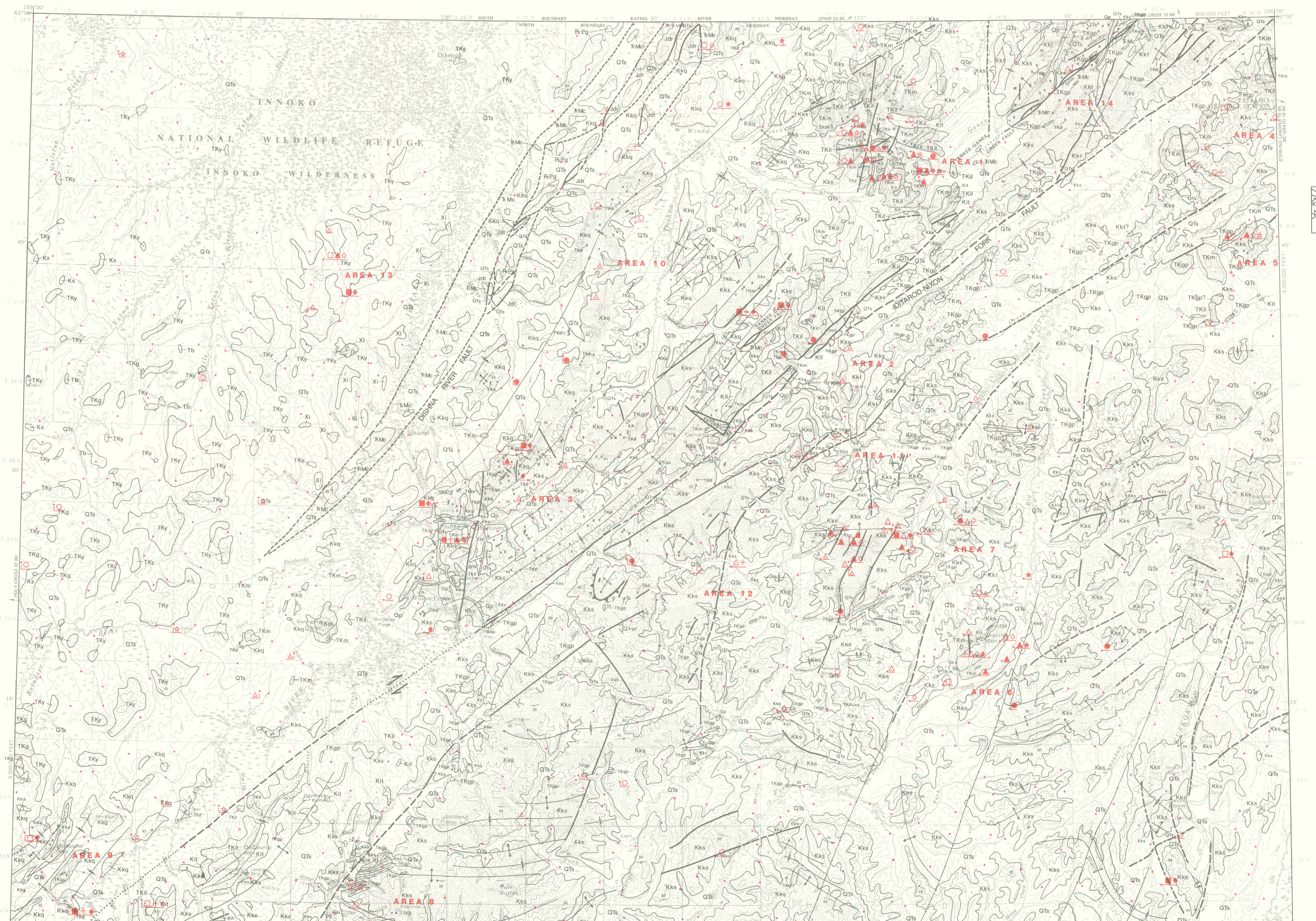
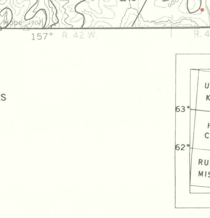


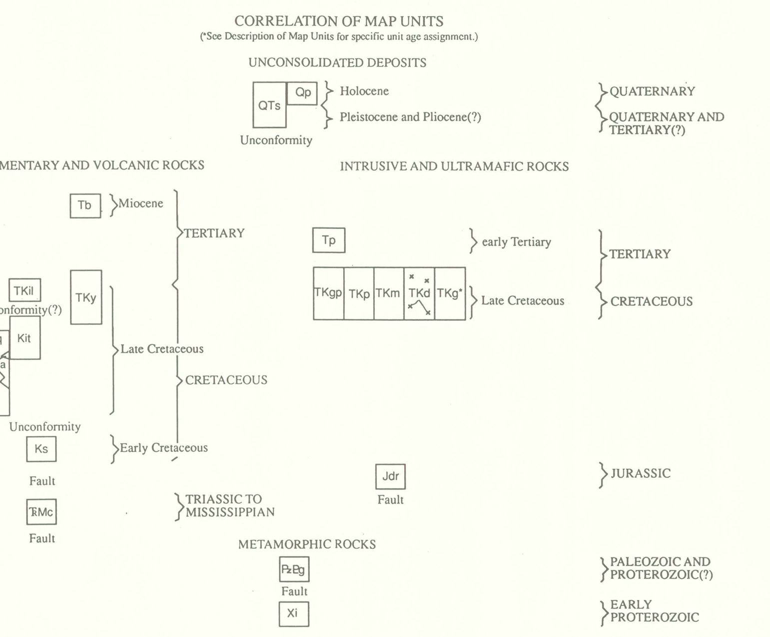
Base from U.S. Geological Survey, 1956
Geologic base from Miller and Bundtzen, 1994

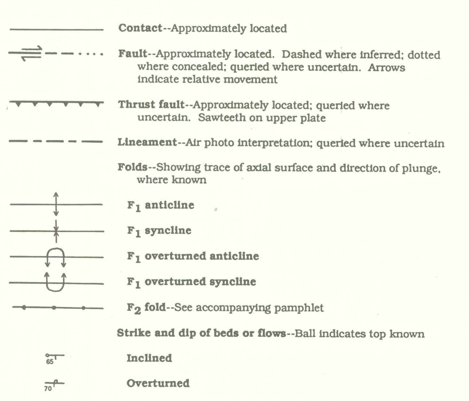
Manuscript approved for publication, July 22, 1997

SCALE 1:250 000

CONTOUR INTERVAL 200 FEET







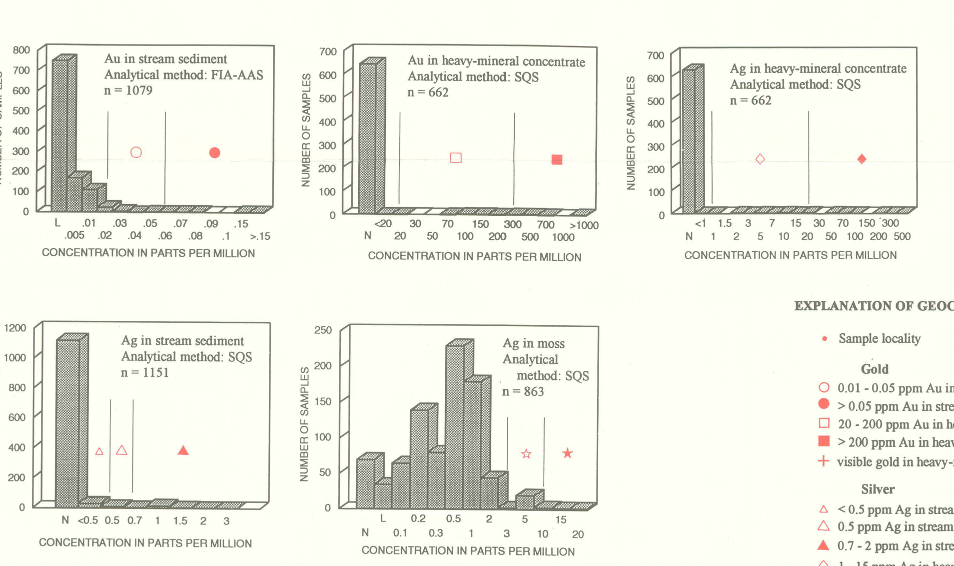


Figure 2. Histograms showing frequency distribution of Au and Ag in various sample media. Gold in the mineralogy samples of heavy-mineral concentrate is not shown because only 9 samples contained visible gold. Symbols on histograms show anomaly selections and are the same as those on the map. [N, not detected at the lower limit of determination; L, detected but less than the lower limit of determination; n, number of samples analyzed; SQS, semiquantitative spectrography; FIA-AAS, flow injection analysis-atomic absorption spectrophotometry.]

