermal Hg-Sb (?)	Grab sample contains 0.16 ppm Hg and 50 ppb Au
SUMMARY: Silicified breccia in sandstone contains slightly elevated Hg and Au values. **REFERENCES:** McGimsey and others, 1988; this report.			

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
115 T. 27 N. R. 43 W.	Unnamed (O) [84BT218 and 84BT219]	Mn (Hg, Mo) Deposit type uncertain	Samples contain >0.5% Mn and up to 0.24 ppm Hg and 10 ppm Mo

SUMMARY: Extensive zone of pyrolusite-bearing masses in sheared sandstone, shale, and volcaniclastic conglomerate. Zone is up to 1 m thick and can be traced for at least 300 m along strike (possibly a sedimentary Mn horizon). **REFERENCES:** McGimsey and others, 1988; this report.

116 T. 27 N. R. 43 W.	Unnamed (O) [I0138]	Au Placer	Visible gold in heavy-mineral concentrate

SUMMARY: Fine gold grains noted in nonmagnetic, heavy-mineral-concentrate sample from small north-flowing tributary of Beaver Creek. **REFERENCES:** Bennett and others, 1988; this report.

117 T. 27 N. R. 42 W.	Unnamed (A) [85AM118]	Sb, As (Au) Epithermal Hg-Sb (?)	Sample contains 14 ppm Sb, 20 ppm As, and trace Au

SUMMARY: Quartz fracture filling in Kuskokwim Group sandstone contains elevated Sb, As, and trace Au; Hg was not analyzed. **REFERENCES:** McGimsey and others, 1988; this report.

118 T. 27 N. R. 42 W.	Bismarck Creek (O) [84BT34 and 86AM104]	Sn, Cu, Ag, Zn (Pb, As, Bi, Sb, In) Plutonic-related Ag-Sn polymetallic	Inferred reserve of 498,000 t grading 0.137% Sn, 47.8 g/t Ag, 0.16% Cu, 0.22% Zn, and anomalous F, Bi, Cd, As, Pb, Sb, and B. Contains up to 116 ppm In (Indium)

SUMMARY: An extensive east-west- to northeast-trending zone of stockwork-like cassiterite-axinite-tourmaline-quartz-bearing gossan in hornfels that can be traced for at least 300 m and for widths ranging from 2 up to 30 m. Sulfides are heavily oxidized; black cassiterite has been identified in polished section. Occurrence has a brecciated style showing blocks of altered sandstone and siltstone that float in quartz gossan matrix within host hornfels. No intrusive rocks recognized, but 10 km^2 hornfels aureole surrounding VABM 2424 suggests presence of concealed pluton beneath mineralized zone. Sn values range from trace amounts to 2.8%. Seventeen chip channel samples taken at uniform intervals along 290 m of strike, over an average width of 0.5 m, form basis of inferred “half square” reserve estimate. **REFERENCES:** McGimsey and others, 1988; Nokleberg and others, 1993; Bundtzen and Miller, 1997; this study.

119 T. 27 N. R. 42 W.	Unnamed (A) [84BT250]	Cu, Sb (Ag, As) Plutonic-related Ag-Sn polymetallic (?)	Grab sample contains 500 ppm Cu, 140 ppm Sb, 0.5 ppm Ag, and 20 ppm As

SUMMARY: Local gossan in fine-grained sandstone associated with shaley section of Kuskokwim Group. **REFERENCES:** McGimsey and others, 1988; this report.

120 T. 27 N. R. 42 W.	Unnamed (O) [86BT128 and 84MSL125]	Ag, Sn, Zn, As (Sb, Cd, Cu) Plutonic-related Ag-Sn polymetallic	Samples locally contain up to 50 ppm Ag, 100 ppm As, 2,000 ppm B, 72 ppm Cd, 150 ppm Cu, 60 ppm Sb, 150 ppm Sn, 7,000 ppm Zn, and 2,000 ppm B

SUMMARY: Rubble of 1–3 cm thick quartz-axinite veins in hornfels sandstone gossan. **REFERENCES:** McGimsey and others, 1988; this report.

121 T. 27 N. R. 42 W.	Unnamed (A) [86AM105]	Sn, Zn, As (Ag) Plutonic-related Ag-Sn polymetallic	Sample of vein contains 300 ppm Sn, 400 ppm Zn, 130 ppm As, 2.2 ppm Cd, >2,000 ppm B, and trace Ag

SUMMARY: Rubble of thin quartz-axinite veins in hornfels sandstone gossan. **REFERENCES:** McGimsey and others, 1988; this report.

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
122 T. 27 N. R. 42 W.	Unnamed (A) [84AAi557 and 84AAi558]	Sn, Ag Plutonic-related Ag-Sn polymetallic	Samples contains up to 5 ppm Ag and >2,000 ppm B; one sample contains 1,000 ppm Sn
SUMMARY: Minor rubble of quartz-axinite veins mixed with rubble of sandstone and hornfels sandstone. **REFERENCES:** McGimsey and others, 1988; this report.			
123 T. 27 N. R. 41 W.	Unnamed (A) [84GL37]	Au (Hg) Granite-porphyry-hosted Au-polymetallic	Sample contains 0.1 ppm Au and 0.5 ppm Hg
SUMMARY: Grab sample of 250-m-wide felsic dike contains low-grade Au and Hg anomalies. Dike may be a northeast extension of an auriferous granite porphyry dike swarm that crops out 4 km to the southwest in the Granite Creek area. **REFERENCES:** McGimsey and others, 1988; this report.			
124 T. 27 N. R. 37 W.	Unnamed (O) [86BT122]	Ag, Zn, Sn (Hg) Deposit type uncertain	Quartz vein contains 0.5 ppm Ag, 900 ppm Zn, 150 ppm Sn, 20 ppm As, 0.96 ppm Hg, 1.9 ppm Cd, and 2,000 ppm B
SUMMARY: Thin quartz veinlets (uncommon) in hematitic, iron-stained, sandstone of the Kuskokwim Group. **REFERENCES:** McGimsey and others, 1988; this report.			
125 T. 26 N. R. 52 W.	Unnamed (A) [85AM183]	Hg	Sample contains 1.2 ppm Hg
SUMMARY: Grab sample of welded rhyolite tuff of the Yetna River volcanic field contains low-grade Hg anomaly. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen; 1994; this report.			
126 T. 26 N. R. 51 W.	Unnamed (A) [85AM202]	Au (Sb) Volcanic-hosted	Grab samples contain up to 50 ppb Au and 18 ppm Sb
SUMMARY: Dacite flow rocks of the Yetna River volcanic field contain low-grade Au and Sb anomalies; hematite veinlets found locally. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen; 1994; this report.			
127 T. 26 N. R. 51 W.	Unnamed (A) [85AM206]	Sn Deposit type uncertain	Sample contains 100 ppm Sn
SUMMARY: Grab sample of devitrified andesite from Yetna River volcanic field. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen; 1994; this report.			
128 T. 26 N. R. 48 W.	Unnamed (A) [85BT260]	Sn, Sb, As Plutonic-related Ag-Sn polymetallic (?)	Grab sample contains 20 ppm Sn, 20 ppm Sb, 40 ppm As, and 2,000 ppm B
SUMMARY: Contact area between intrusive body and hornfels sedimentary rock; no breccia or hydrothermal alteration observed. The sample location is incorrectly plotted in McGimsey and others (1988); it actually lies 2.75 km south-southwest of where they show it. **REFERENCES:** McGimsey and others, 1988; this report.			

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
129 T. 26 N. R. 47–48 W.	Willow Bench (M)	Au, Ag Placer	Produced at least 1,305 kg (41,948 oz) Au and 156.5 kg (5,033 oz) Ag from 1915–1986

SUMMARY: Major system of ancestral channels of Willow Creek, which partly heads into Happy Creek drainage (no. 104). Pay contained in terrace alluvium on perched bench levels 20–30 m above modern deposits of Willow Creek, the latter of which contain lower grade placer gold. Pay gravel, overlain by 8 to 10 m of frozen muck, continues for at least 4 km of strike length, 50 to 200 m of width, and 2 to 3 m of depth. Gold enrichments apparently occur at intersections between small gulches, which drain the southwest flank of Chicken Mountain, and the bench gravels. Air photo analysis and exploration drilling suggest significant resources might occur to the southwest of the main bench levels, probably in multiple ancestral channels. Gold fineness ranges from 856 to 883 and averages 874. Heavy minerals include ilmenite, cinnabar, and zircon. **REFERENCES:** Mertie, 1936; Smith, 1941; Bundtzen and others, 1987; Richard and John Fullerton, oral commun., 1988; Bundtzen and others, 1992; this report.

130 T. 26 N. R. 47 W.	Chicken Mountain (P)	Au, As, Sb, Cu, Hg, Mo Plutonic-hosted Cu-Au polymetallic	Estimated resource of about 14.5 Mt (16 M tons) grading 1.2 g/t (0.04 oz/ton) Au, 4.6 g/t Ag, 0.09% Cu, and 0.46% Sb

SUMMARY: Deposit consists of quartz-sulfide veinlets containing a wide variety of ore minerals including free gold, stibnite, cinnabar, arsenopyrite, chalcopyrite, molybdenite, silver sulfosalts, and arsenian pyrite. Quartz veins contain up to 5% sulfides. All mineralized rock is contained in cupola zones of altered monzonite and syenite of Chicken Mountain stock. Earlier monzodiorite, alkali gabbro, and wehrlite phases also present. Pervasive sericite and ankerite alteration halos present. Dolomite breccia phase synchronous with major sulfide phase. Surface extent of veins occupies a 300 m by 800 m area; drilling indicates at least 250 m of vertical extent. Diamond-drill programs were conducted during 1987–1990 and 1997–1998. Drill results and mapping indicate a vertical temperature zonation is present; epithermal gold-mercury-antimony zones crosscut older mesothermal gold-copper-molybdenum and arsenic-copper events. Pluton and ore veins yield coeval K-Ar ages of 70 Ma. **REFERENCES:** Jason Bressler, written commun., 1980; Bull, 1988; Richard Gosse, written commun., 1990; Victor Hollister, written commun., 1992; Bundtzen and others, 1992; Nokleberg and others, 1993; Bundtzen and Miller, 1997; this report.

