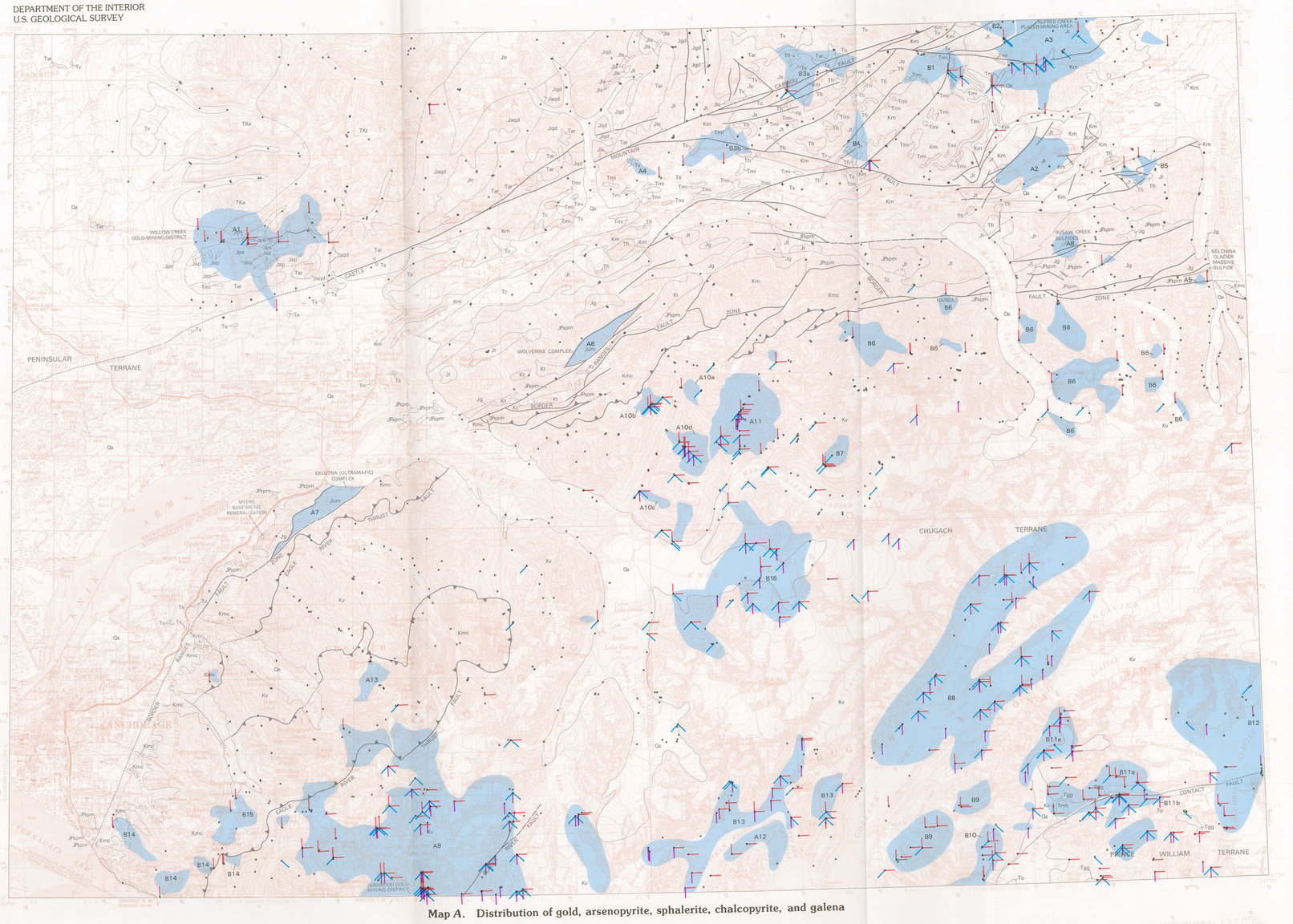
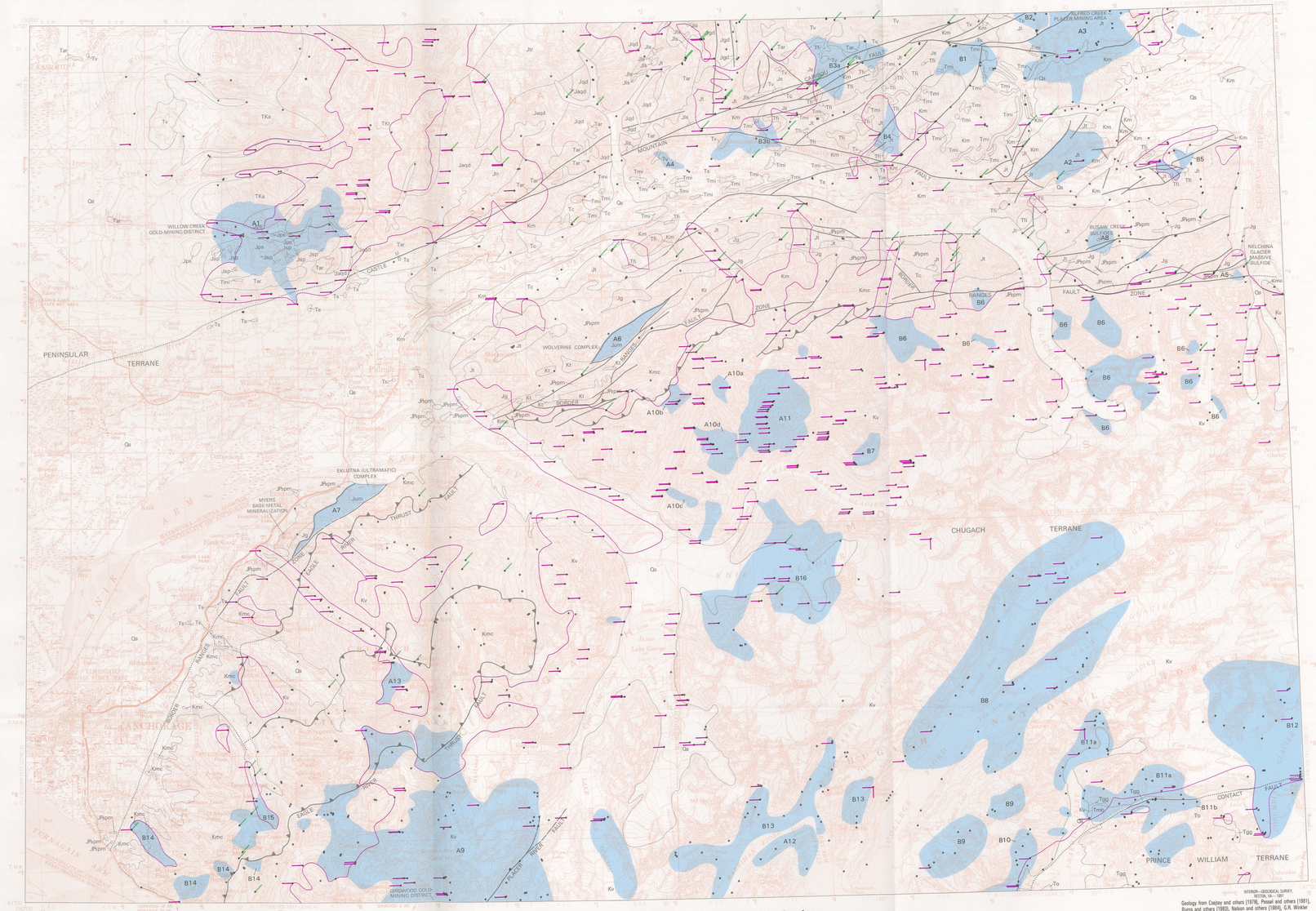