EXPLANATION OF GEOCHEMICAL MAP SYMBOLS

• Sample locality

Gold
- ○ 0.01 - 0.05 ppm Au in stream sediment
- ● > 0.05 ppm Au in stream sediment
- □ 20 - 200 ppm Au in heavy-mineral concentrate
- ■ > 200 ppm Au in heavy-mineral concentrate
- + visible gold in heavy-mineral concentrate

Silver
- △ < 0.5 ppm Ag in stream sediment[1]
- △ 0.5 ppm Ag in stream sediment
- ▲ 0.7 - 2 ppm Ag in stream sediment
- ◇ 1 - 15 ppm Ag in heavy-mineral concentrate
- ◆ 20 - 500 ppm Ag in heavy-mineral concentrate
- ☆ 3 - 5 ppm Ag in aquatic moss
- ★ ≥ 7 ppm Ag in aquatic moss

[1]0.5 ppm Ag in stream-sediment samples determined by SQS that were confirmed to contain 0.1 - 0.5 ppm by AAS.

Table 1. Summary of data used for Au-Ag anomaly map

[All values shown are parts per million (ppm), except detection ratio, *N, L, G*, and mineralogy results (based on visual percentage estimates of gold using a binocular microscope). Detection ratio is the number of unqualified values divided by the total number of samples analyzed. *N* is the number of samples in which concentrations were not detected at the lower limit of determination. *L* is the number of samples in which concentrations were reported as observable but were less than the lower limit of determination. *G* is the number of samples in which concentrations were detected, but were greater than the upper limit of determination. N, not detected at the concentration shown; L, detected but less than the concentration shown; G, greater than the concentration shown; n.d., no gold identified; --, not applicable; SQS, semiquantitative spectrography; FIA-AAS, flow injection analysis-atomic absorption spectrophotometry]

Element	Sample type	Detection ratio	*N*	*L*	*G*	Minimum	Percentiles 50th	90th	95th	98th	Maximum	Selected anomalous concentration
Au	Stream sediment (FIA-AAS)	0.30	0	758	0	0.005L	0.005L	0.006	0.01	0.05	1.55	0.01
	Heavy-mineral concentrate (SQS)	0.02	645	1	3	20N	20N	20N	20N	70	1000G	20
	Mineralogy (gold)	0.01	790	--	--	n.d.	n.d.	n.d.	n.d.	n.d.	1%	any visible gold
Ag	Stream sediment (SQS)	0.03	1084	30	0	0.5N	0.5N	0.5N	0.5L	0.5	3	0.5L[1]
	Heavy-mineral concentrate (SQS)	0.05	629	1	0	1N	1N	1N	1N	20	500	1
	Moss (SQS)	0.88	68	32	0	0.1N	0.5	1.5	2	3	20	3

[1]Only stream-sediment samples that contain less than 0.5 ppm Ag as determined by SQS and that were confirmed to contain 0.1-0.5 ppm Ag as determined by atomic absorption analysis were used in this report.

DESCRIPTION OF MAP UNITS

(Geology is shown in gray on the map)

UNCONSOLIDATED DEPOSITS

Qp **Placer mine tailings (Holocene)**—Symmetrical to irregular piles of artificially water worked, sorted gravel and in situ slab rock derived from bedrock. Fine silt and sand fractions partially removed during placer mining process. Tailings in most drainages range from 1 to 4 m thick

QTs **Surficial deposits (Holocene to Pliocene?)**—Unconsolidated fluvial, terrace, colluvial, glacial, and eolian deposits usually covered by vegetation. Surficial deposits generally range from 3 to 20 m thick and exhibit at least some degree of permafrost, depending on slope orientation and composition. Glacial deposits occur mainly in the Beaver Mountains and nearby highlands. Age of unit is primarily Pleistocene and Holocene; some Pliocene deposits may also be present locally

SEDIMENTARY AND VOLCANIC ROCKS

Tb **Basaltic andesite (Miocene)**—Scattered exposures of very fine grained to aphanitic, dark- to medium-gray, locally vesicular, augite basaltic andesite in west-central part of study area. Unit is undeformed and unaltered except for local devitrification

TKy **Volcanic rocks of Yetna River area (early Tertiary and Late Cretaceous)**—Chiefly subaerial lava flows of andesite, dacite, rhyolite, and minor basalt and subordinate welded to nonwelded rhyolitic to andesitic ash-flow tuffs. Outcrops and rubble found mainly in stream bluffs and occasionally on rounded hill tops as tors; columnar-jointed andesite is present near VABM Reindeer (T. 28 N., R. 50 W.). Unit thickness roughly estimated at 500 m

Iditarod Volcanics (early Tertiary and Late Cretaceous)—Dominantly subaerial volcanic rocks consisting of a heterogeneous basal unit (tuff, altered flows, and volcaniclastic rocks) overlain by mafic and intermediate lava flows. Iditarod Volcanics are 500–600 m thick and overlie sedimentary rocks of Kuskokwim Group. In this area, divided into:

TKil **Andesitic to basaltic subaerial lava flows and mafic volcanic breccia (early Tertiary and Late Cretaceous)**—Subaerial, locally columnar jointed, aphanitic to porphyritic, olivine-clinopyroxene basaltic andesite, clinopyroxene andesite, and minor dacite; volcanic breccia locally interfingers with flow rocks. Unit is generally resistant forming prominent blocky outcrops and tors near ridgetops. Unit is roughly 150 to 250 m thick and contact with underlying unit **Kit** may be disconformable.

Kit **Tuff, volcanic breccia, altered andesitic to dacitic flows, and volcaniclastic sandstone (Late Cretaceous)**—Heterogeneous assemblage characterized by tuff (lithic, crystal, and water-laid) and altered intermediate lava flows; locally includes volcanic breccia, volcaniclastic sandstone, and lahar deposits. Total unit thickness estimated to be around 350 m. Unit may be correlative with unit **Kka**

Kuskokwim Group (Late Cretaceous; Campanian to Cenomanian)—In map area, the Kuskokwim Group consists predominantly of sedimentary rocks but also has minor, interbedded volcanic tuff and flow rocks primarily in upper part of section. The sedimentary rocks represent turbidite fan, foreslope, shallow-marine, and shelf facies deposited into a Late Cretaceous basin. The Kuskokwim Group is estimated to average 2,200 m in thickness northeast of the Iditarod-Nixon Fork Fault, but may be as much as 5,000 m thick southeast of the fault. In this area, divided into:

Kkq **Quartzose sandstone and siltstone (Late Cretaceous; Campanian to Turonian?)**—Quartzose sublithic sandstone, conglomerate, siltstone, and siliceous shale representing shallow-marine and locally non-marine facies. Unit is estimated to be 600 m thick and basal part interfingers with deeper water facies rocks of unit **Kks**. Lower age limit of unit is speculated to be Turonian based on interfingering with unit **Kks**. Upper age limit at least as young as Campanian but not younger than Paleocene.