131 T. 26 N. R. 47 W.	Chicken Creek (M)	Au (Ag) Placer	Produced at least 771 kg (24,800 oz) Au and 98.7 kg (3,174 oz) Ag from 1912–1985 (records 1940–1980 absent)

SUMMARY: Modern stream alluvium and alluvial fan placer deposits on 6-km-long, south-flowing stream that erodes the central and southern parts of Chicken Mountain pluton. Uppermost placers are partially residual on mineralized stockwork (no. 130); lowermost pay streaks are part of an alluvial fan adjacent to Bonanza Creek. Landslide midway down creek has buried placer pay streak. Gold fineness ranges from 850 to 870 and averages 861. Principal heavy minerals include ilmenite, chromite, and cinnabar. **REFERENCES:** Mertie, 1936; Bundtzen and others, 1987; Bundtzen and others, 1992; this report.

132 T. 26 N. R. 47 W.	Prince Creek (M)	Au, Ag (Hg) Placer	Produced at least 1,053 kg (33,864 oz) Au and 123.8 kg (3,979 oz) Ag from 1913–1990

SUMMARY: Stream system of auriferous modern alluvium and several ancestral channels on asymmetrical left limit that trends southeast and south for 8 km before emptying into Bonanza Creek. Stream heads into southeast flank of Chicken Mountain. Original Prince Creek channel beheaded by advancing Chicken Creek valley; hence, placer gold and heavy minerals from both Prince and Chicken Creeks have identical Chicken Mountain lode source. Principal heavy minerals include cinnabar, chrome spinel, ilmenite, zircon, and garnet. (Garnet found where lower paystreaks overlies granite porphyry.) Gold fineness ranges from 838 to 886. Bench placers have higher fineness. Has potential for development of placer reserves on relatively unexploited bench levels. **REFERENCES:** Mertie, 1936; Bundtzen and others, 1987; Bundtzen and others, 1992; this report.

133 T. 26 N. R. 47 W.	Unnamed (O) [84BT98]	Au, Ag, W, Bi (Hg) Plutonic-hosted Cu-Au polymetallic	Sample contains 3.4 ppm Au, 10 ppm Ag, 1,380 ppm W, 78 ppm Bi, and 0.82 ppm Hg

SUMMARY: Hornfels and monzonite dike(?) at Prince Creek placer cut. Veinlets strike N. 20° E. and dip 75° E. Cinnabar noted in vein. **REFERENCES:** Bundtzen and others, 1992; this report.

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
134 T. 26 N. R. 46 W.	Unnamed (A) [86AMc216]	Hg Epithermal Hg-Sb (?)	Sample contains 1.2 ppm Hg

SUMMARY: Grab sample of granite porphyry sill contains slightly elevated Hg value. The sample location is incorrectly plotted in McGimsey and others (1988). **REFERENCES:** McGimsey and others, 1988; this report.

135 T. 26 N. R. 46 W.	Unnamed (O) [86BT390 and 86BT391]	Au, Hg Granite-porphyry-hosted Au-polymetallic	Samples contain up to 2.9 ppm Au and 1.7 ppm Hg

SUMMARY: Quartz stockwork veinlets intrude small 1–2 m wide zone in granite porphyry sill along Bonanza Creek upstream from mouth of First Chance Creek. Larger zone of silicification recognized. **REFERENCES:** McGimsey and others, 1988; Bundtzen and others, 1992; this report.

136 T. 26 N. R. 46 W.	Unnamed (O) [86AGe73]	Sb, Ag, Pb, As (Au) Granite-porphyry-hosted Au-polymetallic	Grab samples contain >1.0% Sb, up to 1 ppm Ag, 300 ppm Pb, 120 ppm As, and trace Au

SUMMARY: Quartz-stibnite vein up to 1 m thick near granite porphyry dike or sill. Vein here may be related to veins at locality no. 135. **REFERENCES:** McGimsey and others, 1988; Bundtzen and others, 1992; this report.

137 T. 26 N. R. 45 W.	Unnamed (A) [86BT404]	Hg Epithermal Hg-Sb (?)	Sample contains 1.4 ppm Hg

SUMMARY: Grab sample of altered granite porphyry dike contains slightly elevated Hg. **REFERENCES:** McGimsey and others, 1988; Bundtzen and others, 1992.

138 T. 26 N. R. 45 W.	Unnamed (A) [86AGe62]	Hg Epithermal Hg-Sb (?)	Sample contains 2.3 ppm Hg

SUMMARY: Grab sample of iron-oxide stained sandstone in vicinity of intermediate dike contains slightly elevated Hg. **REFERENCES:** McGimsey and others, 1988; this report.

139 T. 26 N. R. 45 W.	Unnamed (P) [84MSL146]	Sb, Hg, As Epithermal Hg-Sb (?)	Sample contains 54 ppm Sb, 0.9 ppm Hg, 100 ppm As, and 1,000 ppm Cr

SUMMARY: Prospect pit on altered dike. Quartz-calcite veins containing minor sulfides noted. **REFERENCES:** McGimsey and others, 1988; this report.

140 T. 26 N. R. 45 W.	Unnamed (A) [84MSL143]	Hg Epithermal Hg-Sb (?)	Sample contains 1.2 ppm Hg

SUMMARY: Grab sample of felsic dike contains slightly elevated Hg value. **REFERENCES:** McGimsey and others, 1988; this report.

141 T. 26 N. R. 44 W.	Unnamed (A) [86AGe68]	As, Hg Epithermal Hg-Sb	Sample contains 60 ppm As and 1.1 ppm Hg

SUMMARY: Sample from small area of limonite gossan chips in Kuskokwim Group sandstone; contains slightly elevated As and Hg values. **REFERENCES:** McGimsey and others, 1988; this report.

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
142 T. 26 N. R. 42 W.	Willow Creek/Granite Pup (M)	Au (Ag) Placer	Produced estimated 101.1 kg (3,250 oz) Au and 12.4 kg (400 oz) Ag from 1924–1990

SUMMARY: Placer gold discovered on Granite Pup in 1924 and creek has been mined intermittently to the present using small underground drift and opencut mining methods. About 1.5 km of pay streak length known. Auriferous zones in very shallow 1–2 m thick gravels covered by 1–2 m of overburden. Source of at least some placer gold is granite porphyry dike swarm, which partially underlies placer deposits. A small monzonite plug lies east of mine and may also be a lode source. Placer pay streaks average 1.0 g/m^3 over large area; reserve base will probably increase with exploration. Principal heavy minerals are ilmenite, zircon, cinnabar, garnet, cassiterite, stibnite, and pyrite. Gold fineness ranges 838 to 871. **REFERENCES:** Tony Gularte, oral commun., 1986; Bundtzen and others, 1986; Szumigala, 1993; this report.

143 T. 26 N. R. 42 W.	Wyrick Lode (P) [85BT112 and 85BT275]	Sb, Ag, Au (Hg) Granite-porphyry-hosted Au-polymetallic	Samples contain up to 31% Sb, 0.8 ppm Au, 10 ppm Ag, and 3 ppm Hg

SUMMARY: Quartz-stibnite gash veins 3–30 cm wide in sheared rocks along contact of granite porphyry with Kuskokwim Group siltstone. Stibnite gash veins range from 0.55% to 30.9% Sb and average 14.5% Sb. Average silver grade is approximately 4 g/t (0.11 oz/ton) and average gold grade is approximately 0.7 g/t (0.02 oz/ton). Probable lode source of placer gold in no. 142. **REFERENCES:** Bundtzen and others, 1986; Szumigala, 1993.

144 T. 26 N. R. 41 W.	Unnamed (P) [84BT41 and 85BT277]	Ag, Sb (As, Hg, Au) Granite-porphyry-hosted Au-polymetallic	Samples contain up to 0.5 ppm Ag, 48 ppm Sb, 0.56 ppm Hg, 40 ppm As, and trace Au

SUMMARY: Old prospect pits exploring granite porphyry dikes were reopened in 1985. Small calcite and quartz veinlets cut dike. Free gold panned from crushed samples. **REFERENCES:** Bundtzen and others, 1986; McGimsey and others, 1988; this report.

145 T. 26 N. R. 41 W.	Unnamed (O) [84GL36 and 84AM60]	Sn, Cu, Zn, Pb (Ag, Sb, Hg) Plutonic-related Ag-Sn polymetallic	Grab samples contain up to >1,000 ppm Sn, 1 ppm Ag, >2,000 ppm B, 500 ppm Cu, 350 ppm Zn, 100 ppm Pb, 160 ppm As, 54 ppm Sb, and 1.2 ppm Hg

SUMMARY: Large limonite-tourmaline breccia zone in hornfels sandstone near monzonite contact; monzonite itself contains numerous quartz-tourmaline stockwork veins. The location for 84GL36 was incorrectly shown in McGimsey and others (1988). **REFERENCES:** McGimsey and others, 1988; this report.

146 T. 26 N. R. 41 W.	Unnamed (A) [84AM186 and 84BT44]	Zn, Cu, Ag (Cd, Bi) Plutonic-related Ag-Sn polymetallic	Samples contain up to 860 ppm Zn, 300 ppm Cu, 2 ppm Ag, 5.1 ppm Cd, and 10 ppm Bi

SUMMARY: Grab samples of sandstone hornfels near southern contact of monzonite intrusion contain anomalous metal values. **REFERENCES:** McGimsey and others, 1988; this report.

147 T. 26 N. R. 41 W.	Unnamed (A) [84BT38]	Cu, As, Bi, Ag Plutonic-related Ag-Sn polymetallic (?)	Sample contains 460 ppm As, 500 ppm Cu, 10 ppm Bi, and 1 ppm Ag

SUMMARY: Gossan areas in sandstone hornfels; disseminated pyrite noted. **REFERENCES:** McGimsey and others, 1988; this report.

148 T. 26 N. R. 41 W.	Munther Creek (P)	Au Placer	May have had small production

SUMMARY: Small, 3-km-long, second-order stream drains south side of ridge intruded by monzonite plug and granite porphyry dikes. Fine-grained placer gold panned from prospect pits in 1920's and 1930's. **REFERENCES:** Tony Gularte, oral commun. to T.K. Bundtzen, 1986; Bundtzen and others, 1986.

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
149 T. 26 N. R. 41 W.	Unnamed (O) [86AM387]	Sb, As (Hg) Epithermal Hg-Sb (?)	Grab sample contains 390 ppm Sb, 850 ppm As, 0.9 ppm Hg, and >20% Fe

SUMMARY: Chips of heavily iron-oxide stained sandstone are found locally. The sample location was incorrectly shown in McGimsey and others (1988) to be approximately 1 km south of the actual collection site. **REFERENCES:** McGimsey and others, 1988; this report.

