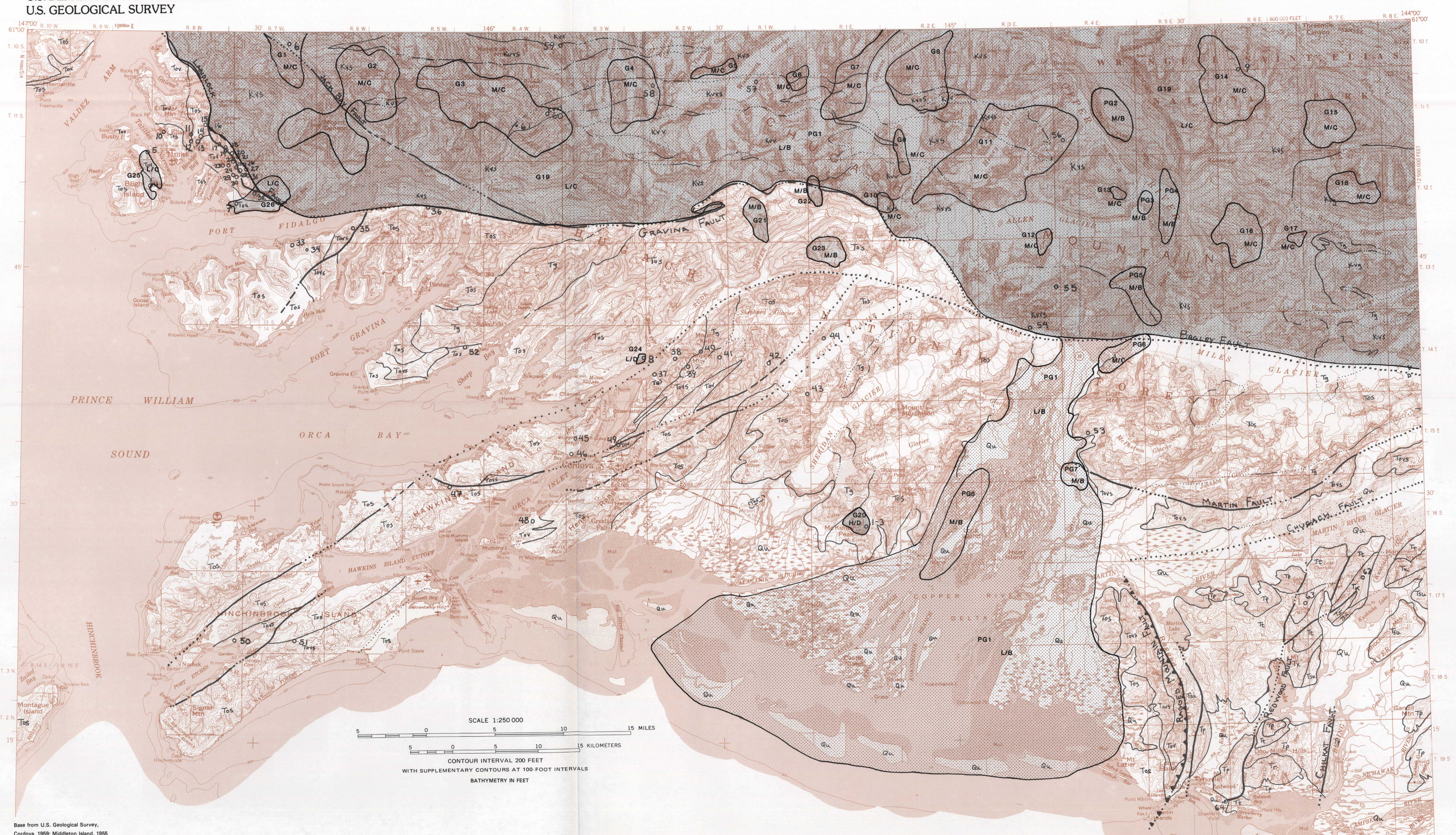