Kks **Sandstone, siltstone, shale, and conglomerate (Late Cretaceous; Campanian? to Cenomanian)**—Thick assemblage of fine- to coarse-grained lithic sandstone, micaceous siltstone, shale, and minor chert-pebble conglomerate that forms the major part of the Kuskokwim Group in the map area. Structures and compositions indicate that unit **Kks** was primarily deposited by turbidity currents. Total thickness of unit is poorly known but may be as much as 5,000 m. Upper age limit is not clearly defined but must be older than the youngest part of unit **Kkq**, which generally overlies unit **Kks**

Kkt **Volcanic tuff and agglomerate (Late Cretaceous)**—Heterogeneous assemblage of tuff, agglomerate, cherty tuff, and locally minor sandstone that crops out in isolated areas. Lithologically and petrographically identical to unit **Kit**; the two units are distinguished only by their associated rocks. Unit **Kkt** is apparently interbedded with sedimentary rocks (**Kks**) of Kuskokwim Group, whereas unit **Kit** is spatially associated with massive flow rocks of unit **TKil** but could either overlie, or locally interfinger with, the Kuskokwim Group. Unit assigned a Late Cretaceous age based on apparent interbedded relation with unit **Kks**

Kka **Altered andesite flows, tuffs, and sills(?) (Late Cretaceous; Campanian)**—Unit crops out in the Mosquito Mountain area (southwestern part of the quadrangle) and consists of 1- to 5-m-thick layers of intermediate igneous rocks apparently interbedded with unit **Kkq**. The flows and tuffs are andesitic in composition and have 15–30 percent phenocrysts of plagioclase, oxidized amphibole, clinopyroxene, magnetite, and local biotite in a groundmass of felted plagioclase laths, opaque oxides, and accessory apatite. Tuffs characterized by broken crystals and abundant andesite lithic fragments

Kkv **Volcanic flow(s) and tuff (Late Cretaceous)**—Hornblende-clinopyroxene andesitic volcanic flow(s) and chlorite-, calcite-altered tuff. Unit poorly exposed and found only in one area (T. 27 N., R. 42 W.); estimated to be no more than 20 m thick. Assigned a Late Cretaceous age based on apparent interbedded relation with unit **Kks**

Ks **Sandstone and siltstone (Early Cretaceous)**—Medium-grained to very fine grained sandstone, tuffaceous sandstone, and siltstone exposed only as colluvial chips in western part of map area

TRMc **Chert, volcanic rocks, metasandstone, and limestone (Triassic to Mississippian)**—Radiolarian chert (partly to wholly recrystallized), clinopyroxene basalt to basaltic andesite, lithic tuff, water-laid tuff, metasiltstone, and minor fossiliferous shallow-water limestone. Unit primarily exposed along the Dishna River Fault Zone in the north-central part of the map area; however, six small occurrences, interpreted as fault slivers, are scattered throughout the northeastern part of the quadrangle. Prehnite-pumpellyite facies metamorphism is indicated by presence of secondary prehnite, chlorite, clinozoisite, and pumpellyite in the volcanic rocks. Unit is correlative with the Innoko terrane of Jones and others (1987) and Patton and others (1989b)

INTRUSIVE AND ULTRAMAFIC ROCKS

Tp **Porphyritic granodiorite plug (early Tertiary)**—Unit consists of one exposure in T. 28 N., R. 46 W. Small granodiorite body containing abundant phenocrysts of hornblende and albitic plagioclase in finer-grained, phaneritic groundmass

TKgp **Hypabyssal granite porphyry dikes, sills, and plugs (early Tertiary and Late Cretaceous)**—Porphyritic to fine-grained phaneritic dikes, sills, and plugs of granitic composition. Phenocrysts of biotite + quartz + plagioclase + sanidine + white mica ± trace garnet compose as much as 5 percent of most dikes and 20 percent of most plugs; sericitic alteration common in groundmass. Biotite generally composes less than 5 percent of the samples, so rocks could be classified as alaskite

TKp **Pilotaxitic dacite-andesite plugs (early Tertiary and Late Cretaceous)**—Three small bodies of subvolcanic dacite to andesite are exposed in the east-central part of the quadrangle. Unit is moderately resistant and morphology of exposures suggests they are hypabyssal intrusive bodies rather than volcanic flows, but they have a distinctive pilotaxitic (flow-oriented) texture to the fine-grained groundmass

TKm **Monzonite, quartz monzonite, syenite, granodiorite, granite, and minor lamprophyre (early Tertiary and Late Cretaceous)**—Small stocks and plutons of fine- to coarse-grained, phaneritic to hypidiomorphic, clinopyroxene-biotite ± olivine monzonite, hornblende-clinopyroxene-biotite quartz monzonite, biotite syenite, biotite-hornblende granodiorite, biotite granite, and rare lamprophyric rocks. Composite intrusive rocks are in part overlain by, and in part intrude coeval volcanic rocks (Iditarod Volcanics)

TKd **Altered intermediate to mafic dikes (early Tertiary and Late Cretaceous)**—Porphyritic biotite-clinopyroxene-plagioclase ± olivine dikes, which are partly to extensively altered to chlorite-calcite-silica assemblages. Original compositions were probably intermediate to mafic. Dikes generally are less than 1 m thick, discontinuous, and usually cannot be traced for more than 10 m. Presence of dike is indicated by "x" on the map for visual emphasis, but extent of actual exposures is exaggerated

TKg **Alkali granite (early Tertiary and Cretaceous)**—Poorly exposed, medium-grained, granophyric alkali granite found as discontinuous rubble cropping out under heavily vegetated cover in the western part of the map area. All rocks of the unit are light colored (color index <7 percent), but the mafic minerals vary locally. In the southwestern part of the quadrangle (T. 24 N., R. 53 W. and T. 25 N., R. 52 W.) mafic minerals consist of alkali amphibole, pyroxene, and biotite, but exposures farther north have biotite (chloritized) only

Jdr **Dishna River mafic and ultramafic rocks (Jurassic)**—Assemblage of poorly exposed mafic and ultramafic rocks in north-central part of quadrangle. Mafic and ultramafic rocks are probably ophiolitic in origin but now occur as isolated, fault-bounded blocks that lie along the Dishna River Fault Zone. Mafic rocks include two-pyroxene gabbronorite, clinopyroxene + hornblende gabbro, hornblende gabbro, and diabase. Ultramafic rocks include harzburgite, minor dunite, and rare pyroxenite, all partially to completely serpentinized. Unit assigned a Jurassic age based on correlation with lithologically similar mafic and ultramafic complexes that lie north of the map area (the Tozitna-Innoko belt described by Patton and others, 1989a)

METAMORPHIC ROCKS

PzPg **Greenschist, pelitic schist, and metagranite (Paleozoic and Proterozoic?)**—Generally poorly exposed, mixed assemblage of greenschist facies metamorphic rocks including mafic meta-igneous rocks, subordinate metasedimentary rocks (pelitic schist, phyllite, calcareous schist, and quartzite), and minor granitic orthogneiss. Mafic schists commonly exhibit secondary mineral assemblages of epidote-chlorite-hornblende/actinolite-albitic plagioclase-quartz ± biotite ± sphene, indicative of middle greenschist facies, but assemblages characteristic of lower and upper greenschist facies also occur. Unit is correlative with rocks of the Ruby terrane as outlined by Jones and others (1987) and Patton and others (1989b), and is therefore assigned the same age. Unit assigned a Proterozoic(?) and Paleozoic age based on correlation with rocks of the Ruby terrane

Xi **Idono Complex (Early Proterozoic)**—Foliated metaplutonic rocks, lesser amphibolite, and minor metasedimentary rocks. Outcrop exposure is limited to a dozen localities; frost-riven rubble is sparse but widespread. The compositionally diverse metaplutonic rocks consist primarily of biotite ± muscovite granitic orthogneiss but also include orthogneisses of tonalite, granodiorite, quartz diorite, and quartz monzonite, minor metagabbro, and rare hornblendite. Texturally, metaplutonic rocks range from slightly foliated varieties to blastomylonitic augen gneiss. Amphibolite varies little in composition and consists of moderately foliated to well-foliated epidote-biotite-hornblende-intermediate plagioclase ± garnet ± sphene. The well-foliated, semipelitic metasedimentary rocks include muscovite-biotite-feldspar-quartz ± garnet ± epidote schists. Metamorphic grade of the Idono Complex is amphibolite facies

STUDIES RELATED TO AMRAP

The U.S. Geological Survey (USGS) is required by the Alaska National Interests Lands Conservation Act (Public Law 96-487, 1980) to survey certain federal lands to determine their mineral potential. Results from the Alaska Mineral Resource Assessment Program (AMRAP) must be made available to the public and be submitted to the President and Congress.