150 T. 26 N. R. 40 W.	Unnamed (O) [84AM220]	Ag, Sn, Pb, Sb, As, Bi Plutonic-related Ag-Sn polymetallic	Samples contain up to 7 ppm Ag, 300 ppm Sn, 500 ppm Pb, 54 ppm Sb, 100 ppm As, 54 ppm Bi, and >2,000 ppm B

SUMMARY: Extensive boron metasomatism in Granite Mountain pluton. Tourmaline-rich quartz porphyry and tourmaline-cemented breccias occur locally in upper portion of pluton. Disseminated cassiterite observed in one sample near site; no sulfides observed. **REFERENCES:** McGimsey and others, 1988; this report.

151 T. 26 N. R. 40 W.	Granite Mountain (O) [84BT231 and 84AM218]	Sn, Ag, Au, Bi, Sb, As Plutonic-related Ag-Sn polymetallic	Samples contain up to 100 ppm Sn, 0.5 ppm Ag, 50 ppb Au, 9 ppm Bi, 28 ppm Sb, 80 ppm As, and >2,000 ppm B

SUMMARY: Extensive boron metasomatism in stock along northern contact with hornfels; occurs as tourmaline sheeted zones, tourmaline cemented breccias, and axinite-tourmaline replacements in plutonic rocks and hornfels. One large area of tourmaline breccia is 400 m long, 15 m wide, cylindrical in cross section, and may contain approximately 5 million tonnes of boron alteration. Average metal content of this pipe not ascertained. **REFERENCES:** McGimsey and others, 1988; Bundtzen and Miller, 1997; this report.

152 T. 26 N. R. 40 W.	Unnamed (O) [86AMc219]	Zn, Hg As (Bi, Sb) Plutonic-related Ag-Sn polymetallic	Grab sample contains 450 ppm Zn, >10 ppm Hg, 400 ppm As, 7 ppm Bi, 22 ppm Sb, and 15% Fe

SUMMARY: Grab sample of hematite-cemented, limonite-stained breccia of Kuskokwim Group sandstone. **REFERENCES:** McGimsey and others, 1988; this report.

153 T. 26 N. R. 40 W.	Unnamed (A) [84AAi512]	Ag, Pb (Sn, Sb) Plutonic-related Ag-Sn polymetallic	Samples contain up to 1.5 ppm Ag, 200 ppm Pb, 15 ppm Sn, 12 ppm Sb, and >2,000 ppm B

SUMMARY: Grab samples of tourmaline-rich quartz monzonite border phase. **REFERENCES:** McGimsey and others, 1988; this report.

154 T. 26 N. R. 40 W.	Unnamed (O) [I1559]	Au Placer	Visible gold in heavy-mineral-concentrate sample

SUMMARY: Visible gold in nonmagnetic, heavy-mineral-concentrate sample. Stream drains southeast side of Granite Mountain, cutting through quartz monzonite and hornfels Kuskokwim Group sedimentary rock. **REFERENCES:** Bennett and others, 1988; Miller and Bundtzen, 1994; this report.

155 T. 26 N. R. 39 W.	Unnamed (A) [86AMc7]	Ag, Pb, As (Bi, Sb) Deposit type uncertain	Sample contains 0.5 ppm Ag, 200 ppm Pb, 10 ppm Bi, 100 ppm As, and 12 ppm Sb

SUMMARY: Grab sample of fine- to medium-grained sandstone contains elevated values of Ag, Pb, As, Bi, and Sb; Hg was not analyzed. No sulfides or alteration were noted. **REFERENCES:** McGimsey and others, 1988; this report.

<table>
<tr><th>Site no.
Township
Range
(Seward Meridian)</th><th>Name
(Category[1])
[Station no(s).]</th><th>Significant metals
(minor metals)
Deposit type[2]</th><th>Production, grade/
tonnage, and/or
analytical data[3]</th></tr>
<tr><td>156
T. 25 N.
R. 49 W.</td><td>Yousure (O)
[85AM172 and
I0160]</td><td>Hg, Sb, W, As (Ag, Ba)
Epithermal Hg-Sb</td><td>Grab samples contain up to 15% cinnabar, >1.0% As, 0.46% Sb, 50 ppm W, trace Ag, and 5,000 ppm Ba</td></tr>
<tr><td colspan="4">SUMMARY: Quartz-cinnabar-stibnite veins and veinlets cut siltstone of Kuskokwim Group and silica-carbonate altered mafic dikes; scheelite identified in one sample. Small, deep red, euhedral cinnabar crystals are locally abundant in the quartz vein rubble. Grab samples contain up to 15% cinnabar and 5% stibnite. Occurrence exposed as rubble crop in a steep cut bank on the north side of the Iditarod River. Quartz veins are no more than 5 cm thick, but one vein was traced for 30 m. The mineralized rock is concentrated in a 30-m-wide zone. REFERENCES: McGimsey and others, 1988; this report.</td></tr>
<tr><td>157
T. 25 N.
R. 47 W.</td><td>Unnamed (A)
[86AM408]</td><td>Au, Hg (Ag)
Granite-porphyry-hosted
Au-polymetallic (?)</td><td>Sample contains 50 ppb Au, 1.8 ppm Hg, and trace Ag</td></tr>
<tr><td colspan="4">SUMMARY: Grab sample of iron-oxide-stained, sericitically altered granite porphyry intrusive contains 50 ppb Au and trace Ag. REFERENCES: McGimsey and others, 1988; this report.</td></tr>
<tr><td>158
T. 25 N.
R. 46 W.</td><td>Unnamed (A)
[84AM93]</td><td>Hg, As
Epithermal Hg-Sb (?)</td><td>Grab sample contains 2.0 ppm Hg and 20 ppm As</td></tr>
<tr><td colspan="4">SUMMARY: Grab sample of iron-oxide-stained, sericitically altered granite porphyry dike contains slightly elevated Hg value; dike is localized along northeast-trending high-angle fault. REFERENCES: McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.</td></tr>
<tr><td>159
T. 25 N.
R. 44 W.</td><td>Unnamed (O)
[84BT73]</td><td>Ag, Sn, As (Bi, Cd, Sb)
Granite-porphyry-hosted
Au-polymetallic (?)</td><td>Quartz vein rubble contains 10 ppm Ag, 100 ppm Sn, >0.2% As, 11 ppm Bi, 3.3 ppm Cd, and 12 ppm Sb</td></tr>
<tr><td colspan="4">SUMMARY: Granite porphyry intrusive contains disseminated arsenopyrite and quartz veinlets. Extensive gossan zone (40 m by 40 m) exposed in rubble. REFERENCES: McGimsey and others, 1988; this report.</td></tr>
<tr><td>160
T. 24–25 N.
R. 44 W.</td><td>Julian Creek (M)</td><td>Au (Ag)
Placer</td><td>Produced at least 361 kg (11,600 oz) Au and 51.3 kg (1,650 oz) Ag between 1911 and 1993</td></tr>
<tr><td colspan="4">SUMMARY: Small, but relatively rich, 3-km-long, second-order stream drains eastward to George River. Shallow placer deposit occurs in modern stream alluvium and in low bench levels on north limit. Pay zones are 10–30 m wide and are covered with 2 m of colluvium from hillslopes. Principal heavy minerals include radioactive monazite, barite, zircon, cinnabar, chromite, magnesiochromite, and stibnite. Gold fineness ranges from 657 to 840 (n=3). Mineralized granite porphyry body (no. 159) at head of creek is probable source of gold. Deposit was mined sporadically from 1911 to 1939; and then again from about 1979 to 1993. Much of pay streak worked out, but rich fractions remain. REFERENCES: Smith, 1941; Cobb, 1973; Larry Wilmarth, oral commun., 1984; Bundtzen and others, 1987; this report.</td></tr>
<tr><td>161
T. 25 N.
R. 43–44 W.</td><td>Michigan Bench (M)</td><td>Au (Ag)
Placer</td><td>Produced about 3.9 kg (125 oz) Au and 0.3 kg (9 oz) Ag in 1980’s</td></tr>
<tr><td colspan="4">SUMMARY: Small remnant terrace alluvial deposit on south limit of Michigan Creek. Terrace alluvium occurs where small gulch intersects valley of Michigan Creek; gulch drains a large granite porphyry dike swarm—the suspected source of gold. Placer concentrates contain cinnabar, garnet, and magnetite. REFERENCES: Glenn Bass, oral commun., 1984; Bundtzen and others, 1987; this report.</td></tr>
<tr><td>162
T. 25 N.
R. 43 W.</td><td>Unnamed (O)
[85AM320, 85AM322,
and 86AM429]</td><td>Au, Sb, Hg, As, W
Granite-porphyry-hosted
Au-polymetallic (?)</td><td>Samples contain up to 250 ppb Au, 2,000 ppm Sb, >14 ppm Hg, 610 ppm As, 200 ppm W, 5 ppm Mo, and 20% Fe</td></tr>
<tr><td colspan="4">SUMMARY: Gossan and hematite-healed breccia in hornfels zone surrounding small, altered granite porphyry intrusion. Breccias of both sedimentary rock and volcanic rock hornfels host the mineralized rock. Encouraging mineral occurrence—consists of multiple outcrops over 0.1 mi2 area. REFERENCES: McGimsey and others, 1988; this report.</td></tr>
</table>