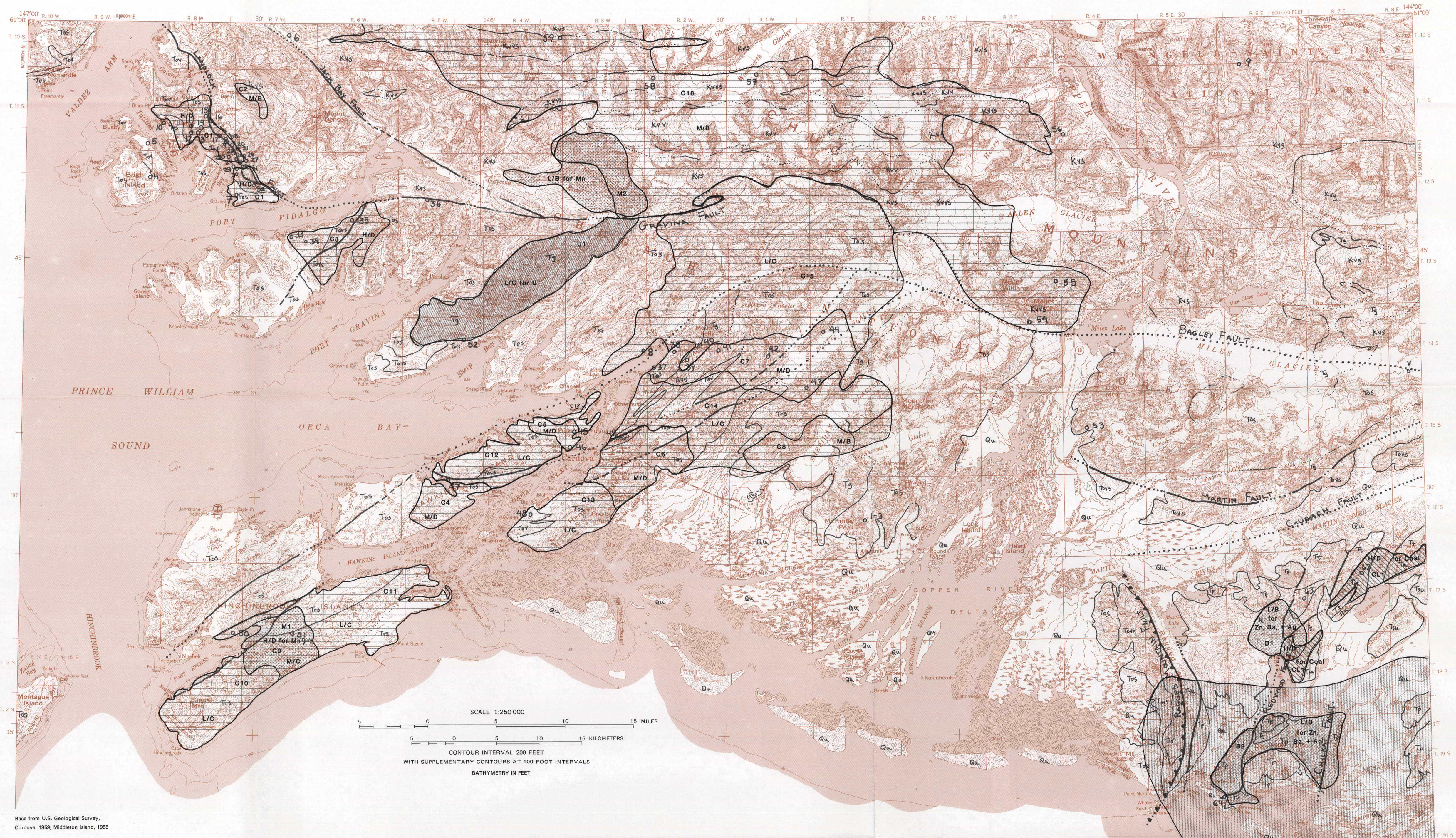