This is one of a series of maps that present geological and geochemical results from the mineral resource assessment study of the Iditarod quadrangle, Alaska. This report shows the distribution of anomalous concentrations of Au and Ag determined from the geochemical analysis of stream-sediment, nonmagnetic heavy-mineral-concentrate, and aquatic-moss samples, as well as visible gold in the nonmagnetic heavy-mineral-concentrate samples, collected from the quadrangle. Other reports in this series on the Iditarod quadrangle include a geologic map (Miller and Bundtzen, 1994), a mineral resource assessment of the quadrangle (Miller and others, in press), a Hg-Sb-As anomaly map (Gray, Folger, and Hageman, 1997), and a Cu-Pb-Zn-Sn-W anomaly map (Gray, Ryder, and Taylor, 1997). The geologic map from Miller and Bundtzen (1994) is used as a base map for interpretations in this study.

INTRODUCTION

During the summers of 1984-86, a reconnaissance geochemical survey was conducted in the Iditarod 1° X 3° quadrangle, Alaska. The quadrangle is bounded by latitudes 62°N and 63°N and by longitudes 156°W and 159°W. The study area is about 6,700 mi^2 (17,350 km^2) in southwestern Alaska and it includes the Beaver Mountains and part of the Kuskokwim Mountains (see map). Part of the Innoko National Wildlife Refuge is in the northwestern corner of the quadrangle. Few roads exist in the quadrangle and access to much of the study area is limited to travel by aircraft or by foot on various trails. Boat access is possible on some larger rivers.

The terrain is dominated by low rolling hills and broad, sediment-filled lowlands. This terrain is best exemplified by the Kuskokwim Mountains in the central part of the quadrangle. Rugged topography characterizes the Beaver Mountains and a few other mountain peaks scattered throughout the quadrangle. The maximum elevation in the quadrangle is 4,055 ft (1,236 m) in the northern Beaver Mountains. Much of the western part of the quadrangle is low and swampy, particularly in the Yetna and Iditarod River basins where the minimum elevation is about 100 ft (30 m). Most of the quadrangle is covered with vegetation that ranges from northern latitude forest to subarctic tundra.

GENERAL GEOLOGY

The map shows the geology of the quadrangle as described by Miller and Bundtzen (1994). The following descriptions are summarized from their work, but additional details of the geology of the quadrangle are given in Miller and Bundtzen (1994). Bedrock of the Iditarod quadrangle can be broadly subdivided into (1) displaced slices of pre-Cretaceous rocks that are found in narrow fault bounded belts, and (2) overlap assemblages of Cretaceous and younger sedimentary, volcanic, and plutonic rocks that constitute about 95 percent of the bedrock in the quadrangle (Miller and Bundtzen, 1994). The overlap assemblages have experienced at least two periods of open to isoclinal folding that includes a well-expressed generally northeast-trending earlier event and a poorly expressed north-trending later event. The Iditarod-Nixon Fork Fault is a major northeast-trending strike-slip fault that bisects the quadrangle. The Dishna River Fault lies in the north-central part of the quadrangle and defines the southeast side of the northeast-trending belt of pre-Cretaceous rocks (Miller and Bundtzen, 1994).

Late Cretaceous sedimentary rocks of the Kuskokwim Group (Cady and others, 1955) is a regionally extensive basin-fill sequence found throughout southwestern and west-central Alaska and is the dominant bedrock in the Iditarod quadrangle. Rocks of the Kuskokwim Group represent turbidite fan, foreslope, shallow-marine, and shelf facies deposited in a Late Cretaceous basin, but subordinate shallow-marine and fluvial strata were deposited along the basin margins (Miller and Bundtzen, 1994). Rocks of the Kuskokwim Group consist primarily of intercalated sandstone, shale, chert, and conglomerate (Kks, Kkq), but they also include interbedded volcanic tuff and flow rocks (Kka, Kkt, Kkv). Volcano-plutonic complexes intrude or overlie rocks of the Kuskokwim Group at many localities such as the Beaver Mountains, Camelback Mountain, Swinging Dome, Chicken Mountain, Granite Mountain, Mount Joaquin, Takotna Mountain, and VABM Tatalina (Miller and Bundtzen, 1994). Volcanic rocks of these complexes consist primarily of Late Cretaceous and early Tertiary andesitic to basaltic flows (Kit and TKil) that together constitute the Iditarod Volcanics (Miller and Bundtzen, 1994). The volcanic rocks are generally in fault contact with or overlie comagmatic monzonite, quartz monzonite, syenite, granodiorite, granite, and minor lamprophyric plutons (TKm). At the contacts with the plutons, volcanic and sedimentary rock hornfels are common. Other Late Cretaceous and Tertiary igneous rocks include: (1) an extensive field of felsic to mafic volcanic rocks of the Yetna River area (TKy) that covers much of the western part of the quadrangle, (2) small dikes of intermediate to mafic composition (TKd) found throughout the quadrangle, (3) granite porphyry dikes, sills, and plugs (TKgp), (4) dacite-andesite plugs (TKp), and (5) alkali granite (TKg) in the western part of the quadrangle (Miller and Bundtzen, 1994). Minor exposures of Early Cretaceous sandstone and siltstone (Ks), Miocene basaltic andesite (Tb), and a small early Tertiary granodiorite plug (Tp) are also found in the quadrangle.

Volumetrically minor pre-Cretaceous rocks are divided into four narrow, northeast-trending fault bounded units in the west-central part of the quadrangle. The two older units (Proterozoic to Paleozoic age) are metamorphosed continental rocks and the younger two units (Mississippian and Jurassic age) are oceanic in origin (Miller and Bundtzen, 1994). The oldest rocks are Early Proterozoic rocks of the Idono Complex (Xi), which is a fragment of metamorphosed continental crust that consists of amphibolite grade granitic to dioritic orthogneiss, amphibolite, and metasedimentary rocks (Miller and Bundtzen, 1994). Isotopic data indicate a protolith age of 2.06 Ga for granitic orthogneiss in the complex (Miller and others, 1991). Another belt of continental rocks consists of greenschist facies metaigneous and metasedimentary rocks of middle Paleozoic and possibly Proterozoic protolith age (PzPg). These rocks are characterized by mafic greenschist, lesser pelitic schist, phyllite, calcareous schist, quartzite, and minor granitic orthogneiss that are possibly correlative with rocks of the Ruby terrane of Jones and others (1987). Mississippian to Triassic oceanic crustal and volcanic-arc rocks (TRMc) are also found in the belt of pre-Cretaceous rocks (Miller and Bundtzen, 1994). These rocks consist of radiolarian chert, basalt to basaltic andesite, lithic tuff, metasiltstone, and minor limestone that are correlative with rocks of the Innoko terrane of Jones and others (1987). Mafic and ultramafic rocks (Jdr) of the Dishna River area are the youngest of the pre-Cretaceous rocks (Miller and Bundtzen, 1994). These rocks consist generally of greenschist facies mafic rocks and serpentinized ultramafic rocks of probably ophiolitic origin that are correlative with the Jurassic ophiolites of the Tozitna-Innoko belt of Patton and others (1989a).

MINERAL DEPOSITS

Gold and silver are the most economically significant commodities in the Iditarod quadrangle, for example, over 1,600,000 oz of gold (49,700 kg) and 240,000 oz (7,500 kg) of silver have been produced mostly from placer mines in the quadrangle (Miller and Bundtzen, 1987; Bundtzen, Cox, and Veach, 1988; Bundtzen and Miller, 1997); additional estimated gold reserves in the quadrangle exceed 4,500,000 oz (140,000 kg) (Bundtzen and Miller, 1997). The largest placer mines are those near Flat (T. 27 N., R. 47 W.), Moore Creek (T. 29 N., R 42 W.), Donlin Creek (T. 23 N., R. 49 W.), Ganes Creek (T. 33 N., R. 38 W.), and in the George River area (about T. 26 N., R. 42 W.) (see map).