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
163 T. 25 N. R. 43 W.	Unnamed (O) [85DB284]	Sb, Sn, As Deposit type uncertain	Samples contain up to 10,000 ppm Sb, 200 ppm Sn, and 60 ppm As
SUMMARY: Rubble crop of brecciated hornfels containing quartz and stibnite veins found near creek level by helicopter pilot, David Blair. **REFERENCES:** McGimsey and others, 1988; this report.			
164 T. 25 N. R. 42 W.	Unnamed (A) [86AM2]	Hg Epithermal Hg-Sb (?)	Sample contains 1.6 ppm Hg
SUMMARY: Rubble chips of iron-oxide-stained granite porphyry dike contain slightly anomalous Hg value. The sample location is incorrectly plotted in McGimsey and others (1988); it actually lies approximately 9 km east of where they show it. **REFERENCES:** McGimsey and others, 1988; this report.			
165 T. 25 N. R. 41 W.	Unnamed (A) [86AM388]	Cu, Ag, As, Pb, Sb (Bi) Plutonic-related Ag-Sn polymetallic	Grab sample contains 2 ppm Ag, 700 ppm Cu, 600 ppm As, 50 ppm Sb, 150 ppm Pb, 3 ppm Bi, 20% Fe, and >2,000 ppm B
SUMMARY: Limited rubble of iron-oxide stained sandstone hornfels in vicinity of monzonite dike swarm; 5 km south of Granite Mountain pluton. **REFERENCES:** McGimsey and others, 1988; this report.			
166 T. 24 N. R. 50 W.	Unnamed (A) [85BT101]	Sb Epithermal Hg-Sb (?)	Sample contains 110 ppm Sb
SUMMARY: Grab sample of basaltic andesite from the Iditarod Volcanics contains anomalous Sb value; Hg was not analyzed. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.			
167 T. 24 N. R. 50 W.	Unnamed (A) [85BT106]	Sb (Cu, Mo) Epithermal Hg-Sb (?)	Grab sample contains 240 ppm Sb, 100 ppm Cu, and 7 ppm Mo
SUMMARY: Grab sample of hydrothermally altered olivine-bearing basaltic andesite from the Iditarod Volcanics contains anomalous Sb and slightly elevated Cu and Mo; Hg was not analyzed. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.			
168 T. 24 N. R. 47 W.	Unnamed (A) [86AM414]	Zn, Hg Deposit type uncertain	Samples contain up to 240 ppm Zn and 1.8 ppm Hg
SUMMARY: Sericitically altered granite porphyry dike is cut by small quartz veinlets that have limonitically stained alteration envelopes; grab samples contain anomalous Zn and slightly elevated Hg values. **REFERENCES:** McGimsey and others, 1988; this report.			
169 T. 24 N. R. 47 W.	Unnamed (A) [84BT275]	(As) Deposit type uncertain	Sample contains 700 ppm As
SUMMARY: Grab sample of granite porphyry plug contains anomalous As by emission spectrographic analysis, but not by atomic absorption spectrophotometry. Sb value is slightly elevated; Hg was not analyzed. **REFERENCES:** McGimsey and others, 1988; this report.			
170 T. 24 N. R. 47 W.	Unnamed (A) [86AM410]	Au, Hg Granite-porphyry-hosted Au-polymetallic (?)	Grab sample contains 50 ppb Au and 1.3 ppm Hg
SUMMARY: Grab sample of iron-oxide-stained, sericitically altered granite porphyry intrusive contains 50 ppb Au and slightly elevated Hg. **REFERENCES:** McGimsey and others, 1988; this report.			

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
171 T. 24 N. R. 47 W.	Unnamed (A) [85GL20]	Hg, As Epithermal Hg-Sb (?)	Sample contains 4 ppm Hg and 40 ppm As
SUMMARY: Grab sample of granite porphyry dike contains elevated Hg and As. **REFERENCES:** McGimsey and others, 1988; this report.			
172 T. 24 N. R. 44 W.	Spruce Creek (M)	Au (Ag) Placer	Produced at least 8.5 kg (274 oz) Au prior to 1984
SUMMARY: Second-order stream flows 3 km southeast to George River; very narrow 5–15 m wide pay streak buried by 4–6 m of colluvium. Low-grade source of gold thought to be granite porphyry intrusion at head of creek. Principal heavy minerals include magnetite, garnet, ilmenite, and cinnabar. Gold fineness is 897 (one determination). Gold first discovered in 1911, but only the most recent production (1979–1984) is known. Thought to be nearly mined out. **REFERENCES:** Brooks, 1912; L.E. Wyrick, oral commun., 1985; Bundtzen and others, 1987; this report.			
173 T. 24 N. R. 43 W.	Unnamed (A) [85AM327]	Hg Epithermal Hg-Sb (?)	Dike contains 8 ppm Hg; sandstone contains up to 150 ppm Ni
SUMMARY: East-west-trending, limonite-stained, garnet-bearing granite porphyry dike intrudes Kuskokwim Group sandstone. Grab sample of dike contains anomalous Hg. Limonitic sandstone grab samples contain anomalous Ni. **REFERENCES:** McGimsey and others, 1988; this report.			
174 T. 23 N. R. 53 W.	Unnamed (O) [85AM123]	Ag, Zn, Cu, Sb (As, Bi) Plutonic-hosted Cu-Au polymetallic (?)	Gossan contains 0.7 ppm Ag, 640 ppm Zn, 500 ppm Cu, 110 ppm Sb, 6 ppm Bi, 40 ppm As, and 20% Fe
SUMMARY: Scattered gossan rubble in hornfels siltstone, sandstone, and conglomerate 5 km southwest of summit of Mosquito Mountain, near area containing small intermediate sills(?). Gossan grab sample contains anomalous Ag, As, Bi, Cu, Sb, Zn, and Fe. Grab samples of the hornfels sedimentary rock show elevated Ag, As, B, Bi, Sb, and Zn. Hg was not analyzed. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.			
175 T. 23 N. R. 53 W.	Unnamed (A) [85BT124]	Sb Epithermal Hg-Sb (?)	Sample contains 38 ppm Sb
SUMMARY: Grab sample of intermediate volcanic(?) rock interbedded with sandstone contains elevated Sb; Hg was not analyzed. **REFERENCES:** McGimsey and others, 1988; this report.			
176 T. 23 N. R. 53 W.	Mosquito Mountain (A) [I0048 and 85AM74]	Ag, Sb, As (Hg) Deposit type uncertain	Grab samples contain up to 0.7 ppm Ag, 50 ppm As, 38 ppm Sb, and 1.4 ppm Hg
SUMMARY: Heavily iron-oxide stained sandstone hornfels near top of Mosquito Mountain contains elevated values of Ag, As, Sb, and Hg. **REFERENCES:** McGimsey and others, 1988; this report.			
177 T. 23 N. R. 52 W.	Unnamed (A) [84AM239]	(Ag) Deposit type uncertain	Sample contains 0.5 ppm Ag
SUMMARY: Grab sample of iron-oxide-stained pebble conglomerate from shoreline facies of the Kuskokwim Group contains slightly elevated Ag. **REFERENCES:** McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.			

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

<table>
<tr><th>Site no.
Township
Range
(Seward Meridian)</th><th>Name
(Category[1])
[Station no(s).]</th><th>Significant metals
(minor metals)
Deposit type[2]</th><th>Production, grade/
tonnage, and/or
analytical data[3]</th></tr>
<tr><td>178
T. 23 N.
R. 52 W.</td><td>Unnamed (A)
[85AM80, 85AM81, and 86AM259]</td><td>Hg, As, Zn
Deposit type uncertain</td><td>Samples contain up to 1.2 ppm Hg, 110 ppm Zn, 60 ppm As, and trace Ag</td></tr>
<tr><td colspan="4">SUMMARY: Limonitic, secondary hematite-bearing sandstone and quartz-veined sandstone found locally in vicinity of altered porphyritic felsic and intermediate dikes. One secondary hematite-bearing sandstone sample contains trace Ag and 60 ppm As (Hg not analyzed in this sample). REFERENCES: McGimsey and others, 1988; this report.</td></tr>
<tr><td>179
T. 23 N.
R. 52 W.</td><td>Unnamed (A)
[I1479]</td><td>Zn, As, Sb (Hg, Ag)
Deposit type uncertain</td><td>Sample contains 200 ppm Zn, 400 ppm As, 42 ppm Sb, 0.5 ppm Hg, 50 ppb Ag, and 20% Fe</td></tr>
<tr><td colspan="4">SUMMARY: Grab sample of iron-oxide-stained sandstone that has fine quartz veinlets contains anomalous As, Zn, and Sb, and elevated Hg and Ag. REFERENCES: McGimsey and others, 1988; this report.</td></tr>
<tr><td>180
T. 23 N.
R. 51 W.</td><td>Unnamed (A)
[86AM257]</td><td>Hg
Epithermal Hg-Sb (?)</td><td>Sample contains 1.2 ppm Hg</td></tr>
<tr><td colspan="4">SUMMARY: Grab sample of altered felsic dike that intrudes Kuskokwim Group sandstone contains slightly elevated Hg. REFERENCES: McGimsey and others, 1988; this report.</td></tr>
<tr><td>181
T. 22–23 N.
R. 51 W.</td><td>Little Creek (M)
[I0056]</td><td>Au (Hg)
Placer</td><td>Minor production during testing, but not recorded</td></tr>
<tr><td colspan="4">SUMMARY: Fine-grained placer gold and cinnabar found along the middle course of Little Creek, which originates in Sleetmute quadrangle and flows north into Iditarod quadrangle. Gold first found on Little Creek in 1910; reconnaissance drilling took place probably prior to 1960. Deposit thought to be modern alluvial placer; terrace alluvium not recognized. Little Creek heads into area underlain by the Iditarod Volcanics, but specific placer gold source is not known. REFERENCES: Cady and others, 1955; Spencer Lyman, oral commun., 1984; Bennett and others, 1988; Miller and Bundtzen, 1994; this report.</td></tr>
<tr><td>182
T. 23 N.
R. 51 W.</td><td>Unnamed (A)
[85AAi685]</td><td>(Sb, As)
Epithermal Hg-Sb (?)</td><td>Grab sample contains 10 ppm Sb and 20 ppm As</td></tr>
<tr><td colspan="4">SUMMARY: Sample of iron-oxide-stained Kuskokwim Group sandstone contains slightly elevated Sb and As; Hg was not analyzed. REFERENCES: McGimsey and others, 1988; this report.</td></tr>
<tr><td>183
T. 23 N.
R. 50 W.</td><td>Unnamed (P)
[85AAi682]</td><td>As, Hg (Sb)
Epithermal Hg-Sb (?)</td><td>Samples contain up to 110 ppm As, 0.92 ppm Hg, and 10 ppm Sb</td></tr>
<tr><td colspan="4">SUMMARY: Zone of red-orange, iron-oxide-stained country rock (mixed volcanic flow and tuff unit of the Iditarod Volcanics) associated with rubble of altered felsic(?) dikes. Old claim post present near a prospect pit made on iron-oxide-stained calcite-quartz veins; rubble shows veins up to 10 cm wide. Vein sample contains anomalous As and Sb, but Hg was not analyzed. Sample of altered felsic dike contains elevated values of Hg and As. REFERENCES: McGimsey and others, 1988; Miller and Bundtzen, 1994; this report.</td></tr>
<tr><td>184
T. 23 N.
R. 50 W.</td><td>DeCourcy Mountain mine (M)</td><td>Hg, As, Sb (Ag, Au)
Epithermal Hg-Sb</td><td>Produced 51,700 kg (1,500 flasks) Hg from about 2,250 t (2,480 tons) ore prior to 1949</td></tr>
<tr><td colspan="4">SUMMARY: Kuskokwim Group sandstone and shale cut by sill-like mafic bodies; mineralized veins and vein breccias are localized along intrusive contacts and bedding surfaces. Cinnabar and minor stibnite occur in lenses, veins, and stockworks accompanied by gangue of silica, carbonate, and clay minerals. Also, ferrian cinnabar, stibnite, and arsenopyrite occur in distinctive chalcedonic breccia that fills fractures in both sedimentary and igneous host rocks. Discovered in 1910–11; staked in 1919; operated intermittently 1921–49. In addition to Hg, USGS grab samples contain up to 0.65 ppm Ag, 200 ppm As, and 1.0% Sb. Bruce Hickok (oral commun., 1988) obtained 400 ppb Au values from DeCourcy samples. A tributary to Return Creek contains an unevaluated amount of placer cinnabar derived from DeCourcy Mountain lode; claims staked in various years between 1908–53. REFERENCES: Webber and others, 1947; Malone, 1962; Sainsbury and MacKevett, 1965; McGimsey and others, 1988; Nokleberg and others, 1993; this report.</td></tr>
</table>