Map *A*. Distribution of gold, arsenopyrite, sphalerite, chalcopyrite, and galena



Geology from Csejtey and others (1978), Pessel and others (1981), Burns and others (1983), Nelson and others (1984), G.R. Winkler (written commun., 1982–1987), Madden and others (1987)

Map *B*. Distribution of cinnabar, cassiterite, and scheelite

SCALE 1:250 000

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

CONTOUR INTERVAL 200 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
BATHYMETRIC CONTOUR INTERVAL 10 METERS TO MAXIMUM DEPTH
SUPPLEMENTED BY 5 METER INTERVALS
DATUM IS MEAN LOWER LOW WATER
THE RELATIONSHIP BETWEEN THE TWO DATUMS IS VARIABLE
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
1985 MAGNETIC DECLINATION AT SOUTH EDGE OF SHEET VARIES FROM 25° TO 25°30' EAST

MINERALOGICAL MAPS SHOWING DISTRIBUTION OF ORE-RELATED MINERALS IN THE NONMAGNETIC, HEAVY-MINERAL-CONCENTRATE FRACTION OF STREAM SEDIMENT FROM THE ANCHORAGE 1° × 3° QUADRANGLE, SOUTHERN ALASKA

By
Richard B. Tripp and Dawn J. Madden
1991

LIST OF MAP UNITS

PENINSULAR, CHUGACH, AND PRINCE WILLIAM TERRANES

Qs Surficial deposits (Quaternary)

PENINSULAR TERRANE

Bedded rocks

- Tv Volcanic rocks (Miocene? to Paleocene)
- Ts Sedimentary rocks (Miocene to Paleocene)
- Tc Chickaloon Formation (early Eocene and Paleocene)
- Tar Arkose Ridge Formation (Eocene and Paleocene)
- Km Matanuska Formation (Late and Early Cretaceous)
- Js Sedimentary rocks (Late and Middle Jurassic)
- Jt Talkeetna Formation (Early Jurassic)
- Jls Limestone and marble (Jurassic)

Intrusive rocks

- Tmi Mafic intrusions (Eocene)
- Tfi Felsic intrusions (Eocene)
- TKa Adamellite (early Paleocene and Late Cretaceous)
- TKt Tonalite (early Paleocene and Late Cretaceous)
- Kt Trondhjemite (Early Cretaceous)
- Jtr Trondhjemite (Late Jurassic)
- Jgd Granodiorite (Late and Middle Jurassic)
- Jqd Quartz diorite (Middle and Early? Jurassic)
- Jg Gabbronorite (Early Jurassic?)
- Jum Ultramafic rocks (Jurassic?)
- Jsp Serpentinite (Jurassic?)

Metamorphic rocks

- Jagd Amphibolite and quartz diorite (Middle and Early Jurassic?)
- Jps Pelitic schist (Jurassic)

Intrusive and metamorphic rocks

- JPzpm Plutonic rocks (Jurassic and older, foliated metamorphic rocks (Jurassic and Paleozoic?)

CHUGACH TERRANE

Bedded rocks

- Kv Valdez Group (Late Cretaceous)
- Kmc McHugh Complex (Cretaceous)

Intrusive rocks

- Tmb Miners Bay pluton (Oligocene)
- Tgg Granite and granodiorite (Oligocene?)