Placer mines in the Flat area have produced gold since 1910 and are the most important in the quadrangle. About 1,500,000 oz of Au (46,700 kg) and 197,000 oz of Ag (6,100 kg) have been recovered from several placers near Flat (for instance, Otter Creek, Flat Creek, Black Creek, Chicken Creek, Happy Creek, Prince Creek, Slate Creek, and Willow Creek) (Bundtzen, Cox, and Veach, 1988; Bundtzen and others, 1992), and through 1987, the Flat area ranked as the third largest producer of placer Au in Alaska. Placer mines on Moore Creek have produced about 55,000 oz of Au (1,700 kg) and 13,000 oz of Ag (400 kg), while those in the Donlin Creek area account for about 25,000 oz of Au (780 kg) and 1,000 oz of Ag (31 kg) (Bundtzen and others, 1985; Bundtzen, Cox, and Veach, 1988). In the Ganes Creek area, only a part of the over 204,000 oz of Au (6,300 kg) and 27,000 oz of Ag (840 kg) produced from placer mines in the area was actually recovered in the Iditarod quadrangle (Bundtzen, Cox, and Veach, 1988; Bundtzen and Miller, 1997); most of the Au and Ag from the Ganes Creek area were produced in the Ophir quadrangle, north of the Iditarod quadrangle. In the George River area, gold has been recovered from several placer mines including those on Julian Creek (T. 25 N., R. 44 W.), Michigan Creek (T. 25 N., R. 44 W.), Munther Creek (T. 26 N., R. 41 W.), and Granite Creek (T. 26 N., R. 42 W.) for a total of about 25,000 oz of Au (780 kg) and minor amounts of Ag (Bundtzen and others, 1985). The sources of the Au and Ag in the placer deposits in the quadrangle are generally vein deposits in igneous and surrounding sedimentary rocks that are spatially associated with the placers (Bundtzen and others, 1985; Miller and Bundtzen, 1987; Bundtzen, Cox, and Veach, 1988). Additional discoveries of lode Au-Ag deposits, which are the possible sources for placer Au, are likely.

In the Flat area are also several gold-bearing quartz-carbonate veins. The mineralized veins are found in monzonite plutons and surrounding hornfels or in altered intermediate to mafic dikes (Bundtzen and Gilbert, 1983; Bundtzen and others, 1992). These veins may contain gold, scheelite, cinnabar, stibnite, arsenopyrite, pyrite, chalcopyrite, galena, and sphalerite (Bull, 1988). Fluorite, tourmaline, and sericite gangue are found in veins and vein breccias in the area (Bull and Bundtzen, 1987). The Golden Horn Au-W-Sb deposit (fig. 1) is the most significant Au lode mine in the Flat area and the quadrangle, having produced about 2,700 oz of Au (84 kg) and 2,600 oz of Ag (81 kg) (Bundtzen and others, 1992). Bundtzen and Miller (1997) describe the Golden Horn deposit and similar deposits on Chicken Mountain as plutonic-hosted Cu-Au-polymetallic deposits. Other deposits of this type are possible throughout the Iditarod quadrangle.

Stibnite-rich lodes are known in the Donlin Creek area (T. 23 N., R. 49 W.), Granite Creek (T. 26 N., R. 42 W.), Julian Creek (T. 25 N., R. 44 W.), and at the Independence mine (T. 33 N., R. 38 W.) (Cady and others, 1955; Bundtzen and others, 1986; Bundtzen and Miller, 1997). The Independence mine was briefly operated in 1912 and produced about 161 oz of Au (5 kg) (Bundtzen and Miller, 1997). The lodes consist of small quartz-carbonate veins and vug fillings containing stibnite, pyrite, arsenopyrite, and local cinnabar in granite porphyry dikes, adjacent sedimentary rocks, or at contacts between the two rock types (Bundtzen and Miller, 1997). Clay and sericite gangue are local. Stibnite-rich samples from the Donlin Creek area and Granite Creek have anomalous concentrations of Au and Ag (Cady and others, 1955; Bundtzen and others, 1986; McGimsey and others, 1988; Gray and others, 1990; Bundtzen and Miller, 1997). Stibnite-rich lodes, especially those containing significant gold, are an important deposit type in the Iditarod quadrangle and throughout the Kuskokwim River region. Bundtzen and Miller (1997) describe such deposits as granite-porphyry-hosted Au-polymetallic deposits.

Several epithermal cinnabar and stibnite vein deposits are found in a belt covering several tens of thousands of square kilometers in the Kuskokwim River region, which includes part of the Iditarod quadrangle (Sainsbury and MacKevett, 1965). These deposits are found generally in sedimentary rocks of the Late Cretaceous Kuskokwim Group and Late Cretaceous and early Tertiary mafic to felsic dikes, sills, or small stocks that intrude these sedimentary rocks (Sainsbury and MacKevett, 1965; Gray and others, 1997). Gray and others (1997) used geochemical, isotopic, and age data to suggest that epithermal Hg-Sb deposits in southwestern Alaska formed in response to Late Cretaceous and early Tertiary subduction-related arc magmatism. Cinnabar and stibnite are the dominant ore minerals in veins and vein breccias that contain abundant quartz and carbonate gangue; subordinate realgar, orpiment, native mercury, pyrite, gold, hematite, limonite, and dickite are found locally (Sainsbury and MacKevett, 1965; Gray and others, 1990). These deposits are a significant Hg resource and over 41,000 flasks of Hg (1 flask weighs 76 lbs or 34.5 kg) have been produced from mines in the Kuskokwim River region, although most of the Hg (about 36,000 flasks) was recovered from the Red Devil mine in the Sleetmute quadrangle (Miller and others, 1989; Gray and others, 1997). The DeCourcy Mountain mine (T. 23 N., R. 50 W.; fig. 1) is the most significant Hg mine in the Iditarod quadrangle, having produced over 1,200 flasks of Hg (Cady and others, 1955). Several cinnabar-stibnite deposits in southwestern Alaska contain significant concentrations of gold and silver (Hawley and others, 1969; Gray and others, 1990; Bundtzen and Miller, 1997; Gray and others, 1997); as a result, Bundtzen and Miller (1997) consider these deposits to be epithermal Au-Ag deposits. Epithermal cinnabar and stibnite deposits such as at DeCourcy Mountain are a type of mineral deposit that is favorable in many areas in the Iditarod quadrangle and throughout southwestern Alaska (Gray, Folger and Hageman, 1997; Gray and others, 1997).

In the Beaver Mountains, the Cirque prospect (T. 32 N., R. 41 W.) and other similar prospects consist of quartz-tourmaline-axinite-fluorite veins and vein breccias that contain chalcopyrite, pyrite, galena, and sphalerite (Bundtzen and Laird, 1982; Bundtzen and Miller, 1997). Tetrahedrite, cassiterite, arsenopyrite, scheelite, and wolframite are also found locally in these veins (Bundtzen and Gilbert, 1983). The veins are hosted in monzonite, syenite, intermediate to mafic volcanic rocks, and sedimentary rock hornfels that form a large volcano-plutonic complex in the Beaver Mountains (Bundtzen and Laird, 1982). Bundtzen and Miller (1997) designate such lodes in the Beaver Mountains, as well as similar lodes near Granite Mountain (T. 26 N., R. 40 W.), Bismarck Creek (T. 27 N., R. 42 W.), and the Broken Shovel lode (fig. 1) in the Moore Creek area (T. 29 N., R. 42 W.) as plutonic-related B-enriched Ag-Sn-polymetallic deposits. Although native gold is rare in these deposits, anomalous concentrations of Au and Ag have been reported from mineralized vein samples in the Beaver Mountains (Bundtzen and Laird, 1982; McGimsey and others, 1988).

METHODS

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

In this study, 1,151 stream-sediment samples were collected, sieved to minus-80-mesh, ground, and chemically analyzed. There were 799 panned-concentrate samples collected that were sieved to minus-30-mesh, separated in bromoform, and then further separated magnetically to obtain a nonmagnetic heavy-mineral-concentrate sample. The nonmagnetic heavy-mineral-concentrate samples were split, and one split was ground for semiquantitative spectrographic analysis (SQS) and the other split was saved for mineralogy identification.

Aquatic-moss samples were collected preferentially near or just above the current water level from boulders or dead-fall vegetation in the active stream channel. Moss from the channel walls or overbank was collected in the absence of moss within the active stream channel. Moss could not be located at many localities and, thus, only 863 moss samples were collected. Moss and sediment trapped within the moss were collected together as one sample, and the sediment was later removed by agitating the samples in water (Arbogast and others, 1991). When all of the sediment was removed, the moss samples were dried, ground, ashed, and analyzed by SQS.