Base from U.S. Geological Survey,
Cordova, 1959; Middleton Island, 1955

Geologic base simplified from Winkler and Plafker, 1981

MAP A. AREAS OF RESOURCE POTENTIAL FOR GOLD-BEARING QUARTZ VEINS (G1-G26) AND PLACER GOLD (PG1-PG8)



Base from U.S. Geological Survey,
Cordova, 1959; Middleton Island, 1955

Geologic base simplified from Winkler and Plafker, 1981

MAP B. AREAS OF RESOURCE POTENTIAL FOR VOLCANOGENIC MASSIVE SULFIDES (C1-C16), VOLCANOGENIC MANGANESE (M1-M2), GRANITIC URANIUM (U1), STRATABOUND BASE METALS (B1-B3), COAL (CL1), AND PETROLEUM (O1)

EXPLANATION OF RESOURCE POTENTIAL

[The mineral resource potential symbols used on this map are described and defined in the following paragraphs and diagram]

Definitions of Mineral Resource Potential

LOW mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics define a geologic environment in which the existence of resources is unlikely. This broad category embraces areas with dispersed but insignificantly mineralized rock as well as areas with few or no indications of having been mineralized.

MODERATE mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a reasonable likelihood of resource accumulation, and (or) where an application of mineral-deposit models indicates favorable ground for the specified type(s) of deposits.

HIGH mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a high degree of likelihood for resource accumulation, where data support mineral-deposit models indicating presence of resources, and where evidence indicates that mineral concentration has taken place. Assignment of high resource potential to an area requires some positive knowledge that mineral-forming processes have been active in at least part of the area.

UNKNOWN mineral resource potential is assigned to areas where information is inadequate to assign low, moderate, or high levels of resource potential.

NO mineral resource potential is a category reserved for a specific type of resource in a well-defined area.

Levels of Certainty

LEVEL OF RESOURCE POTENTIAL ↑			
U/A UNKNOWN POTENTIAL	H/B HIGH POTENTIAL	H/C HIGH POTENTIAL	H/D HIGH POTENTIAL
	M/B MODERATE POTENTIAL	M/C MODERATE POTENTIAL	M/D MODERATE POTENTIAL
	L/B LOW POTENTIAL	L/C LOW POTENTIAL	L/D LOW POTENTIAL
			N/D NO POTENTIAL
A	B	C	D

LEVEL OF CERTAINTY →

A. Available information is not adequate for determination of the level of mineral resource potential.
B. Available information suggests the level of mineral resource potential.
C. Available information gives a good indication of the level of mineral resource potential.
D. Available information clearly defines the level of mineral resource potential.

Abstracted with minor modifications from:

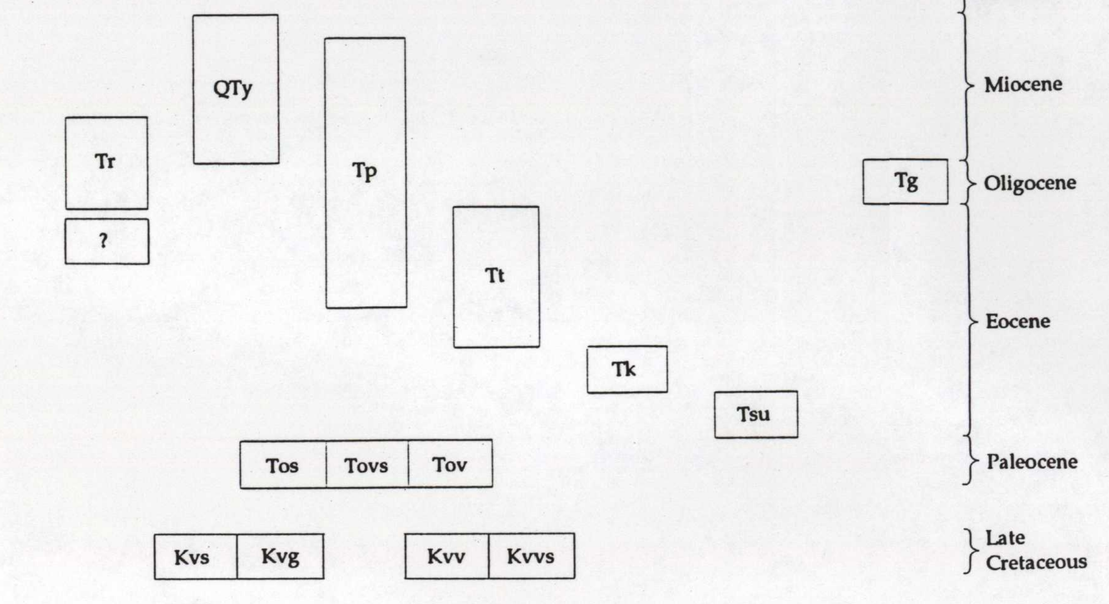
Taylor, R. B., and Steven, T. A., 1983, Definition of mineral resource potential: Economic Geology, v. 78, no. 6, p. 1268–1270.

Taylor, R. B., Stoneman, R. J., and Marsh, S. P., 1984, An assessment of the mineral resource potential of the San Isabel National Forest, south-central Colorado: U.S. Geological Survey Bulletin 1638, p. 40–42.

Goudarzi, G. H., compiler, 1984, Guide to preparation of mineral survey reports on public lands: U.S. Geological Survey Open-File Report 84–0787, p. 7, 8.