PRINCE WILLIAM TERRANE

Bedded rocks

- To Orca Group (Eocene to Paleocene)
- Tgg Granite and granodiorite (Oligocene?)

EXPLANATION FOR MAP A

Contact—Dashed where approximately located

Fault—Dashed where approximately located; dotted where concealed. U, upthrown side; D, downthrown side

Thrust fault—Sawteeth on upper plate. Dotted where concealed

Sample locality

Mineral symbols—aspy, arsenopyrite; cp, chalcopyrite; gn, galena; sl, sphalerite

A1 Areas enriched in particular minerals—Labeled areas correspond to numbered areas in tables 2 and 3; unlabeled areas contain gold not discussed in text

EXPLANATION FOR MAP B

Contact—Dashed where approximately located

Fault—Dashed where approximately located; dotted where concealed. U, upthrown side; D, downthrown side

Thrust fault—Sawteeth on upper plate. Dotted where concealed

Sample locality

sch ci cs Mineral symbols—ca, cassiterite; ci, cinnabar; sch, scheelite

A1 Areas enriched in scheelite

Areas enriched in particular minerals—Labeled areas correspond to numbered areas in tables 2 and 3; unlabeled areas contain gold not discussed in text

INTRODUCTION

This report is part of a series of publications prepared by the USGS (U.S. Geological Survey) as part of AMRAP (Alaska Mineral Resource Assessment Program) to provide the public with information on the mineral resources of Alaska. This report presents the results of a reconnaissance mineralogical survey of the nonmagnetic, heavy-mineral-concentrate fraction of stream sediments in the Anchorage 1:250,000-scale quadrangle, southern Alaska. Two objectives of this study were to determine which suites of minerals are associated with known mineral occurrences and then to determine whether similar suites occur in similar geologic environments elsewhere in the quadrangle. A third objective was to find additional suites of minerals indicative of types of mineral occurrences previously unrecognized in the quadrangle. Two companion reports (Madden, in press a, b) present the distributions of geochemical data from stream sediments and concentrates. The chemical analyses for the samples are available in Arbogast and others (1987).

SAMPLE COLLECTION AND PREPARATION

In 1982–1985, the USGS collected samples of stream sediments and panned heavy-mineral concentrates for geochemical and mineralogical study. We primarily sampled first-order (unbranched) and second-order (below the junction of two first-order streams) streams as shown on USGS 1:63,360-scale topographic maps. At nearly all of these sample sites (maps *A* and *B*), we collected both a stream-sediment and a heavy-mineral-concentrate sample; at some sites concentrate samples were not collected because of a scarcity of sediment. In addition to collecting sediment from streams, we also collected it from medial and lateral moraines in areas of extensive glacial cover and treated it in the same manner as the stream-sediment samples.

The average sampling density for the quadrangle is one site per 14 km², though parts of the quadrangle were only sparsely sampled. For example, few samples were taken in the snowfields along the crest of the Chugach Mountains; relatively few samples were taken in the Prince William Sound area, which was sampled by Goldfarb and others (1984); and no samples were taken in the mainly forested north of Knik Arm in the western part of the quadrangle, where mainly forested lands north of Knik Arm are exposed the sampling density no rocks are exposed. In contrast, where rocks are exposed the sampling density was much higher, ranging between one site per 2.6 km² and one site per 10 km².

The method of collecting heavy-mineral-concentrate samples was to scoop numerous grab samples along a 9- to 30-m length of active stream channel or across the entire width of an active moraine. The grab samples were composited into a single 5- to 4-kg sample and screened in the field with a 2.0-mm (10-mesh) stainless steel screen to remove the coarse material. The minus-2.0-mm material then was panned with a gold pan to remove quartz, feldspar, organic material, and clay-size particles.

In addition to the stream and moraine samples, composite rock samples were collected from 16 nunataks in order to concentrate their heavy minerals and expand the area sampled for heavy-mineral concentrates. These rocks were coarsely pulverized in the laboratory with ceramic plates set 1 mm apart, panned, and then treated in the same way as the other heavy-mineral-concentrate samples.

All of the heavy-mineral concentrates were air dried and then treated with an electromagnet to remove the highly magnetic minerals, such as magnetite and ilmenite. Following the first magnetic separation, the less-magnetic material was separated by flotation in bromoform, which has a specific gravity of 2.86, and the denser heavy-mineral fraction was extracted. The heavy-mineral fraction then was separated into nonmagnetic and magnetic fractions with a Franz Isodynamic Separator with a tilt setting equivalent to 0.7 ampere and two magnetic settings equivalent to 5° forward slope and 10° side tilt. The nonmagnetic fraction was examined under the microscope to identify any ore and ore-related minerals.