All 1,151 stream-sediment and 863 aquatic-moss samples collected in this study were chemically analyzed. The 799 heavy-mineral-concentrate samples were microscopically examined for the presence of gold, but only 662 concentrate samples contained sufficient material for chemical analysis. The stream-sediment, heavy-mineral-concentrate, and aquatic-moss samples were analyzed for multi-element suites that included Au and Ag using the SQS technique described by Grimes and Marranzino (1968). However, no samples contained Au above the SQS lower limit of determination for the stream-sediment samples (10 ppm) and moss samples (2 ppm). Therefore, the stream-sediment samples were also analyzed for Au using a flow injection analysis-atomic absorption spectrophotometry (FIA-AAS) method described by Hopkins and others (1991), but material was available for the analysis of only 1,079 stream-sediment samples. Geochemical results for the stream-sediment and heavy-mineral-concentrate samples are listed in Gray and others (1988) and Hopkins and others (1991). Mineralogy results for this study appear in Bennett and others (1988). Geochemical results for the moss samples are found in Arbogast and others (1991). Histograms for the data used in this report are shown in figure 2.

RESULTS

Anomalous concentrations of Au and Ag were selected by identifying breaks in the frequency distribution of each data set (fig. 2), between the 95th and 98th percentiles. Samples with these selected anomalous concentrations of Au and Ag most clearly delineate areas favorable for Au- and Ag-bearing deposits. For example, stream-sediment sample localities that contain at least 0.010 ppm Au (95th percentile) generally form clusters instead of single-locality anomalies. However, when the 90th percentile data are added to the data set, numerous single-locality anomalies appear that are difficult to explain. Thus, the 95th percentile was selected as the anomalous concentration for Au and Ag in the stream-sediment data set. Table 1 lists a summary of the data used in this report and the selected anomalous concentrations.

The majority of the samples that contain anomalous concentrations of Au or Ag can be grouped into 14 areas on the map. All of these areas are spatially associated with Late Cretaceous and Tertiary igneous rocks that intrude sedimentary rocks of the Kuskokwim Group. Six of the areas are near volcano-plutonic complexes, 7 areas are near intermediate to mafic intrusions or volcanic flows, and 1 area is in volcanic rocks of the Yetna River area. Several other samples that have anomalous concentraions of Au or Ag are generally from isolated sample localities. These sample localities are difficult to explain, but may suggest the presence of less extensive precious-metal occurrences.

Some of the Au-Ag anomalies in this report overlap Hg-Sb-As anomalies (Gray, Folger, and Hageman, 1997) and Cu-Pb-Zn-Sn-W anomalies (Gray, Ryder, and Taylor, 1997). However, on this map additional areas favorable for primarily Au and Ag are delineated. Anomalies are numbered to be consistent (when possible) with other USGS geochemical maps in the Iditarod series. For example, area 1 (Beaver Mountains) correlates with area 1 in Gray, Folger, and Hageman (1997) and area 1 in Gray, Ryder, and Taylor (1997).

Area 1 includes much of the Beaver Mountains and is one of the largest areas that contain samples that have anomalous Au and Ag concentrations in the Iditarod quadrangle. This area is underlain by a large volcano-plutonic complex consisting of monzodiorite to syenite intrusions, intermediate to mafic volcanic rocks, and sedimentary and volcanic rock hornfels; intermediate to mafic dikes are also found in the area (Bundtzen and Laird, 1982). Several plutonic-related B-enriched Ag-Sn-polymetallic prospects containing base-metal sulfides are known in the Beaver Mountains (Bundtzen and Laird, 1982; Bundtzen and Miller, 1997). Numerous Au and Ag anomalies are found in samples in this area (see map). There are 10 stream-sediment Ag anomalies (0.3-2 ppm), and 9 stream-sediment Au anomalies (0.010-0.079 ppm) in area 1. Additionally, 8 moss samples collected in area 1 contain 5-15 ppm Ag, and 2 heavy-mineral-concentrate samples contain 100 ppm Ag, 1 of which also contains 700 ppm Au. This area was also found to have anomalous concentrations of Hg, Sb, and As (Gray, Folger, and Hageman, 1997) and Cu, Pb, Zn, Sn, and W (Gray, Ryder, and Taylor, 1997). Area 1 is probably most favorable for the occurrence of B-enriched Ag-Sn-polymetallic deposits similar to the Cirque prospect (Bundtzen and Miller, 1997). The lack of visible gold in heavy-mineral-concentrate samples collected in the Beaver Mountains suggests that the area probably has low favorability for the occurrence of significant gold deposits.

Areas 2-6 are spatially associated with other volcano-plutonic complexes similar to, but generally smaller than, that in the Beaver Mountains (see map). Placer gold has been reported from Moore, Maybe, Deadwood, and Fourth of July Creeks (Brooks, 1912; Mertie, 1936; Bundtzen, Laird, and Lockwood, 1988; Cobb, 1972) and area 2 is near the headwaters of these creeks. Altered volcanic rocks and silicified sedimentary rock hornfels in this area contain as much as 5.1 ppm Ag, 1.4 ppm Au, 150 ppm Cu, 200 ppm Pb, 10 ppm Hg, 32 ppm Sb, and 100 ppm As (McGimsey and others, 1988). Also in area 2 is the tetrahedrite-arsenopyrite-tourmaline-scheelite-bearing Broken Shovel vein lode where mineralized samples contain as much as 555 ppm Ag, 1.6 ppm Au, 5,590 ppm As, 4,860 ppm Cu, 1,430 ppm Pb, 2,400 ppm Sb, and 760 ppm Zn (Bundtzen, Laird, and Lockwood, 1988). In this study, 2 heavy-mineral-concentrate samples collected in area 2 contain 50 and 300 ppm Ag and 500 and greater than 1,000 ppm Au, respectively, the second sample also contains microscopically visible gold. Also in this area are 2 stream-sediment samples that contain 0.30 and 0.35 ppm Ag, and 2 other stream-sediment samples contain 0.056 and 0.077 ppm Au. A much larger area around Moore Creek was outlined by Gray, Folger, and Hageman (1997) as having anomalous concentrations of Hg, Sb, and As. Gray, Ryder, and Taylor (1997) also designated a Pb-Zn-Sn-W anomaly in this area. Area 2 is favorable for the occurrence of plutonic-related B-enriched Ag-Sn-polymetallic vein deposits as discussed by Bundtzen and Miller (1997), but possibly also epithermal Hg-Sb vein deposits and Au-polymetallic deposits.

Area 3 is roughly centered around the community of Flat where placer gold and lode deposits are numerous. Quartz veins at the Golden Horn and those on Chicken Mountain contain gold, pyrite, arsenopyrite, chalcopyrite, scheelite, stibnite, and cinnabar (Bundtzen and others, 1992; Bundtzen and Miller, 1997). The lodes in this area are associated with monzonite plutons, sedimentary rock hornfels, or altered dikes. Quartz veins and vein breccias in granite porphyry and sedimentary and volcanic rock hornfels in area 3 contain as much as 2,000 ppm Ag, 50 ppm Au, 10,000 ppm Sb, 5,000 ppm Cu, 20,000 ppm Pb, 2,000 ppm Zn, 300 ppm Cd, 78 ppm Bi, 2,000 ppm W, 200 ppm Sn, and greater than 10 ppm Hg, 10,000 ppm As, and 2,000 ppm B (McGimsey and others, 1988). In the drainage basin reconnaissance data collected during this study, 5 heavy-mineral-concentrate samples contain anomalous concentrations of Ag (20-500 ppm), 2 of which also contain anomalous concentrations of Au (500 ppm and greater than 1,000 ppm), and 1 concentrate contains microscopically visible gold. There are also 5 stream-sediment Ag anomalies (0.1-1 ppm) and 2 stream-sediment Au anomalies (0.015 and 1.5 ppm) found in area 3. Although Au is well known in the Flat area, anomalous concentrations of Au and Ag (shown on the map) in additional tributaries of Otter and Moose Creeks, slightly extend the limits of reported Au occurrences. In addition, Gray, Folger, and Hageman (1997) identified a Hg-Sb-As anomaly and Gray, Ryder, and Taylor (1997) outlined a Cu-Pb-Sn-W anomaly in the Flat area. Area 3 is favorable for plutonic-hosted Cu-Au polymetallic vein deposits (Bundtzen and Miller, 1997) and epithermal Hg-Sb veins.