[Note: The following correlation and description are for the geologic base map shown in gray on maps A and B]

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Qu	Surficial deposits, undivided (Holocene)
QTy	Yakataga Formation (Pleistocene to Miocene)
Tr	Redwood Formation (Pliocene to Oligocene?)
Tp	Poul Creek Formation (Miocene to Eocene)
Tt	Tokun Formation (Eocene)
Tk	Kulthieth Formation (Eocene)
Tsu	Stillwater Formation (Eocene)
	ORCA GROUP (EOCENE AND PALEOCENE)--DIVIDED INTO:
Tos	Sedimentary rocks
Tovs	Sedimentary and volcanic rocks, undivided--Interbedded strata
Tov	Volcanic rocks
Tg	Intrusive rocks (Tertiary)
	VALDEZ GROUP (LATE CRETACEOUS)--DIVIDED INTO:
Kvs	Sedimentary rocks
Kvv	Volcanic rocks
Kvg	Paragneiss
Kvvs	Volcanic and sedimentary rocks--Interbedded strata

Contact--Dotted where concealed

Fault--D, downthrown side; U, upthrown side. Dotted where concealed

Thrust fault--Sawteeth on upper plate. Dotted where concealed

o45 Mine, mineral occurrence, or prospect--Number referred to in table 1

Table 1. Mines, occurrences, and prospects in the Cordova 1° x 3° quadrangle

OCCURRENCE[1]	HOST UNIT[2]	ORE MINERALOGY[3]
Gold-bearing quartz veins (Au, Ag)		
1 M McKinley Lake Mining Co.	Tos, near Tg	Qtz veins with py,aspy,po, stb, Au
2 P Lucky Strike Mining Co.	Tos, near Tg	Qtz veins with py,aspy,Au
3 P Bear Creek Mining Co.	Tos, near Tg	Quartz veins
4 P Cloudman Bay	Tos	Qtz veins with py,sl,cp
5 P Bligh Island	Tov	Qtz veins
6 P Jack Bay 2	Kvs	Qtz veins with cp,po
7 P Banzer	Tos	Qtz veins with cp,po,py,sl, gn,Au
8 P Wilson Point	Tos	Qtz veins
9 P Standard Mines Co.	Kvv	Qtz vein with Au,py,gn
Volcanogenic-related sulfides (Cu, Zn, Fe, Au, Ag)		
10 M Ellamar	Tos, near Tov	Massive py,cp,cub,po,sl,gn
11 P Wagner	Tos, Tov	Cp-bearing qtz in shear zone
12 P Rua	Tov	Py and po in shear zone
13 M Reynolds-Alaska Dev. Co.	Tos, Tov	Massive, veinlets, and disseminated cp,py,po,sl
14 P Fielder & Hemple	Tov, Tos	Shear zone with py,cp,po,qtz
15 P Mogul	Tov	Masses of cp,py,po,sl in shear
16 P Copper Mountain	Tov, Tos	Cp in qtz veins
17 P Galena Bay Mining Co.	Tov	Masses and veins of cp,py,po,sl
18 P Threeman Mining Co	Tov	Cp,po in shear zone
19 P Tibbits	Tov, Tos	Cp,py,po in shear zones
20 P Steinmetz	Tov	Lenses of cp,po in qtz-cc in shear zone
21 P Reynolds-Alaska--Landlocked Bay	Tov, Tos	Lenses and stringers of po, cp
22 P Falck	Tov	Cp,po,sl,Cu, with qtz-cc, in shear zones
23 M Standard Copper Mines Co.	Tov, Tos	Cp,po,py,sl lenses
24 P Montezuma	Tov	Cp-po lenses; disseminated py
25 M Alaska Commercial Co.	Tov	Lenses and stringers of cp,po,sl,gn,aspy,cub(?)
26 P Hemple Copper Co.	Tov, Tos	Po,py,cp,sl in shear zones
27 M Threeman	Tov, Tos	Lenses of cp,po,sl,cub,gn
28 P Alaska-Pioneer-Sourdough	Tov	Lenses of cp, po
29 P Hoodoo	Tov	Shear zones with lenses of cp,po,sl
30 M Landlocked Bay Mining Co.	Tov, Tos	Cp,po,sl,cub in qtz-cc in shear zone
31 P Chisna Consolidated Mining	Tov	Cp,py in shear zones
32 P Billygoat Mountain	Tov	Stringers and lenses of cp,py,po
33 M Schlosser	Tos	Lenses of cp,py,po,sl
34 M Dickey Copper Co.	Tos	Cp,py,po,sl in shear zones
35 M Fidalgo	Tov, Tos	Cp,py,po in shear zones
36 P Whalen & Nelson	Tos	Stringers and dissem of cp,po
37 P Shepard-Macpherson	Tos	Po,cp,gn in qtz veins
38 P Hanson & Co. No. 1	Tos	Py in shear zones; po,cp in qtz veins
39 O Snyder Falls Creek	Tov	Cp veinlets; dissem py,po
40 P Head-of-Bay	Tov, Tos	Po,cp in shear zones
41 P Caledonia Group	Tov	Bn,ml in shear zones
42 P Ibeck Creek	Tov	Lenses and dissem po,py,cp,sl
43 O Scott Glacier	Tos	Lenses and dissem cp,po,bn,sl
44 O Northern Scott Glacier	Tos, Tov	Dissem cp,py,sl
45 P Revenue	Tos	Dissem py,po
46 P Hawkins Island No. 1	Tos	Dissem py
47 P Flynn & Scott	Tov	Dissem po
48 P Hartney Bay	Tov	Dissem py,po
49 P Cordova Copper Co.	Tov	Cp,bn,ch,Cu,cu
50 P Port Etches	Tov	Cp (?)
Bedded manganese (Mn)		
51 O Hinchinbrook Island	Tos, near Tov	Massive Mn oxide and silicate minerals
Occurrences of unknown affinity		
52 O Ellis, Boone & Ibeck, No.2	Tos-Tg contact	Cp,py in qtz vein
53 O Sheep Creek	Tos	Cp in shear zones; anomalous Ag
54 O Childs Glacier	Kvv, Kvs	Dissem py,cp
55 O Grinnell Glacier	Kvs, Kvv	Py,po,cp,ml in shear zones
56 O Shiels Glacier	Kvs, Kvv	Dissem and lenses of py,po,gn,sl; anomalous Ag,Au
57 O Woodworth Glacier	Kvv	Cp in quartz veins
58 O Wortmanns Glacier	Kvs	Dissem sl,cp,py
59 O Upper Brown Creek	Kvs, Kvv	Dissem and quartz-hosted cp
60 O Upper Dead Creek	Kvs	Sl,py,ml in shear zone
61 O Dead Creek	Kvs, Kvv	Cp,sl,ml,az in shear zone
Coal		
62 P Bering River Coal N.	Tt	Coal seams
63 F Bering River Coal S.	Tt	Coal seams
Oil		
64 M Katalla Oil Field	Tp	Hydrocarbons