<table>
<tr><th>Site no.
Township
Range
(Seward Meridian)</th><th>Name
(Category[1])
[Station no(s).]</th><th>Significant metals
(minor metals)
Deposit type[2]</th><th>Production, grade/
tonnage, and/or
analytical data[3]</th></tr>
<tr><td>185
T. 23 N.
R. 49 W.</td><td>Unnamed (A)
[85AAi676]</td><td>Hg (Sb, As, Zn)
Epithermal Hg-Sb (?)</td><td>Grab sample of dike contains 1.78 ppm Hg, 6 ppm Sb, 20 ppm As, and 100 ppm Zn</td></tr>
<tr><td colspan="4">SUMMARY: Hematite-altered Kuskokwim Group sandstone in vicinity of hematite-altered porphyritic felsic dike rubble. Dike contains slightly elevated values of Hg, As, and Zn; the sandstone was not analyzed for Hg. REFERENCES: McGimsey and others, 1988; this report.</td></tr>
<tr><td>186
T. 23 N.
R. 49 W.</td><td>Unnamed (A)
[85AM70]</td><td>Hg, Sb (Zn, As)
Epithermal Hg-Sb (?)</td><td>Samples contain up to 2.3 ppm Hg, 18 ppm Sb, 110 ppm Zn, and 30 ppm As</td></tr>
<tr><td colspan="4">SUMMARY: Locality has rubble of iron-oxide-stained Kuskokwim Group sandstone, lesser iron-oxide stained lithic tuff, some heavily iron-oxide-stained altered felsic dike, and minor small chips of quartz vein. A grab sample of the sandstone contains elevated As and Sb. The tuff contains elevated As (20 ppm), Hg (2.0 ppm), Sb (18 ppm), and Zn (110 ppm). A grab sample of felsic dike contains 2.3 ppm Hg. The quartz vein material contains 0.94 ppm Hg. A blue-green mineral identified by x-ray diffraction to be dickite(?) (analyst Elizabeth Bailey, U.S. Geological Survey) coats some fracture surfaces. REFERENCES: McGimsey and others, 1988; this report.</td></tr>
<tr><td>187
T. 23 N.
R. 49 W.</td><td>Unnamed (A)
[85AM69]</td><td>Hg, As
Epithermal Hg-Sb</td><td>Samples contain up to 7.1 ppm Hg and 100 ppm As</td></tr>
<tr><td colspan="4">SUMMARY: Altered sandstone in vicinity of altered felsic dike; both sandstone and dike have abundant secondary hematite. Sandstone contains 7.1 ppm Hg; dike contains 1.3 ppm Hg. Both have elevated As and trace (2 ppm) Sb. REFERENCES: McGimsey and others, 1988; this report.</td></tr>
<tr><td>188
T. 23 N.
R. 49 W.</td><td>Lewis Gulch (M)</td><td>Au (Ag)
Placer</td><td>Produced up to 188 kg (6,039 oz) Au from 1918 to 1939</td></tr>
<tr><td colspan="4">SUMMARY: Small, 2.5-km-long, first-order stream that flows west to intersect Donlin Creek. Most placer gold probably recycled from auriferous Donlin Creek bench, an ancestral terrace alluvial deposit; some placer gold was probably originally introduced from lode sources in mineralized granite porphyry dikes. Principal heavy minerals are cinnabar, stibnite, and arsenopyrite. REFERENCES: Cady and others, 1955; Cobb, 1972; this report.</td></tr>
<tr><td>189
T. 23 N.
R. 49 W.</td><td>Unnamed (O)
[85AM161]</td><td>Au, Ag, As, Hg, Sb
Granite-porphyry-hosted Au-polymetallic</td><td>Grab samples of three dikes contain up to 0.2% As, 0.9 ppm Au, 1.5 ppm Ag, 6.4 ppm Hg, and 14 ppm Sb</td></tr>
<tr><td colspan="4">SUMMARY: Sericitically altered granite porphyry dikes cut Kuskokwim Group sandstone. The numerous dikes, each about 1 m wide, form a swarm covering 200 m. Arsenopyrite identified in one dike. REFERENCES: McGimsey and others, 1988; this report.</td></tr>
<tr><td>190
T. 23 N.
R. 49 W.</td><td>Queen Gulch (M)</td><td>Au (Ag)
Placer</td><td>Production estimate included with Donlin Creek (no. 195)</td></tr>
<tr><td colspan="4">SUMMARY: Small, 2.5-km-long, first-order stream flows northwest to intersect Donlin Creek. Placer gold thought to be recycled from auriferous Donlin Creek bench, an ancestral terrace alluvial deposit. Gold probably ultimately derived from mineralized granite porphyry dike swarm to the east. REFERENCES: Cady and others, 1955; Cobb, 1972; this report.</td></tr>
<tr><td>191
T. 23 N.
R. 49 W.</td><td>Ruby Gulch (M)</td><td>Au (Ag)
Placer</td><td>Produced 4.5 kg (145 oz) gold in about 1911</td></tr>
<tr><td colspan="4">SUMMARY: Small, 1-km-long, first-order stream that flows west to intersect Donlin Creek. Placer gold thought to be recycled from auriferous Donlin Creek bench, an ancestral terrace alluvial deposit. Seven assays of gold were reported to range from 902 to 910 fine. In addition to gold, concentrates yielded magnetite, scheelite, cassiterite, garnet, cinnabar, stibnite, and pyrite. Placer gold probably ultimately derived from mineralized granite porphyry dike swam to the east. REFERENCES: Maddren, 1915; Cady and others, 1955; Cobb, 1972; this report.</td></tr>
</table>

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
192 T. 23 N. R. 49 W.	Donlin lode system (P)	Au, Ag, Sb, As (Sn, Cu, Pb, Zn, Hg) Granite-porphyry-hosted Au-polymetallic	Reserve estimate (all reserve categories) of 259 Mt at an average grade of 3.1 g/t gold or 792 tonnes (25.45 M oz) gold (Szumigala and others, 2004)

SUMMARY: Exploration for lode deposits began in the 1980's and property was extensively drilled during 1987–1990, 1995–1998, and 2000–2002; this description is based on published information and our own data—it does not include complete information from the most recent exploration programs conducted by NovaGold Resources, Inc.. Blades, crystals and disseminations of stibnite, arsenopyrite, complex arsenic sulfosalts, and minor to trace cinnabar and free gold in quartz veins and shear zones associated with 4-km-long sheeted dike and sill complex. Mineralized rock commonly occurs near contacts between dikes and mid-Cretaceous Kuskokwim Group flysch, but locally, auriferous zones extend up to 20 m away from the contact, encompassing sedimentary rock and hornfels. Dikes vary compositionally and texturally and include quartz monzonite, alaskite, and granite porphyry varieties. Cross-cutting relationships indicate there are at least three ages of dikes, but they may be within a several million year time span. One granite porphyry dike yields a minimum K-Ar age of 65 Ma; another dike yields 69.5 Ma on biotite and 70.9 Ma on muscovite. A sample of hydrothermal sericite associated with mineralized rock yielded a $^{40}Ar/^{39}Ar$ of >69.5 Ma. Grab samples contain up to 100 ppm Ag, 0.5% As, 23 ppm Au, 200 ppm Be, 190 ppm Bi, 3.8 ppm Cd, 700 ppm Cu, >10 ppm Hg, 1,000 ppm Pb, 1% Sb, 70 ppm Sn, 20 ppm W, and 350 ppm Zn. Cinnabar is recognized in trenches. Considerable gold found in lattice structures of arsenic minerals. Reserve estimate quoted above is mainly from the Lewis/Rochelieu area. Other prospects include Farside, Snow, 400, ACMA, and Duqum (also see Dome prospect no. 196, this table). **REFERENCES:** McGimsey and others, 1988; Nokleberg and others, 1993; Retherford and McAtee, 1994; Dodd, 1996; Bundtzen and Miller, 1997; Gray and others, 1997b; Szumigala and others, 2000; Szumigala and others, 2004; this report.

193 T. 23 N. R. 49 W.	Snow Gulch (M)	Au, Ag Placer	Produced at least 256 kg (8,238 oz) Au and 18.8 kg (605 oz) Ag from 1910 to 1992

SUMMARY: Gold was discovered on Snow Gulch in 1910 and after 1914 it became the principal producer of gold in Donlin Creek-Crooked Creek area. Second-order stream flows 6 km northwest to intersect Donlin Creek. Virtually all the placer gold has been recovered where Snow Gulch intersects the ancestral Donlin Creek bench, an ancestral terrace alluvial deposit; hence, economic placers are thought to be the result of recycling of gold from the auriferous bench. Principal heavy minerals identified include garnet, cassiterite, scheelite, stibnite, and trace radioactive monazite. Gold fineness is 927, the highest average of all placer deposits in the Iditarod quadrangle. Placer gold is coarse and angular; a flat 280 g (9 oz) nugget was mined in 1984. The source of gold and heavy minerals is probably a 1-km-wide granite porphyry dike swarm of the Donlin Property (no. 192). **REFERENCES:** Maddren, 1915; Cady and others, 1955; Bundtzen and others, 1987; Spencer and Carolyn Lyman, oral commun., 1990, 1991; this report.

194 T. 23 N. R. 49 W.	Quartz Gulch (M)	Au (Ag) Placer	Produced at least 61.2 kg (1,968 oz) Au and 0.4 kg (14 oz) Ag from 1910 to 1987

SUMMARY: From 1910 to 1914, Quartz Gulch was the largest producer in the Donlin Creek-Crooked Creek area. This small, first-order stream flows 3.5 km northwest to intersect Donlin Creek. Almost all placer gold recovered where Quartz Gulch intersects auriferous Donlin Creek bench alluvial terrace deposits. Origin of placers similar to that described for Lewis, Queen, Ruby, and Snow Gulches (nos. 188, 190, 191, and 193). **REFERENCES:** Maddren, 1915; Cady and others, 1955; Bundtzen and others, 1987; this report.