Less extensive Au-Ag anomalies around Mount Joaquin and Tatalina Mountain (areas 4 and 5, respectively) are found downstream from known prospects. Bundtzen and Laird (1983) reported that a prospect in monzodiorite on Mount Joaquin contains cinnabar ore, minor arsenopyrite, 0.24 ppm Au, and 0.8 ppm Ag. In area 4 are 4 stream-sediment samples containing 0.010-0.018 ppm Au, and 1 heavy-mineral-concentrate sample containing microscopically visible gold and cinnabar. The area shown on the map, extends the known Au anomaly into 2 additional watersheds on the east side of Mount Joaquin. The Mount Joaquin area also has anomalous concentrations of Hg, Sb, and As (Gray, Folger, and Hageman, 1997) and Zn and W (Gray, Ryder, and Taylor, 1997). Area 4 is favorable for the occurrence of epithermal Hg-Sb vein and epithermal Au-Ag vein deposits. The Au-Ag anomaly outlined here supports this conclusion.

Area 5 includes Tatalina Mountain where a prospect in Mn-stained and brecciated hornfels contains 0.01 ppm Au and 2-5 ppm Ag, and a heavy-mineral-concentrate sample collected downstream from the prospect contains 0.01 ppm Au, 23 ppm Ag, 5,000 ppm Pb, and microscopically visible galena (Bundtzen and Laird, 1983). A silicified sedimentary rock hornfels also collected from Tatalina Mountain contains 33 ppm Ag, 0.10 ppm Au, 1,100 ppm As, 9 ppm Bi, 0.12 ppm Hg, 500 ppm Pb, 36 ppm Sb, 200 ppm Sn, and 170 ppm Zn, and greater than 2,000 ppm B (McGimsey and others, 1988). In this study, area 5 is delineated by 2 sample localities that contain 3 ppm Ag in stream sediment, 5 and 15 ppm Ag in heavy-mineral concentrate, and 3 ppm Ag in a moss sample. Gray, Ryder, and Taylor (1997) outlined a Pb-Sn anomaly around Tatalina Mountain. In addition, Gray, Folger, and Hageman (1997) designate a large area that includes Tatalina Mountain as having anomalous concentrations of Hg, Sb, and As. Area 5 is favorable for the presence of epithermal Hg-Sb veins deposits, but the Tatalina Mountain area is probably also favorable for plutonic-related B-enriched Ag-Sn-polymetallic vein deposits (Bundtzen and Miller, 1997).

Area 6 surrounds Granite Mountain. No mines or prospects are known in this area, but altered monzonite, vein breccias, and sedimentary rock hornfels collected in the Granite Mountain area contain as much as 0.05 ppm Au, 7 ppm Ag, 390 ppm Sb, 850 ppm As, 700 ppm Cu, 500 ppm Pb, 450 ppm Zn, 300 ppm Sn, 54 ppm Bi, 1.2 ppm Cd, and greater than 10 ppm Hg and 2,000 ppm B (McGimsey and others, 1988). The area 6 anomaly consists of 7 stream-sediment samples containing as much as 1 ppm Ag, 1 stream-sediment sample containing 0.030 ppm Au, 2 moss samples containing 7 ppm Ag, 1 heavy-mineral-concentrate sample containing 100 ppm Au, and 3 other heavy-mineral-concentrate samples containing 2-5 ppm Ag, 1 of which contains microscopically visible gold. Smaller areas on the south side of Granite Mountain have anomalous concentrations of Sb and As (Gray, Folger, and Hageman, 1997) and Pb, Zn, and W (Gray, Ryder, and Taylor, 1997). The Granite Mountain area is probably most favorable for the occurrence of plutonic-related B-enriched Ag-Sn-polymetallic vein deposits (Bundtzen and Miller, 1997).

Area 7 is approximately centered near the headwaters of Bismarck Creek. A large exposure of sedimentary and volcanic rock hornfels, as well as granite porphyry dikes, are found in this area (Miller and Bundtzen, 1994). In area 7, mineralized quartz veins, vein breccias, and sedimentary rock hornfels that contain as much as 100 ppm Ag, 0.05 ppm Au, 10,000 ppm As, 2.8 ppm Hg, 200 ppm Sb, 500 ppm Cu, 500 ppm Pb, 7,000 ppm Zn, 72 ppm Cd, 1,200 ppm Sn, 64 ppm Bi, and greater than 2,000 ppm B and 5,000 ppm Mn (McGimsey and others, 1988). A gold placer and lode deposit on Granite Creek (Bundtzen and others, 1986) is about 1 mi (1.6 km) south of the anomaly boundary. Samples of quartz vein containing stibnite from Granite Creek have anomalous concentrations of Au, Ag, As, Sb, and Hg and are in and near granite porphyry dikes in the area (Bundtzen and others, 1986; Bundtzen and Miller, 1997). In this study, numerous Au and Ag anomalies found in various sample media delineate area 7. There are 17 stream-sediment samples that contain 0.1-1 ppm Ag, and 4 that contain 0.012-0.070 ppm Au in area 7. Additionally, 5 heavy-mineral-concentrate samples contain 7-50 ppm Ag, and 1 has 500 ppm Au. A Cu-Pb-Zn-Sn-W anomaly was also delineated in area 7 (Gray, Ryder, and Taylor, 1997). Area 7 is most favorable for plutonic-related B-enriched Ag-Sn-polymetallic vein deposits and the Granite Creek area is favorable for granite-porphyry-hosted Au polymetallic deposits (Bundtzen and Miller, 1997); anomalous concentrations of Au and Ag in stream-sediment and heavy-mineral-concentrate samples support these conclusions.

Area 8 surrounds placer gold mines in the Donlin Creek area. Several granite porphyry dikes intrude shale and siltstone of the Kuskokwim Group in this area. Stibnite-rich lodes hosted in the granite porphyry dikes containing anomalous concentrations of Au, Ag, Hg, Sb, and As are well documented in this area (Cady and others, 1955; McGimsey and others, 1988; Gray and others, 1990). Placer gold mines in this area have recovered over 24,000 oz of gold (750 kg) (Bundtzen and Miller, 1997) and a gold lode deposit in the Donlin Creek area is estimated to contain about 3,600,000 oz of gold (112,000 kg) (Bundtzen and Miller, 1997; Millholland and Freeman, 1997). In this area, 2 stream-sediment samples contain anomalous concentrations of Au (0.011 and 0.035 ppm), and 1 stream-sediment sample has an anomalous concentration of Ag (0.5 ppm). The Donlin Creek area also contains anomalous concentrations of Hg, Sb, and As (Gray, Folger, and Hageman, 1997). Anomalous concentrations of Au and Ag in area 8 suggest the area is favorable for the occurrence of granite-porphyry-hosted Au-polymetallic deposits and the area is also favorable for epithermal Hg-Sb vein deposits (Gray, Folger, and Hageman, 1997). The Au found on American Creek has not been previously reported, slightly extending the boundary of favorable ground for Au and Ag in this area.

Area 9 is near Mosquito Mountain where granite porphyry and intermediate to mafic dikes intrude sedimentary and volcanic rocks of the Kuskokwim Group. No mines, prospects, or mineral occurrences are known in this area. In or within 2 mi (3 km) of area 9, samples of oxidized sedimentary and volcanic rock hornfels and quartz veins in sedimentary rocks of the Kuskokwim Group contain as much as 0.05 ppm Au, 0.7 ppm Ag, 400 ppm As, 110 ppm Sb, 1.4 ppm Hg, 500 ppm Cu, 640 ppm Zn, 6 ppm Bi, and 1,000 ppm B (McGimsey and others, 1988). One heavy-mineral-concentrate sample collected in area 9 contains 20 ppm Ag and 200 ppm Au; a second concentrate sample contains 200 ppm Ag, greater than 1,000 ppm Au, and microscopically visible gold. Area 9 is probably most favorable for granite-porphyry-hosted Au-polymetallic deposits.

Area 10 is found near the headwaters of First Chance Creek where sedimentary rocks of the Kuskokwim Group are cut by several intermediate to mafic dikes. No mines, prospects, or mineral occurrences are known in this area. A sample of oxidized and altered mafic dike contains 2.4 ppm Hg and 14 ppm Sb (McGimsey and others, 1988). Area 10 is defined by 2 stream-sediment samples containing 0.020 and 0.030 ppm Au, and 2 other stream-sediment samples containing 0.10 and 0.15 ppm Ag. In addition, 1 heavy-mineral-concentrate sample from this area contains microscopically visible gold. Anomalies of Hg and Sb (Gray, Folger, and Hageman, 1997) and Cu, Pb, Zn, and W (Gray, Ryder, and Taylor, 1997) are found in stream-sediment and heavy-mineral-concentrate samples in this area. Geochemical anomalies in stream-sediment and heavy-mineral-concentrate samples suggest that area 10 is favorable for epithermal Hg-Sb vein deposits or epithermal Au-Ag deposits.