Table 1. *List of known mineral occurrences in the Anchorage quadrangle*

Deposit type(s)	Location(s)	Host rock(s) (Map-unit symbol)	Ore-related metals and associated elements enriched in rocks	Mineralogy[1]
Peninsular terrane				
mesothermal gold-vein deposits.	Willow Creek gold-mining district.	TKt, Jps	Au, As, Ag, Hg, Pb, W[2], Cu, Zn, Te.	gold, py, aspy, cp, gn, sl, sch, te[2].
Hydrothermal porphyry(?) and (or) veins[3,5]; or syngenetic, hydrothermal sea-floor minerals.	Sheep Mountain	Jt	Cu, Fe, Au[3]	cp, sl, as, bn, cc[3], gold not identified.
Mineralized breccia zones; disseminated sulfide grains	Nelchina Glacier	JPzpm[4]	Au, Ag, Cu, Pb[5]	py, cp, gn[5]
Podiform chromite	Wolverine Creek	Jum[3]; Wolverine (ultramafic) Complex of Burns (1985): pyroxenite, peridotite[5].	Cr, Ni, Cu, Co, Pt, Pd, Ng[5].	chr[5]
Chromite	East of Eklutna	Jum (peridotite, dunite, gabbro)[3].	Cr, Ni[7]	chr[7]
Vein (1 ft thick) in silicified greenstone[3].	Jim Creek	JPzpm, including silicified greenstone[4].	Cu, Ag, Zn[3]	cp, po, sl, calc[3]
Disseminated sulfide minerals in a 3-ft-wide zone; thin vein (2 in. thick)[3].	Mt. Eklutna	JPzpm, including silicified greenstone and rhyolite[3].	Cu, Pb, As, Zn[3]	aspy, py, sl, gn[3]
Disseminated chalcopyrite and magnetite in a basic segregation in quartz diorite[3]; porphyry(?)[5].	Eagle River, South Fork Matanuska River.	JPzpm[6], including quartz diorite[3].	Cu[3]	cp, mgt[3]
Placer gold	Alfred Creek	Km, Js, Jt[6]. Above the creek, a conglomerate on slopes of Horn Mountain may contain paleoplacer gold deposits[3].	Au, Pt[3]	gold[3]
Placer gold	Boulder Creek-Chickaloon River.	Tc, Tmi, Jt, Tfi, Km[6]. Unit Km is intruded by diabase in Boulder Creek; gold-bearing vein occurs upstream in Chickaloon River[3].		gold[3]
Chugach terrane				
Veins of lode gold; placer deposits.	Girdwood mining district.	Kv (unmapped Tfi, quartz diorite[3]).	Au, As, Sb, Hg, Pb, Zn, Ba, Cu[3].	aspy, gn, py, sl, cp, gold[3].
Placer gold	Crow Creek	Kv. Argillite, metasandstone, minor conglomerate intruded by a stock of quartz diorite and felsic dikes. Contact-metamorphic aureole surrounds stock of quartz diorite[3].		aspy, py, gn, sl, gold, mo, cp.
Placer gold	Metal Creek	Kv, Kmc (metasedimentary rocks, greenstone, stock of quartz diorite[3]).		gold, silver, platinum minerals, sch[3].
Hydrothermal, contact-metamorphic(?). Veins of rusty rocks surrounding quartz diorite stocks; vein within stocks[3,7].	Upper Grasshopper Valley.	Kv, (unmapped Tfi, quartz diorite[3]).	Ag, Cu, Mo, As, Au	po, cp, gold, silver[3]
Veins of quartz	Prince William Sound, Eagle River, Peters Creek[3].	Kv, some with felsic granitic dikes[3].	Au, Cu, Pb, Zn, Ag[3], As, Sb.	gn, py, gold, aspy sl, sch[3].
Stibnite	Prince William Sound, Barry Arm[3].	Kv, layer of stibnite crystals mixed with quartz and a ferruginous carbonate along a thrust fault[3].	Sb[3]	sb[3]
Prince William terrane				
Veins; disseminated grains; pyrrhotized diorite and pyrrhotite in pegmatite veins[3].	Miners Bay, Prince William Sound.	Tgg and Tgn[8], granodiorite and gabbro along the Contact fault system.	Ni[3], Cu, Cr[9], Pb, W, As, Ba.	po[3], gn, sch, aspy, barite[9].
Copper lode, low-grade ore bodies[3]; veins, placers[3].	Prince William Sound between Unakwik Inlet and Columbia Glacier.	To, Tgg, Tfi[3,7]	Cu, Zn, Ag[3], As	aspy, cp, sl[9]
Zn and Pb veins[9]	Prince William Sound between Unakwik Inlet and Columbia Glacier.	To, including metasedimentary and mafic volcanic rocks[8].	Ag, As, Pb, Sb, Zn[9], Cu, Ba.	aspy, cp, py, sl, barite[9].

[1]aspy, arsenopyrite; as, asurite; ba, barite; bn, bornite; calc, calcite; ca, cassiterite; cc, chalcocite; chr, chromite; ci, cinnabar; cp, chalcopyrite; gn, galena; mgt, magnetite; ml, malachite; mo, molybdenite; po, pyrrhotite; py, pyrite; qz, quartz; sb, stibnite; sch, scheelite; sl, sphalerite; te, tellurides.
[2]Ray (1954).
[3]Cobb (1979).
[4]Csejtey and others (1978); G.R. Winkler (written commun, 1985).
[5]Henning and Pessel (1980).
[6]Clark (1973).
[7]Rose (1966).
[8]MacKevett and Holloway (1977).
[9]Nelson and others (1984).

Table 2. *Suites of minerals found downstream from known mineral occurrences in the Anchorage quadrangle*