195 T. 23 N. R. 48–49 W.	Donlin Creek/ Crooked Creek (M)	Au (Ag) Placer	Produced at least 130 kg (4,170 oz) Au and 3.7 kg (119 oz) Ag from 1911 to 1956

SUMMARY: Third-order trunk stream into which auriferous second-order placer-gold-producing streams (nos. 188, 190, 191, 193, and 194) enter. This major placer deposit is a conspicuous ancestral terrace alluvial deposit (the Donlin Creek bench) that extends for at least 25 km from Omega Gulch on the southwest to the headward reaches of Donlin Creek to the northeast. Gold production activities confined to 10-km-long, left-limit bench along Donlin Creek adjacent to Lewis, Queen, Snow, and Quartz Gulches. Paleocurrent data in mine cuts (imbricate pebbles in fluvial gravels) and aerial photographic interpretation indicate that, at one time, Donlin Creek flowed north to intersect the Iditarod River drainage basin, probably in Late Tertiary time judging from antiquity of the ancestral stream drainage. Gold production derives mostly from terrace gravels, but some came from modern alluvial deposits, between Queen and Lewis Gulches. **REFERENCES:** Maddren, 1915; Cady and others, 1955; Cobb, 1972; Bundtzen and others, 1987; this report.

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
196 T. 23 N. R. 48 W.	Donlin lode system, Dome area (P) [85BT194 and 85BT195]	Ag, Hg, Sn, As (Au, Bi) Granite-porphyry-hosted Au-polymetallic	Surface samples of dike contain up to 1 ppm Ag, 5.1 ppm Hg, 100 ppm As, 70 ppm Sn, 3 ppm Bi, and trace Au
SUMMARY: This area was explored and drilled in 1996 and 1997 as part of the Donlin lode system (no. 192); this description is based on published information and our own data—it does not include up-to-date information from the drilling program. Natural exposures are mostly rubble crop of granite porphyry dikes in biotite-bearing hornfels sandstone of Kuskokwim Group; quartz veins 1 to 6 cm wide cut dikes locally. **REFERENCES:** McGimsey and others, 1988; Bundtzen and Miller, 1997; this report.			
197 T. 23 N. R. 48 W.	Unnamed (O) [85GL100 and 86BT290–292]	Zn, As, Cu, Sb, Hg (Sn, Ag) Granite-porphyry-hosted Au-polymetallic	Grab samples contain up to 440 ppm Zn, 200 ppm As, 100 ppm Cu, 62 ppm Sb, 2.3 ppm Hg, 20 ppm Sn, and trace Ag
SUMMARY: Area of local gossan in hornfels sedimentary rock adjacent to quartz-veined granite porphyry dikes and small intrusions; contact areas are locally brecciated. Three grab samples of the hornfels collectively contain up to 440 ppm Zn, 180 ppm As, 100 ppm Cu, 60 ppm Sb, 20 ppm Sn, 2.3 ppm Hg, and trace Ag. One grab sample of quartz veins in dike contains 200 ppm As, 62 ppm Sb, 1.5 ppm Hg, and 10 ppm Sn. **REFERENCES:** McGimsey and others, 1988; this report.			
198 T. 23 N. R. 47 W.	Unnamed (A) [85BT269]	Hg Epithermal Hg-Sb (?)	Sample contains 4.7 ppm Hg
SUMMARY: Grab sample of locally calcareous lithic sandstone of the Kuskokwim Group; no evidence of nearby igneous activity. **REFERENCES:** McGimsey and others, 1988; this report.			
199 T. 23 N. R. 47 W.	Unnamed (A) [85BT139]	Sb Epithermal Hg-Sb (?)	Sample contains 110 ppm Sb and trace Ag
SUMMARY: Grab sample of lithic sandstone of the Kuskokwim Group; no evidence of nearby igneous activity. Sample contains 110 ppm Sb and trace Ag; Hg was not analyzed. **REFERENCES:** McGimsey and others, 1988; this report.			
200 T. 23 N. R. 47 W.	Unnamed (A) [85BT144]	Ag (Sb) Deposit type uncertain	Sample contains 1.5 ppm Ag and 10 ppm Sb
SUMMARY: Grab sample of Kuskokwim Group sandstone contains low-level anomalies of 1.5 ppm Ag and 10 ppm Sb; Hg was not analyzed. **REFERENCES:** McGimsey and others, 1988; this report.			
201 T. 23 N. R. 46 W.	Unnamed (A) [85BT130]	(Sb) Epithermal Hg-Sb (?)	Sample contains 34 ppm Sb
SUMMARY: Medium-grained lithic sandstone of Kuskokwim Group contains 34 ppm Sb; Hg was not analyzed. No evidence of nearby igneous activity. **REFERENCES:** McGimsey and others, 1988; this report.			
202 T. 23 N. R. 46 W.	Unnamed (A) [86BT198]	Sb, As Epithermal Hg-Sb (?)	Sample contains 14 ppm Sb and 20 ppm As
SUMMARY: Hematite-altered lithic sandstone of Kuskokwim Group contains 14 ppm Sb and 20 ppm As; Hg was not analyzed. **REFERENCES:** McGimsey and others, 1988; this report.			
203 T. 22 N. R. 53 W.	Unnamed (A) [86BT307]	Ag (Hg) Deposit type uncertain	Sample contains 10 ppm Ag and 0.12 ppm Hg
SUMMARY: Grab sample of shallow-water facies, quartzose sandstone of Kuskokwim Group; altered dike lies about 400 m to the south. **REFERENCES:** McGimsey and others, 1988; this report.			

Table 1. *Mines, prospects, occurrences, and rock geochemical anomalies, Iditarod quadrangle—continued*

Site no. Township Range (Seward Meridian)	Name (Category[1]) [Station no(s).]	Significant metals (minor metals) Deposit type[2]	Production, grade/ tonnage, and/or analytical data[3]
204 T. 22 N. R. 52 W.	American Creek (O) [I0052]	Au Placer	Visible gold in heavy-mineral-concentrate sample

SUMMARY: Visible gold grains (<1% of sample) found in nonmagnetic, heavy-mineral-concentrate sample taken on American Creek. Mineral occurrences on Mosquito Mountain could potentially have contributed to this placer accumulation. **REFERENCES:** Bennett and others, 1988; this report.

205 T. 22 N. R. 49 W.	Crooked Creek and Omega Gulch (M)	Au, Ag Placer	This part of Crooked Creek produced 89.4 kg (2,873 oz) Au and 7.87 kg (253 oz) Ag prior to 1955. Omega Gulch produced 189 kg (6,089 oz) Au and 0.3 kg (10 oz) Ag from 1911 to 1939

SUMMARY: Placer deposits in modern Crooked Creek drainage below Omega Gulch and above Anaconda Creek explored and developed around 1910. Little information available; U.S. mint record production quoted above also might include production from Donlin Creek (no. 195). Mint records indicate Omega Gulch mined between 1911 and 1939. **REFERENCES:** Maddren, 1915; Cady and others, 1955; Bundtzen and others, 1987; this report.

206 T. 22 N. R. 47 W.	Unnamed (A) [85AAi646]	Ag (Cu) Deposit type uncertain	Sample contains 2 ppm Ag and 100 ppm Cu

SUMMARY: Grab sample of lithic sandstone of Kuskokwim Group contains 2 ppm Ag and 100 ppm Cu; Hg was not analyzed. No igneous rocks nearby. **REFERENCES:** McGimsey and others, 1988; this report.

Table 2. *List of deposit types/models used to describe the metallic mineral resources of Iditarod quadrangle*

Number	Deposit Model or Type	Reference
Model 1	Peraluminous granite-porphyry-hosted gold-polymetallic	Bundtzen and Miller (1997)
Model 2	Plutonic-hosted copper-gold-polymetallic stockwork and vein	Cox (1986b); Vila and Sillitoe (1991); Bundtzen and Miller (1997)
Model 3	Plutonic-related, boron-enriched, silver-tin-polymetallic	Reed (1986); Togashi (1986); Bundtzen and Miller (1997)
Model 4	Epithermal mercury-antimony (gold)	Rytuba (1986); Kuznetsov 1974); (Babkin (1975)
Model 5	Volcanic-hosted precious and other metals	Berger (1986); Mosier and others (1986a, b)
Model 6	Mafic-ultramafic related Cr-Ni-Co	Albers (1986); Page (1986)
Model 7	Heavy-mineral placer	Yeend (1986)

Table 3. *Definitions of resource assessment terms used in this report (adapted from Goudarzi, 1984; and Hansen, 1991, p. 96–97)*

Mineral resource potential

High:

Areas where (1) geologic, geochemical, and geophysical characteristics indicate a favorable environment for resource occurrence, (2) data indicate a high degree of likelihood for resource accumulation, (3) characteristics of a defined mineral deposit type are present, and (4) data indicate that minerals have concentrated in at least part of the area

Moderate:

Areas where (1) geologic, geochemical, and geophysical characteristics indicate a favorable environment for resource occurrence, (2) data indicate a reasonable likelihood of resource accumulation, and (3) characteristics of a defined mineral deposit type are well enough expressed for the ground to be considered favorable

Low:

Areas where geologic, geochemical, and geophysical characteristics define environments in which the existence of resources is unlikely

Unknown:

Areas where information is inadequate to assign high, moderate, or low level of potential

Levels of certainty

Level B:

Available information only suggests the level of mineral resource potential; used where the general geologic environment is known, but key information may be missing

Level C:

Available information gives a good indication of the level of mineral resource potential; used where the geologic environment is clearly defined, but data is inadequate to determine that minerals were forming (or not)

Level D:

Available information clearly defines the level of mineral resource potential; used where the geologic environment is clearly defined, it can be ascertained that minerals were forming (or not), and the mineral deposit type and indicative characteristics are well understood

Table 4. *Estimate of number of undiscovered deposits in the Iditarod quadrangle by deposit type*

Deposit Model[1]	Minimum deposit size	Median estimtate of undiscovered deposits at various confidence limits		
		90 percent	50 percent	10 percent
Model 1—Peraluminous granite-porphyry-hosted hosted gold-polymetallic	155 kg (5,000 oz) gold	3	5	10
Model 2—Plutonic-hosted copper-gold-polymetallic stockwork and vein	155 kg (5,000 oz) gold	3	5	10
Model 3—Plutonic-related, boron-enriched, silver-tin-polymetallic	175,000 t (193,000 tons)	8	15	30
Model 4—Epithermal mercury-antimony (gold)	3,450 kg (100 flasks) of mercury	6	15	30