Area 11 includes parts of George River, Banner Creek, and Moore Creek areas where sedimentary rocks of the Kuskokwim Group are cut by granite porphyry dikes and a small dacite-andesite plug (Miller and Bundtzen, 1994). No mines, prospects, or mineral occurrences are known in this area, but a sample of altered dacite contains 1 ppm Ag (McGimsey and others, 1988). In area 11, 2 heavy-mineral-concentrate samples contain 2 and 3 ppm Ag, 1 stream-sediment sample contains 0.3 ppm Ag, and 1 stream-sediment sample contains 0.019 ppm Au. Larger anomalies in this area are indicated for Hg (Gray, Folger, and Hageman, 1997) and Cu, Zn, and W (Gray, Ryder, and Taylor, 1997). Area 11 is favorable for the presence of epithermal Hg-Sb vein deposits or granite-porphyry-hosted Au-polymetallic deposits and the Au and Ag anomalies are consistent with this conclusion.

Area 12 includes parts of Beaver and Ruby Creeks where sedimentary rocks of the Kuskokwim Group are cut by intermediate to mafic dikes; sedimentary rock hornfels is also in the area (Miller and Bundtzen, 1994). Placer gold has been known for some years on Beaver Creek (Brooks, 1912), but no gold production has been reported from this locality. Also in this area, a sample of silicified breccia in sandstone contains 0.05 ppm Au and 0.16 ppm Hg (McGimsey and others, 1988). A heavy-mineral-concentrate sample collected from Beaver Creek contains microscopically visible gold. Also in area 12, a stream-sediment sample contains 0.5 ppm Ag and 2 other stream-sediment samples contain 0.011 and 0.058 ppm Au. Our study confirms the presence of placer gold reported from this area, however, the area 12 anomaly extends the Au anomaly to the headwaters of Ruby Creek, which is immediately west of the placer gold reported on Beaver Creek. Area 12 is probably favorable for epithermal Au-Ag or Hg-Sb vein deposits.

Area 13 is delineated by samples containing anomalous concentrations of Au and Ag collected from tributaries of the Yetna River. Bedrock in the area consists of felsic to mafic volcanic rocks of the Yetna River area (Miller and Bundtzen, 1994). No mines, prospects, or mineral occurrences are known in this area, but samples of oxidized and silicified rhyolite contain as much as 10 ppm Ag, 3,000 ppm Ba, 500 ppm Pb, 70 ppm Sn, 100 ppm Nb, and 15 ppm Be (McGimsey and others, 1988). In this area, 2 heavy-mineral-concentrate samples contain 150 and 300 ppm Au and 10 and 300 ppm Ag, respectively. In addition, 3 stream-sediment samples contain 0.1-1 ppm Ag. Other geochemical anomalies are not abundant in this area, but 2 heavy-mineral-concentrate samples collected within 2 mi (3.2 km) of area 13 contain greater than 2,000 ppm Sn (Gray, Ryder, and Taylor, 1997). Although the anomalies in this area are somewhat enigmatic, area 13 is probably favorable for epithermal Au-Ag deposits as discussed by Bundtzen and Miller (1997).

Area 14 is a small Au-Ag anomaly in the Ganes Creek area. This area is underlain by sedimentary rocks of the Kuskokwim Group cut by granite porphyry and intermediate to mafic dikes; sedimentary rock hornfels is also found (Miller and Bundtzen, 1994). Several Au placer mines and the Independence lode Au mine are found in this area. About 204,000 oz of Au (6,300 kg) and 27,000 oz of Ag (840 kg) have been produced from placer mines in the Ganes Creek area (Bundtzen and Miller, 1997); however, the most of this was produced in the Ophir quadrangle, north of the Iditarod quadrangle. Only about 161 oz of Au (5 kg) were produced from the Independence lode mine (Bundtzen and Miller, 1997). Mineralized quartz veins in altered granite porphyry collected from the Independence mine contain arsenopyrite, pyrite, cinnabar, stibnite, stephanite, and gold and as much as 180 ppm Au, 13 ppm Ag, 5,000 ppm As, 20 ppm Bi, 200 ppm Cu, 1.8 ppm Cd, 0.5 ppm Hg, 1,500 ppm Pb, 46 ppm Sb, 5 ppm W, and 260 ppm Zn (McGimsey and others, 1988; Bundtzen and Laird, 1983). In our reconnaissance geochemical study few samples were collected within the area of known placer activity. However, area 14 is defined by a heavy-mineral-concentrate sample, which contains microscopically visible gold, collected from Spalding Creek, and by a stream-sediment sample, which contains 0.5 ppm Ag, collected from a tributary of Ganes Creek. Area 14 is favorable for granite-porphyry-hosted Au-polymetallic deposits.

CONCLUSIONS

In this study, 14 areas were identified as geochemically favorable for the presence of precious-metal deposits. Of these, 9 areas (1-5, 7, 8, 12, and 14) surround or are near known Au and Ag lode or placer mines, prospects, or mineral occurrences. However, 5 areas (6, and 9-11, 13) are found where no precious-metal mines or prospects have been discovered. In addition, Au and Ag anomalies in areas 1, 3, 4, 7, 8, and 12 extend favorable ground for precious-metal deposits to drainage basins that have no reported mines, prospects, or mineral occurrences.

All of the 14 anomalies delineated here are spatially associated with Late Cretaceous and Tertiary plutons, stocks, dikes, volcanic rocks, or adjacent hornfels aureoles. All of the areas containing anomalous concentrations of Au and Ag shown in this report are favorable for granite-porphyry-hosted Au-polymetallic deposits, plutonic-related B-enriched Ag-Sn-polymetallic vein deposits, plutonic-hosted Cu-Au polymetallic vein deposits, epithermal Au-Ag deposits, or epithermal Hg-Sb vein deposits. The data presented here also suggest that Au concentrations greater than 0.010 ppm and Ag concentrations greater than 0.1 ppm Ag in stream-sediment samples are useful for the identification of precious-metal resources in southwestern Alaska.

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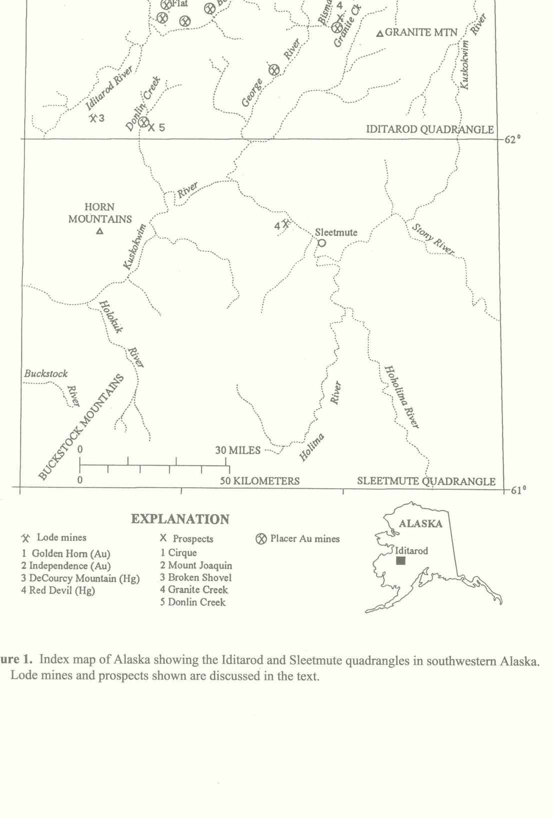

Figure 1. Index map of Alaska showing the Iditarod and Sleetmute quadrangles in southwestern Alaska. Lode mines and prospects shown are discussed in the text.

MAP SHOWING THE DISTRIBUTION OF ANOMALOUS CONCENTRATIONS OF GOLD AND SILVER IN STREAM SEDIMENT, HEAVY-MINERAL CONCENTRATE, AND AQUATIC MOSS IN THE IDITAROD QUADRANGLE, ALASKA

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