Area	Known mineral occurrence	Heavy-mineral-concentrate mineralogy[1]	Geologic map unit(s)
Peninsular terrane			
A1	Willow Creek gold-mining district: Willow Creek, Fishhook Creek, Crabstake Gulch, Little Susitna River.	gold, aspy, gn, sch.	TKt, Jps
A2	Sheep Mountain hydrothermal porphyry(?).	sch, ci	Jt
A3	Alfred Creek placer-gold mining area.	cp, sl, gold, gn, aspy, sch.	Jt, Js, Km
A4	Chickaloon River placer-gold mining area.	gold; upstream ci, sch.	Tc, Tmi, Jt, Tfi, Km.
A5	Nelchina Glacier massive-sulfide occurrence.	gold	JPzpm
A6	Wolverine (ultramafic) Complex, podiform chromite.		Jum
A7	Ekluna (ultramafic) complex, chromite.		Jum
A8	Russ Creek disseminated sulfides, South Fork Matanuska River.		JPzpm
Chugach and Prince William terranes			
A9	Girdwood gold-mining district	gold, aspy, sl, cp, gn, sch.	Kv, unmapped Tfi.
A10a	Metal Creek area[2] Tributary south of Metal Creek Glacier.	gold, gn, sch	Kv
A10b	Cottonwood Canyon	gold, aspy, sl, cp, gn, sch.	Kv, Tfi
A10c	Lower Metal Creek	aspy, sl, cp, gn, sch.	Kv
A10d	Canyon north of Paradise Creek	gold, aspy, sl, cp, gn, sch.	Kv
A11	Upper Grasshopper Valley[2]	gold, aspy, gn, sl, sch, cp.	Kv, Tfi
A12	Point Doran quartz veins	gold, aspy	Kv
A13	Peters Creek quartz veins	gold, sch	Kmc

[1]aspy, arsenopyrite; ci, cinnabar; cp, chalcopyrite; gn, galena; sch, scheelite; sl, sphalerite.
[2]Richter (1967).

In contrast to the Peninsular terrane, samples collected downstream from all of the known mineral occurrences in the Chugach and Prince William terranes contain suites of ore-related minerals (table 2). Most of these suites include gold.

Suites of ore-related minerals also occur outside of areas of known mineral occurrences in locations that are potential targets for further exploration (table 3). Gold occurs in most of these locations. Because gold is the commodity of greatest interest in the quadrangle, areas with potential for gold exploration are particularly important. In the Peninsular terrane, these locations are Caribou Creek, Flume Creek, Boulder Creek, and Knob Lake. The remaining area listed in table 3 is Hicks Creek, where no gold was found in this survey. All of these areas are discussed below.

Gold, sphalerite, chalcopyrite, and arsenopyrite occur in Caribou Creek (area B1) and gold and sphalerite occur in Flume Creek (area B2); these minerals also occur in Alfred Creek (area A3), which contains known placer-gold deposits. Therefore, placer gold, mineralized lodes may occur in the Tertiary volcanic unit in upper Caribou Creek. This same volcanic unit, farther north, is intruded by altered andesitic dikes containing minor amounts of tin and zinc in the Talkeetna Mountains quadrangle (Singer and others, 1980).

Gold, arsenopyrite, sphalerite, galena, cinnabar, and scheelite occur in Boulder Creek (area B3a) in the midst of sedimentary rock units that are intruded by felsic stocks of Tertiary age. The sample containing gold is from a tributary exposing sandstone and conglomerate of the Tuxedni Group and marine shale and siltstone of the Chinitna Formation, both of which are Middle Jurassic in age.

Arsenopyrite, sphalerite, chalcopyrite, galena, and scheelite occur in Hicks Creek (area B4), suggesting that there are mineral deposits in this drainage. The mineral deposits may be similar to other occurrences in the Talkeetna Formation that occur (1) in the Boulder Creek drainage near Puddingstone Hill, (2) on Sheep Mountain, and (3) to the east in the Valdez quadrangle at Heavenly Ridge and Willow Mountain.

At the Puddingstone Hill occurrence (area B3b), mineralized zones of disseminated sulfides occur in two tributaries to Boulder Creek in T. 21 N., R. 7 E. These mineralized zones lie along fractures in the Lower Jurassic Talkeetna Formation, near felsic and mafic plugs of Tertiary age. The age of the mineralization is unknown. Mineralization could be Early Jurassic in age and syngenetic with the andesitic submarine volcanic and volcaniclastic host rocks, or it could be a later phenomenon associated with Tertiary igneous activity. The mineralized rocks contain high values of Ag, Pb, and Zn in one tributary and Au (0.1 ppm), Ag (10 ppm), Sb, Bi, Cu (2 percent), Pb (5,000 ppm), Zn (3,000 ppm), Cd, and Mo in the other tributary. This type of mineralization could have contributed ore-related minerals to lower Boulder Creek, East Boulder Creek, and Hicks Creek.

At Sheep Mountain (area A2) the hydrothermally altered volcanic rocks of the Talkeetna Formation contain veins of quartz, calcite, epidote, and minor chalcopyrite, malachite, and azurite, and possibly bornite and chalcocite and disseminated chalcopyrite lying approximately parallel to bedding (Martin and Mertie, 1924). Although MacKevett and Holloway (1977) suggested that this may be a porphyry(?) hydrothermal deposit, potentially valuable for copper and gold, later work has suggested an alternate origin. Neuberg (1986) has suggested that the mineral occurrences formed on and below the Jurassic sea floor during hydrothermal metamorphism in the presence of circulating, hot sea water.

On Heavenly Ridge and Willow Mountain, in the adjacent Valdez quadrangle, a Tertiary plug of dacite cuts mafic volcanic breccia of the Talkeetna Formation. Around the plug of dacite, stringers and pods of silicified and recrystallized quartz contain molybdenum, copper, and zinc (Winkler and others, 1981).

Gold occurs near Knob Lake (area B5), in the northeastern part of the quadrangle. Area B5 also contains anomalous concentrations of Zn, W, As, Pb, Ag, Bi, Ni, Cr, and Co. In heavy-mineral concentrates. The geologic setting in the immediate areas consist of marine shale and siltstone of the Matanuska Formation, which are intruded by a plug of felsite. The plugs of felsite are generally porphyritic hypabyssal dacite to andesite, which contain phenocrysts of oligoclase and a sericite groundmass (Csejtey and others, 1978). The intrusion in the Knob Lake area is probably 37–45 Ma, based on the ages of similar intrusions in the quadrangle (Silberman and Grantz, 1986). The sources of the gold and anomalous, ore-related metals in the drainage are unknown.