[1]Refers to models list in table 2

Table 5. *Characteristics of lode deposit resource areas*

[Deposit models from table 2. Rank of mineral resource potential: H, high; M, moderate; L, low. Levels of certainty: B, C, D, are listed in table 3]

Resource area	Deposit model	Rank/ certainty	Map unit(s)	Mines	Prospects	Occur-rences	Rock anomalies	Rock	Moss	Stream sediment	Heavy-mineral concentrate	Ore minerals in concentrate
Peraluminous granite-porphyry-hosted gold-polymetallic deposit type												
1a	1	H/D	TKgp, Kks	1-lode 6-placer	3-lode	1-lode	2-lode	Ag, As, Au, Sb (Hg)	As, Sb	Ag, As, Cu, Hg, Pb	Pb, Sn	cinnabar, gold
1b	1	H/D	TKgp, Kks	1-placer	2-lode	0	1-lode	Ag, Au, Sb (Hg)	As	As, Au, Hg (Ag)	B, Zn	cassiterite, cinnabar, scheelite, stibnite
1c	1	H/C	TKgp, Kks	3-placer	0	3-lode	1-lode	Ag, Au, As, Sb, Sn (Hg)	Sb	Ag, As, Au	Sn	cassiterite, scheelite
1d	1	H/D	TKgp, Kks	7-placer	2-lode	4-lode	9-lode	Ag, Au, As, Hg, Sb	As, Sb	Ag, As, Au, Hg	Sn, W	cassiterite, cinnabar, scheelite, sphalerite
Plutonic-hosted copper-gold-polymetallic stockwork and vein deposit type												
2a	2 3	H/C M/C	TKm, hornfels	0	1-lode	1-placer	0	Au, Hg (Ag, As)	As	Au, Hg, Zn	W	cinnabar, gold, scheelite
2b	2 3	H/D M/C	TKm, TKil, Kit, hornfels	2-placer	1-lode 1-placer	1-lode 3-placer	4-lode 1-placer	Ag, Au, Hg (As, Cu, Pb, Sb)	Sb	As, Au, Hg	Ag, Au, B, Mo, Pb, Sb, Sn, W	cassiterite, chalcopyrite, cinnabar, gold, scheelite
2c	2 3	M/B	TKm, hornfels M/B	0	0	0	1-lode	Ag (As, Zn)	none collected	none collected	none collected	none collected
2d	2 3	H/D M/C	TKm, TKil, hornfels	1-lode 9-placer	6-lode	1-lode	0	Ag, As, Au, B, Hg, Sb (Cu, Pb, W, Zn)	As, Sb	Ag, As, Au, Cu, Hg	Ag, As, Au, Bi, Sb, W	cinnabar, gold, scheelite
2e	2 3	H/C M/B	Kka, hornfels	0	0	1-lode 1-placer	6-lode	Ag, Zn (As, Bi, Cu, Hg, Sb)	none detected	Hg	Ag, Au, Bi	gold
Plutonic-related, boron-enriched silver-tin-polymetallic deposit type												
3a	3 2	H/D M/C	TKm, TKil, Kit, hornfels	0	3-lode	6-lode	2-lode 1-placer	Ag, B, Cu,	Ag, As, Sb Sb, Sn, Zn (As, Au, Pb)	Ag, As, Au, B, Cu, Hg, Mo, Pb, Sn, Zn	Ag, Au, B, Bi, Cu, Pb, Sn, W	none detected
3b	3 2	H/C M/C	TKm, TKil, hornfels	0	0	1-lode	1-lode	Ag, Cu, Zn (Au)	none	As, Au detected	Mo, Pb, Sn, W	none detected

Table 5. *Characteristics of lode deposit resource areas—continued*

[Deposit models from table 2. Rank of mineral resource potential: H, high; M, moderate; L, low. Levels of certainty: B, C, D, are listed in table 3]

Resource area	Deposit model	Rank/ certainty	Map unit(s)	Mines	Prospects	Occur-rences	Rock anomalies	Rock	Moss	Stream sediment	Heavy-mineral concentrate	Ore minerals in concentrate
3c	3 2	H/D M/C	TKm, TKil, TKgp	0	1-lode	1-placer	1-lode	Ag, As (Cu, Hg)	Ag, As	Ag, As, Bi, Pb, Sn	Ag, As, B, Bi, Pb, Sb	cassiterite
3d	3 2	H/D M/C	TKm, TKil, Kit, Kks, hornfels	0	0	4-lode	2-lode	Ag, As, B, Cu, Hg, Sb, Zn (Au)	As	As, Mo	B, Zn	cassiterite, scheelite
3e	3 1	H/C M/C	TKgp, hornfels	0	0	4-lode	0	Ag, As, Au, B, Pb, Sb, Sn, Zn (Cu)	As	Ag, As, Sn	Ag, Au, Bi, Sb, Sn, W	cassiterite
3f	3 2	M/B M/B	TKm, hornfels	0	0	0	1-lode	As, Sb, Sn	none collected	Ag	none detected	none detected
3g	3 2	H/D M/C	hornfels, faults	0	0	2-lode	4-lode	Ag, As, B, Cu, Sn, Zn (Au, Sb)	none detected	Ag, As, Au, Cu, Sn, Zn	Ag, Au, B, Sn, W	cinnabar, scheelite
3h	3	H/B	TKm	0	0	1-lode	2-lode	Ag, B, Cu, Zn (Sn)	As	As	none detected	none detected
3i	3 2	H/D M/C	TKm, TKil, hornfels	0	0	4-lode 1-placer	2-lode	Ag, As, Pb, Sb, Sn (Au, Bi, Hg)	Ag, As, Sb	Ag, As, Au, B, Hg, Pb	Ag, Au, B, Bi, Pb, Sb, W	cassiterite, cinnabar, gold
Epithermal mercury-antimony (gold) deposit type												
4a	4	H/C	Kkq, TKd	0	0	1-placer	2-lode	Hg, Sb, As	none detected	Ag, Au, Hg, Zn	Cu, Pb, Sb, W, Zn	cinnabar, gold, scheelite, sphalerite
4b	4	H/D	Kks, Kkq, TKil, Kit, TKm, TKgp, TKd, TRMc	2-placer	0	1-lode 3-placer	9-lode	Hg, Au, As (Ag)	Sb	Ag, As, Hg, Sn	Ag, Au, B, Sb, Pb, W	cinnabar, chalcopyrite, gold, scheelite
4c	4 1	H/C M/C	Kks, TKgp	0	0	0	2-lode	Hg (As, Au, Ag)	none detected	Au	Cu, Sn, Zn	cinnabar
4d	4 1	H/C M/B	Kks, TKgp	0	0	1-lode	3-lode	Hg, Sb, As	As	none detected	Ag, Sb, Sn, W	cassiterite, cinnabar, scheelite
4e	4	H/D	Kks, Kkq, TKd, TKgp, TKm, TKil, hornfels	1-lode 8-placer	7-lode	2-lode	4-lode	Hg, Sb, Au, As (Ag)	As, Sb	Ag, As, Au, Hg, Zn	Ag, As, Au, Pb, Sb, Sn, W	cassiterite, cinnabar, gold, scheelite
4f	4	H/C	Kks, TKm,	0	0	3-lode	3-lode	Hg, As (Sb)	As	As, Hg	W	cinnabar, scheelite

Table 5. *Characteristics of lode deposit resource areas—continued*

[Deposit models from table 2. Rank of mineral resource potential: H, high; M, moderate; L, low. Levels of certainty: B, C, D, are listed in table 3]

Resource area	Deposit model	Rank/ certainty	Map unit(s)	Mines	Prospects	Occur- rences	Rock anomalies	Rock	Moss	Stream sediment	Heavy- mineral concentrate	Ore minerals in concentrate
			TKil, Kit									
4g	4 1	H/B M/B	Kks, TKgp	0	0	0	1-lode	Ag	none detected	Ag, Au, Hg	Ag, Cu, Sn, W, Zn	cassiterite, cinnabar, scheelite
4h	4 1	H/D M/C	Kks, TKgp, TKd	0	1-lode	0-lode 1-placer	7-lode	Hg, Sb, As (Au)	none detected	Ag, Au	Hg	cassiterite, cinnabar, gold, sphalerite
4i	4	M/B	Kks	0	0	0	2-lode	Sb, Hg, As	Sb	Ag, Au	Ag, Pb, Sb, Sn	none detected
4j	4	H/D	Kks, Kkq, TKil, Kit, TKd	1-lode 1-placer	1-lode	1-lode	4-lode	Hg, Sb, As (Au, W)	Ag	Hg	Ag, Au, B, W	cinnabar, gold, scheelite
4k	4	M/C	Kks	0	0	0	6-lode	Hg, Sb, Ag, As	none detected	Ag, Hg	Sn	cinnabar, sphalerite
4l	4	M/C	Kks, TKgp	0	0	2-lode	2-lode	Hg, Sb, As (Au)	none detected	Ag, Hg	Sn	cinnabar
4m	4	M/C	Kks, TKd, TKgp				6-lode	Hg, Sb, As (Au)	Ag, As, Sb	Ag, As, Au, Hg, Zn	Ag, Au, Cu, Pb, Sb, Sn, W, Zn	cinnabar, galena, scheelite
4n	4	L/C	Kks	0	0	0	0	none detected	Sb	Au, Hg	Ag, Au, Sn, W, Zn	cassiterite, cinnabar, scheelite
Volcanic-hosted precious and other metals deposit type												
5a	5	H/B	TKy	0	0	0	5-lode	Ag, Pb, Sn (Nb)	none detected	Ag, As	Ag, Au, Sn	none detected
5b	5	M/B	TKy	0	0	0	8-lode	Hg, Sb, Au, As (Ag)	Ag	Ag, As, Au	Cu, Sb, W	cassiterite, chalcopyrite, cinnabar, galena, scheelite
Mafic-ultramafic related Cr-Ni-Co deposit type												
6	6	L/C	Jdr	0	0	0	1-lode	Ag (Cr, Ni)	Ag	Cr	Ag, Au	cinnabar, scheelite

Table 6. *Characteristics of heavy-mineral placer deposit resource areas*

[M, number of mines; P, number of prospects; O, number of occurrences; Rank of mineral resource potential: H, high ..; Levels of certainty: B, C, D (see table 3); ss, stream-sediment sample; hmc, heavy-mineral-concentrate sample; mv, microscopically visible]