[1]M=mine, P=prospect, O=occurrence
[2]Same units as designated on geologic base
[3]aspy=arsenopyrite, Au=gold, az=azurite, bn=bornite, cc=calcite, ch=chalcocite, cp=chalcopyrite, Cu=native copper, cu=cuprite, cub=cubanite, gn=galena, ml=malachite, po=pyrrhotite, py=pyrite, qtz=quartz, sl=sphalerite, stb=stibnite

SUMMARY

Geological, geophysical, and geochemical data have been interpreted to identify areas of mineral resource potential in the Cordova and northern Middleton Island quadrangles. Sixteen areas have been identified that have potential for copper (±zinc, silver, gold) in Besshi- or Cyprus-type volcanogenic massive sulfide deposits. Most of these areas are underlain by interbedded metavolcanic and metasedimentary rocks of the Orca Group. However, the north-central part of the Cordova quadrangle, underlain by Valdez Group metavolcanic and metasedimentary rocks, also has a moderate potential for such massive sulfide deposits.

Approximately 20 percent of the area north of the Contact fault system has a moderate potential for mesothermal quartz veins containing resources of gold and silver; the remaining parts of the Valdez Group have a low potential for such deposits. Seven small areas underlain by metasedimentary rocks of the Orca Group also have potential for mesothermal veins. Areas underlain by rocks of the Valdez Group and of the Yakataga Formation, and most alluvial deposits along the Copper River, have a low potential for placer gold. Aeromagnetic data identify 7 areas along the Copper River of black sand accumulations which have a moderate potential for placer gold.