In the Chugach and Prince William terranes of the Chugach National Forest, Nelson and others (1984) identified two main types of mineral deposits: (1) base-metal sulfide deposits occurring as massive and disseminated sulfides, and as veins associated with metavolcanic rocks, and (2) gold deposits occurring in veins and placers. The locations (shown on maps *A* and *B*) listed in table 3 that contain minerals and elements characteristic of base-metal sulfide deposits are as follows: Matanuska Glacier area (area B6), Coghill Lake (area B9), Jonah Bay (area B10), Matanuska Glacier near Kadin Lake (area B12), Serpentine Glacier and Harriman Fiord (area B13), and the Tanaina Peak–Mount Williams area (area B15). Some of these areas may contain undiscovered layers or dikes of metavolcanic greenstone, as well as volcanogenic, massive-sulfide mineral occurrences. The locations (shown on maps *A* and *B*) in table 3 that contain minerals and elements characteristic of gold-vein deposits are as follows: the glacier north of Marcus Baker Glacier (area B7), lower Harvard and Yale Glaciers (area B8), the area north of the Contact fault (area B11a), Indian Creek (area B14), and Peeking Mountain, which is along Peters Creek (area A13).

Scheelite and cinnabar have particular distributions among the geologic units in the quadrangle. Scheelite occurs throughout the Valdez Group, in some units of the Talkeetna Mountains batholith, and locally in the Cretaceous and Tertiary post-accretionary deposits. Scheelite generally is sparse or absent in the geologic units forming the early Jurassic volcanic arc and its pre-Jurassic(?) basement (units JPzpm, Jum, Jt, Jg), and in the Orca Group (Tfi). In contrast, cinnabar occurs preferentially in units of the Early Jurassic volcanic arc and its pre-Jurassic(?) basement (units Jt, JPzpm, Jagd, and Jps) and also in the Tertiary volcanic rocks along the northern border of the quadrangle. This distribution of cinnabar suggests that the source of the original mercury was in the volcanic processes that formed the arc and the later Tertiary volcanic rocks. The mercury may have been remobilized from the volcanic rocks and redeposited in cinnabar in later fractures. Rose (1966) reported such an occurrence of cinnabar along a fault near Ekluta.

Scheelite is ubiquitous in the heavy-mineral concentrates from the Valdez Group. This distribution of scheelite may be related to late metamorphic processes occurring during uplift of the metamorphic rocks. In the Valdez Group, the gold-bearing quartz veins have been interpreted to be metamorphic deposits formed at depth from ascending metamorphic fluids travelling along faults and fractures through the uplifted metamorphic sequence (Goldfarb and others, 1986). Hensley and others (1976) presented a similar interpretation for ores hosted by metasedimentary rocks in New Zealand. In New Zealand, scheelite abundance between the Valdez and Orca Groups occur across the Contact fault (Nelson and others, 1984; this report), its significance as a terrane boundary is in question. Based on new sandstone petrographic data from the Valdez and Orca Groups (Dumoulin, 1988).

KNOWN MINERAL OCCURRENCES IN THE ANCHORAGE QUADRANGLE

The geology and tectonic history in the Anchorage quadrangle has included the formation of several types of mineral occurrences. These formed in a variety of geologic environments and are characterized by different geochemical signatures. Gold is historically the commodity of greatest economic interest in the quadrangle. Gold has been produced from quartz veins and placer deposits. The two main gold-mining districts are Willow Creek in the Peninsular terrane in the northwestern part of the quadrangle, and Girdwood in the Chugach terrane in the southwestern part of the quadrangle. Lode-gold production in the Willow Creek district, between 1909 and 1950, was 623,874 oz (Cobb, 1984); total gold production in the Girdwood district, through 1982, was 200,000 oz (Hawkins, 1984). A smaller district is Alfred Creek, which is a placer-gold-mining area in the Peninsular terrane in the northeastern part of the quadrangle. Gold production in the Alfred Creek area, from 1911 through 1913, was only 70–75 oz (Martin and Mertie, 1914). More recent figures are not available, but seasonal mining operations were active in Alfred Creek during this study.

PENINSULAR TERRANE

A number of types of mineral occurrences occur in this part of the quadrangle. For example, north of the Border Ranges fault system, the Peninsular terrane contains (1) deposits of podiform chromite in alpine peridotite of the Wolverine Complex of Burns and Decker (1977) (see also Clark, 1972) and the informally named Eklutna (ultramafic) complex of Clark and Greenwood (1972), (2) mineralized breccia zones containing gold, silver, chalcopyrite, and galena in gossan zones and as disseminations near the Nelchina Glacier, and (3) the mesothermal gold-quartz veins in the Willow Creek gold-mining district. In addition, the terrane has the potential to contain Kuroko-type massive-sulfide and porphyry-copper mineral occurrences in andesitic submarine volcanic rocks of the Talkeetna Formation. The Talkeetna Formation represents the remnants of an Early Jurassic volcanic arc. The mineral occurrence on Sheep Mountain has been suggested to be either a syngenetic, hydrothermal deposit formed on the Jurassic sea floor (Newberry, 1986) or a porphyry deposit (MacKevett and Holloway, 1977).

Table 1 lists the main mineral occurrences known in the Peninsular terrane of the Anchorage quadrangle, together with their geochemical and mineralogical suites. These suites consist of anomalously abundant, ore-related metals and minerals. The list includes all of the types of deposits, but not every locality, listed in Cobb (1979).