Resource area	Rank/ certainty	Main commodity	Placer			Supportive anomalies	
			M	P	O	Bedrock	Drainage basins
7a—Ganes-Yankee Creeks	H/D	Gold	6	0	0	Ag, Au (As)	ss-Ag, hmc-mu gold
7b—Carl Creek	H/C	Gold	0	0	1	Ag	ss-Ag, As; hmc-Ag, As, Pb
7c—Moore Creek area	H/D	Gold	2	1	3	Ag, Au (Hg)	ss-Au; hmc-Ag, Au, Mo, W, mv gold
7d—Iditarod-Flat area	H/D	Gold	11	0	0	Ag, Au	ss-Ag, Au; hmc-Ag, As, Au, Sb, W, mv gold
7e—Little Waldren Fork	H/B	Gold	0	0	0	none collected	ss-Ag, Au, Zn; hmc-Ag, Au, Sn, W
7f—Granite and Munther Creek	H/D	Gold	1	1	0	Ag, Au, Cu, Sb	ss-Au
7g—Julian Creek area	H/D	Gold	3	0	0	Ag, Au, As, Sb	ss-Ag, Hg
7h—American Creek	H/C	Gold	0	0	1	Ag, As, Hg, Sb, Zn	hmc-Ag, Au, Bi, mv gold
7i—Little Creek	H/C	Gold	1	0	1	none detected	ss-Hg; hmc-Ag, Au, mv gold
7j—Return Creek	H/D	Cinnabar	0	0	1	As, Hg, Sb (Ag, Au)	ss-Hg; hmc-mv cinnabar
7k—Donlin Creek area	H/D	Gold	7	0	0	Ag, As, Au, Hg, Sb	ss-Ag, Au, As, Hg; hmc-Sn

Table 7. *Summary of land tracts including contained resource areas, commodities, and deposit types (by model)*

Land tract[1]	Resource areas contained[2]	Commodities of interest	Deposit types contained[3, 4]						
			Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
VH-1	1b, 3g, 3h, 3i, 4i, 7e, 7f	Au, Ag, Sn, Hg, Sb	X	X	X	X			X
VH-2	2d, 3e, 3f, 4e, 7d	Au, Ag, W, Sn, Hg	X	X	X	X			X
VH-3	3c, 4d, 7b	Au, Ag, Hg (Sn, W)	X	X	X	X			X
VH-4	2b, 4b, 7c	Au, Ag, Pb, Hg, W		X	X	X			X
VH-5	1d, 7k	Au, Ag, Sb, Hg, Sn, W	X			X			X
VH-6	1a, 7a	Au, Ag, Hg	X			X			X
VH-7	1c, 4l, 7g	Au, Ag, Hg, Sb	X			X			X
VH-8	2c, 4c	Ag, Au, Hg, Zn	X	X	X	X			
VH-9	2e, 7h	Ag, Au, Hg, Sb		X	X	X			X
H-1	3d, 4f	Ag, Au, Hg, Sb, W		X	X	X			
H-2	4j, 7i, 7j	Au, Hg, Sb, Ag, W				X			X
H-3	3a	Ag, Cu, Sn, Au, Pb, Hg, W		X	X	X			
H-4	2a	Au, Hg (Ag, W)		X	X	X			
H-5	3b	Ag, Zn, Cu (Au, Sn)		X	X	X			
H-6	4h	Hg, Sb (Au)	X			X			
H-7	4g	Ag, Hg (Au)	X			X			
H-8	5a	Pb, Sn, Ag (Au)					X		
H-9	4a	Hg, Sb (Au)				X			
H-10	4k (part of 4m)	Ag, Hg, Sb				X			
M-1	5b	Ag, Au, Hg, Sb					X		
M-2	4m	Hg, Sb (Au)				X			
L-1	4n	Hg				X			
L-2	6	Cr						X	

[1] Land tracts refer to figure 3

[2] Resource areas refer to map B

[3] Deposit models: 1—Peraluminous granite-porphyry-hosted gold-polymetallic, 2—Plutonic-hosted copper-gold-polymetallic stockwork and vein, 3—Plutonic-related, boron-enriched, silver-tin-polymetallic, 4—Epithermal mercury-antimony (gold), 5—Volcanic-hosted precious and other metals, 6—Mafic-ultramafic related Cr-Ni-Co, and 7—Heavy-mineral placer

[4] X means model type represented

Table 8. *Correlation of thermal maturity indicators to hydrocarbon generation*

[Modified from Heroux and others (1979) and Johnsson and others (1993)]

Vitrinite Reflectance (R_o, %)	Thermal Alteration Index (TAI)	Hydrocarbon Generation[1]	Thermal Maturity Categories[2]
		Undermature	U Undermature
0.6	2.6	*Onset of oil generation*	
		Mature	M-I Mature I
1.3	3.0	*Limit of oil generation*	
		Limit of oil preservation	M-II Mature II
2.0	3.7	*Limit of wet gas preservation*	
		Overmature	O Overnature
3.5	4.5		
			S Supernature
5.0			
			Ig-M Igneous-Metamorphic

[1]Poole and Claypool (1984)
[2]Johnsson and others (1993)

Table 9. *Vitrinite reflectance in Kuskokwim Group rocks from the Iditarod quadrangle*

[Map number refers to figure 5. Map unit refers to geologic base map: Kkq rocks represent shallow marine to non-marine facies and Kks rocks represent marine turbidite facies. Samples analyzed by Mark Pawlewicz, U.S. Geological Survey, Denver. Levels of thermal maturity (from Johnsson and others, 1993), are discussed in the text and abbreviated as follows: M–I, mature I; M–II, mature II; O, overmature; S, supermature]

Map number	Sample number	Vitrinite Reflectance (R_o)(percent) Mean	Min	Max	Map unit	Rock type	Analyst comments	Level of thermal maturity
1	84BT271	1.89 ± 0.08	1.73	2.07	Kkq	Mudstone	Very good sample; abundant consistent vitrinite	M–II
2	84AM249A	1.25 ± 0.06	1.14	1.38	Kkq	Mudstone	Good sample; some recycled pieces	M–I
3	83BT12	1.84 ± 0.13	1.68	2.18	Kkq	Shale	Difficult sample; multiple populations	M–II
4	83BT18	3.89 ± 0.40	2.70	4.78	Kkq	Shale	All high rank material, but not much	S
5	84AM256A	3.39 ± 0.33	2.81	3.99	Kkq	Mudstone	All high reflectance	O
6	83BT32	3.85 ± 0.63	2.92	4.92	Kks	Shale	Poor sample; several populations; could be contaminated	S
7	83BT82	0.83 ± 0.14	0.65	1.06	Kks	Mudstone	Difficult sample; multiple populations	M–I
8	83BT86	0.94 ± 0.08	0.84	1.12	Kks	Mudstone	Difficult sample; multiple populations	M–I
9	83BT56	0.73 ± 0.06	0.61	0.86	Kks	Mudstone	Difficult sample; two distinct populations; one much higher than the one measured	M–I
10	83BT58	2.29 ± 0.26	1.84	2.70	Kks	Mudstone	Fair sample; two distinct populations; low rank material considered contamination	O
11	83GL61	1.22 ± 0.18	0.97	1.44	Kks	Mudstone	Fair sample; vitrinite common, but not consistent	M–I
12	83BT67	4.67 ± 0.27	4.08	5.13	Kks	Siltstone	Fair sample	S
13	83BT65	1.27 ± 0.13	1.10	1.54	Kks	Mudstone	Difficult sample; wide variety of organics; no dominant population	M–I
14	83MSL44	2.82 ± 0.25	2.46	3.33	Kks	Mudstone	Two populations; measured the one showing lowest reflectance	O
15	83BT47	3.81 ± 0.63	3.00	4.75	Kks	Shale	Fair sample; possible contamination	S
16	83GL72	1.67 ± 0.13	1.48	1.85	Kks	Mudstone	Nearly barren sample	M–II
17	84AM166E	2.49 ± 0.17	2.30	2.77	Kks	Mudstone	Fair sample; variable vitrinite; possible contamination	O
18	84AM129A	2.15 ± 0.12	1.95	2.37	Kks	Mudstone	Abundant organics and fairly consistent	O
19	84AAi532C	1.36 ± 0.12	1.14	1.49	Kks	Mudstone	Multiple populations, but no dominant group; possible contamination	M–II
20	84AM5C	4.48 ± 0.34	3.83	4.99	Kks	Mudstone	Fair sample; all very high rank material	S
21	84BT99	4.29 ± 0.39	3.63	4.95	Kks	Shale	Fair sample; all very high rank material	S
22	84BT283	4.72 ± 0.21	4.34	5.00	Kks	Mudstone	Good sample; mostly very high rank material; possible contamination	S
23	84BT79	4.72 ± 0.22	4.37	5.08	Kks	Mudstone	Fair sample, but multiple populations	S
24	84AAi529	2.31 ± 0.17	2.01	2.65	Kks	Mudstone	All high rank material	O
25	84BT250	3.90 ± 0.20	3.52	4.30	Kks	Shale	All high rank material	S
26	84BT248	2.86 ± 0.23	2.51	3.48	Kks	Mudstone	All high reflectance	O

Table 10. *Thermal alteration index (TAI) values in Kuskokwim Group rocks from the Iditarod quadrangle*

[Map letter refers to figure 5. Map unit refers to geologic base map: Kkq rocks represent shallow marine to non-marine facies and Kks rocks represent marine turbidite facies. Levels of thermal maturity (from Johnsson and others, 1993), are discussed in the text and abbreviated as follows: U, undermature; M–II, mature II. Samples analyzed by Micropaleo Consultants, Inc.]

Map letter	Sample number	TAI	Map unit	Rock type	Level of thermal maturity
A	86AM38B	3.0	Kkq	Silty shale	M–II
B	86AM132A	3.0?	Kkq	Very fine grained sandstone	M–II?
C	86AM364A	3.0?	Kkq	Silty shale	M–II?
D	84BT239	3.5	Kkq	Fine-grained sandstone; contains plant debris	M–II
E	86BT12	3.5	Kkq	Siltstone	M–II
F	86AM351B	3.0	Kks	Sandstone and siltstone; contains plant debris	M–II
G	86AM182A	3.0	Kks	Siltstone and shale	M–II
H	86AM16B	3.0?	Kks	Shale	M–II?
I	85BT124	3.6	Kkq	Shale	M–II
J	86AM257A	3.0	Kkq	Fine-grained sandstone	M–II
K	85BT130	2.5?	Kks	Fine-grained sandstone; contains plant debris	U?
L	86AM229A	3.0?	Kks	Siltstone and shale	M–II?