CHUGACH AND PRINCE WILLIAM TERRANES

To the south of the Border Ranges fault, the Chugach terrane contains the metasedimentary flysch of the Valdez Group. In the metasedimentary flysch, gold-bearing quartz veins are widespread. The veins have been interpreted to be metamorphic deposits formed from ascending metamorphic fluids (Goldfarb and others, 1986). To the south, massive-sulfide deposits occur in mafic volcanic rocks and associated metasedimentary rocks of the Chugach and Prince William terranes (Nelson and others, 1984; Nelson and others, 1985).

Nelson and others (1984) found areas favorable for gold in a wide band north of the Contact fault system in the Valdez Group, and in the Girdwood and Crow Pass area. In these favorable areas, gold, silver, and less consistently arsenic and antimony are enriched in the nonmagnetic, heavy-mineral concentrates. In the Crow Pass area, at the head of Crow Creek in the Girdwood district, they also found indications of base-metal veins in concentrates enriched in zinc, barium, and cobalt, and containing chalcopyrite, sphalerite, galena, and barite. Additional indications of base-metal-bearing veins were found in the upper part of College Fiord, on Harvard and Yale Glaciers. To the south, in the Orca Group, base-metal-bearing veins may occur east of Miners Lake (Nelson and others, 1984).

In the Prince William terrane, base-metal veins and massive-sulfide pods occur in metasedimentary and mafic volcanic rocks of the Orca Group; veins and disseminations of sulfide minerals enriched in nickel, cobalt, and copper occur in mafic plutonic rocks. However, areas favorable for gold are less common in the Prince William terrane than in the Chugach terrane (Nelson and others, 1984).

Table 1 lists the main mineral occurrences known in the Chugach and Prince William terranes of the Anchorage quadrangle, together with their geochemical and mineralogical suites. The list includes all of the types of deposits, but not every locality, listed in Cobb (1979) and Nelson and others (1984).

CONCLUSIONS

Certain suites of minerals and elements are associated with the known mineral occurrences, both in the mineralized rocks (table 1) and downstream in the heavy-mineral-concentrate samples (table 2). In the Peninsular terrane, the samples collected downstream from the Willow Creek lode-gold mining district (area A1) contain abundant ore-related minerals such as gold, arsenopyrite, galena, and scheelite, all of which occur in the mineralized veins. Samples collected downstream from the other mineralized lodes in the Peninsular terrane, such as Sheep Mountain, Nelchina Glacier, and the chromite-bearing Wolverine (ultramafic) Complex (areas A2, A5, and A6, respectively) lack nonmagnetic ore-related heavy minerals except for local cinnabar and scheelite (table 2). Samples collected in Alfred Creek (area A3), the placer mining drainage, contain chalcopyrite, sphalerite, gold, galena, arsenopyrite, and scheelite.

Table 3. *Suites of minerals found outside of the areas of known mineral occurrences in the Anchorage quadrangle*

Area	Location(s)	Heavy-mineral-concentrate mineralogy[1]	Geologic map unit(s)	Suggested types of mineral occurrences
Peninsular terrane				
B1	Caribou Creek	gold, aspy, sl, cp	Km, Js, Tmi	Gold in veins
B2	Flume Creek	gold, sl	Jt	Enargite-gold system(?)
B3a	Boulder Creek Upper part	gold, ci, aspy, sl, gn, sch.	Km, Js, Te, Tfi.	Disseminated or massive-sulfide mineralization high in creek; veins with gold and silver(?).
B3b	Lower part	gold, ci, sch	Km, Tmi, Tfi, Tv.	Disseminated or massive-sulfide mineralization high in creek; veins with gold and silver(?).
B4	Hicks Creek	aspy, sl, cp, gn, sch.	Jt, Tfi, Tv	Disseminated or massive-sulfide mineralization.
B5	Knob Lake	gold, sch	Km, Tfi, Jt Tmi.	Gold mineralization associated with unit Tfi(?).
Chugach and Prince William terranes				
B6	Matanuska Glacier and areas to east and west in northeast part of Chugach terrane.	gold, sch, ci, gn	Kv, unmapped Tfi.	Local veins with gold and sch(?).
B7	Glacier north of Marcus Baker Glacier.	gold, aspy, gn, sch	Kv, unmapped Tfi.	Veins with gold(?)
B8	Lower Harvard Glacier and lower Yale Glacier.	gold, aspy, sl, cp, gn, sch.	Kv, unmapped Tfi.	Veins with gold(?)
B9	Coghill Lake	gold, aspy, gn, sch	Kv	Veins with gold and aspy
B10	Jonah Bay	gold, aspy, sl, cp, gn, sch.	Kv	Veins with gold and aspy
Prince William Sound				
B11a	North of Contact fault[2].	gold, aspy, sl, cp, gn, sch, ca.	Kv	Gold-bearing veins
B11b	South of Contact fault: Miners Lake to Kadin Lake[2].	gold, aspy, sl, cp, gn, sch.	To, unmapped Tfi.	Base-metal veins
B12	Columbia Glacier, near Kadin Lake.	gold, aspy, cp, gn, sl, sch.	Kv, To	Veins with gold, aspy, sch.
B13	Serpentine Glacier and Harriman Fiord.	gold, cp, aspy, gn, sl, sch, ca.	Kv	Veins with gold(?)
B14	Indian Creek, west of Girdwood mining district.	gold, sch, ci	Kv, Kmc	Veins with gold(?)
B15	Tanaina Peak–Mount Williams.	gold, ci, sch	Kmc	Veins with gold(?)
B16	Knik Glacier	gold, aspy, sl, cp, gn, sch, ci.	Kv	Veins with gold(?)

[1]aspy, arsenopyrite; ca, cassiterite; ci, cinnabar; cp, chalcopyrite; gn, galena; sch, scheelite; sl, sphalerite.
[2]Nelson and others (1984); Nelson and others (1985).

REFERENCES CITED

Arbogast, B.F., Madden, D.J., Hoffman, J.D., and O'Leary, R.M., 1987, Analytical results and sample locality map of stream-sediment, moraine-sediment, and heavy-mineral-concentrate samples from the Anchorage quadrangle, south-central Alaska: U.S. Geological Survey Open-File Report 87–151, 175 p., map scale 1:250,000.
Burns, L.E., Little, T.A., Newberry, R.J., Decker, J.E., and Pessel, G.H., 1983, Preliminary geologic map of parts of the C–2, C–3, D–2, and D–3 quadrangles, Alaska: Alaska Division of Geological and Geophysical Surveys Report of Investigations 83–10, scale 1:25,000.
Carden, J.R., and Decker, J.E., 1977, Tectonic significance of the Kuk River schist terrane, south-central Alaska: Alaska Division of Geological and Geophysical Surveys Geologic Report No. 55, 47 p.
Clark, A.L., and Greenwood, W.R., 1972, Geochemistry and distribution of platinum group metals in mafic to ultramafic complexes of southern and southeastern Alaska [abs.]: 24th International Geological Congress, Proceedings, Section 10, p. 201.
Clark, S.H.B., 1972, The Wolverine complex, a newly discovered layered ultramafic body in the western Chugach Mountains, Alaska: U.S. Geological Survey Open-File Report 72–70, 10 p.
———1973, The McHugh Complex of south-central Alaska: U.S. Geological Survey Bulletin 1372–D, 11 p.
Cobb, E.H., 1979, Summary of references to mineral occurrences (other than mineral fuels and construction materials) in the Anchorage quadrangle, Alaska: U.S. Geological Survey Open-File Report 79–1095, 183 p.
Csejtey, Bela, Jr., Nelson, W.H., Jones, D.L., Silberling, N.J., Dean, R.M., Morris, M.S., Lanphere, M.A., Smith, J.G., and Silberman, M.L., 1978, Reconnaissance geologic map and geochronology, Talkeetna Mountains quadrangle, northern part of Anchorage quadrangle, and southwest corner of Healy quadrangle, Alaska: U.S. Geological Survey Open-File Report 78–558–A, scale 1:250,000.
Doff, A.C., 1984, Independence mine, *in* Blackford, Michael, Clardy, B.L., Doff, A.C., and Visconty, Greg, eds., Guide to the Willow Creek gold mining district, with stops at the Castle Mountain fault and the Alaska Tsunami Warning Center: Anchorage, Alaska, Geological Society of America and Alaska Geological Society, p. 9–24.
Dumoulin, J.A., 1988, Sandstone petrographic evidence and the Chugach–Prince William terrane boundary in southern Alaska: Geology, v. 16, no. 5, p. 456–460.
Goldfarb, R.J., Leach, D.L., Miller, M.L., and Pickthorn, W.J., 1986, Geology, metamorphic setting, and genetic constraints of epigenetic lode-gold mineralization within the Cretaceous Valdez Group, south-central Alaska, *in* Keppie, J.D., Boyle, R.W., and Haynes, S.J., eds., Turbidite-hosted gold deposits: Geological Association of Canada Special Paper 32, p. 87–105.
Goldfarb, R.J., Nelson, S.W., Dumoulin, J.A., and Miller, M.L., 1984, Data report and statistical summary for samples of moraine and stream-sediment, nonmagnetic heavy-mineral concentrate and rocks from the Chugach National Forest, Alaska: U.S. Geological Survey Open-File Report 84–355, 446 p., map scale 1:250,000.
Henley, R.W., Norris, R.J., and Patterson, C.J., 1976, Multistage ore genesis in the New Zealand geosyncline: a history of post-metamorphic lode emplacement: Mineralium Deposita, V. II, p. 180–196.
Henning, M.W., and Pessel, G.H., 1980, Reconnaissance geology of the Nelchina Glacier gold-silver-copper-lead deposit north-central Chugach Mountains, Alaska: State of Alaska, Department of Natural Resources, Open-File Report 126, 5 p.
Hoekzema, R.B., 1984, Mineral deposits and mining history of the Valdez Group in the Kenai Peninsula area, *in* Winkler, G.R., Miller, M.L., Hoekzema, R.B., and Dumoulin, J.A., eds., Guide to the bedrock geology of a traverse of the Chugach Mountains from Anchorage to Cape Resurrection: Anchorage, Alaska, Geological Society of America and Alaska Geological Society, p. 13–23.
Hudson, Travis, and Plafker, George, 1982, Paleogene metamorphism of an accretionary flysch terrane, eastern Gulf of Alaska: Geological Society of America Bulletin, v. 93, p. 1280–1290.
Jones, D.L., and Clark, S.H.B., 1973, Upper Cretaceous (Maestrichtian) fossils from the Kenai-Chugach Mountains, Kodiak, and Shumagin Islands, southern Alaska: U.S. Geological Survey Journal of Research, v. 1, no. 2, p. 125–136.
MacKevett, E.M. Jr., and Holloway, C.D., 1977, Map showing metalliferous and selected nonmetalliferous mineral deposits in the