An area on eastern Hinchinbrook Island has high potential and another along the Gravina River has low potential for volcanogenic manganese deposits. The Sheep Bay Granite, which intrudes sedimentary rocks of the Orca Group, has a low potential for uranium. In the southeastern part of the study area, younger Tertiary sedimentary rocks near Dick Creek, in the Don Miller Hills, and on Kayak Island have a low potential for stratabound zinc, barium, and silver. Outcrops of the Kulthieth Formation are recognized as having a high potential for coal resources. Eocene and older sedimentary rocks, both on the mainland east of the Ragged Mountain fault and offshore east and south of Kayak Island, have a moderate potential for petroleum resources.

INTRODUCTION

This map describes the potential for mineral resources in the Cordova and northern Middleton Island 1:250,000-scale quadrangles in south-central Alaska (fig. 1). About fifty percent of the Cordova quadrangle consists of the rugged and glaciated Chugach Mountains or the narrow peninsulas, broad outwash plains, and Copper River deltas within the Gulf of Alaska physiographic province. The other half of the quadrangle consists of waters of the eastern edge of Prince William Sound and the northern Gulf of Alaska. The Middleton Island quadrangle is almost entirely covered by waters of the Gulf of Alaska. It contains only two small bodies of land, Kayak and Middleton Islands. Cordova is the largest town within the studied area; the small community of Tatitlek is in the northwest corner of the Cordova quadrangle.

The first 1:250,000-scale geologic map of the entire area was by Winkler and Plafker (1981). Much of the studied area is within the Chugach National Forest Wilderness Area, and additional geological mapping within the then proposed wilderness boundaries was carried out as part of a detailed U.S. Forest Service Wilderness area study (Nelson and others, 1985). A revised 1:250,000-scale color map of the Cordova and Middleton Island quadrangles has recently been published (Winkler and Plafker, 1991).

A stream-sediment reconnaissance geochemical survey of the quadrangles was done by the Los Alamos National Laboratory for the National Uranium Resource Evaluation (NURE) program (U.S. Department of Energy, 1981). The bias of sample sites to areas of easy access, and the lack of collection of heavy-mineral-concentrate samples, hinder the usefulness of the results. Stream-sediment and heavy-mineral-concentrate samples were subsequently collected by the U.S. Geological Survey (USGS) over much of the quadrangles as part of the Chugach National Forest Wilderness study (Goldfarb and others, 1984; Goldfarb and Smith, 1987). Approximately 150 additional stream-sediment and concentrate sample localities were added to the Chugach data base during this subsequent Alaska Mineral Resource Assessment Program (AMRAP) study, mainly from locations outside of the wilderness boundaries and from areas within the boundaries but with poor existing sample density. Geochemical data collected by the U.S. Geological Survey on the Cordova and Middleton Island quadrangles were tabulated by Sutley and others (1986) and interpreted by Goldfarb and others (1989).

Aeromagnetic surveys were flown over parts of the Cordova and Middleton Island quadrangles in 1975-77 and 1987 (USGS, 1979; Griscom and Sauer, 1990). Marine magnetic surveys were conducted intermittently during 1972-77 (Schwab and Bruns, 1979). The magnetic data may be useful for several purposes: (1) extension of exposed geology beneath areas covered by water, glaciers, and alluvium, (2) delimitation of major fault systems, and (3) evaluation of hydrocarbon resources and metallic mineral resources (Case and others, 1991). A regional gravity anomaly map of the study area has been completed by Barnes and Morin (1990), with most data collected during the Chugach Wilderness study.

Known mines, prospects, and mineral occurrences, all within the Cordova quadrangle, are listed in Table 1. More detailed descriptions of these were presented by Cobb (1979) and Jansons and others (1984). Most of the mines, prospects, and occurrences can be classified as volcanogenic massive-sulfide deposits. A few small mesothermal gold-bearing quartz veins and a bedded manganese deposit have also been recognized. Barnes (1951, 1967) described past coal production, and Plafker (1987) summarized information about petroleum resources, both within the southeast corner of the studied area.

The data collected by the U.S. Geological Survey provide a basis for assessing the potential for undiscovered mineral resources. This map synthesizes information on geologic units and structures, possible environments of mineral deposition, presence of geochemical and geophysical anomalies, and applicable ore-deposit models. The criteria for determining levels of resource potential and certainty of assessment were explained by Goudarzi (1984). The main purpose of this map is specifically to better delineate the boundaries of areas with resource potential in the Cordova and Middleton Island quadrangles as defined by the geological, geochemical, and geophysical data. Many of the areas within the Chugach Wilderness Study Area boundaries were previously identified by Nelson and others (1984). Quantitative, probabilistic estimates of the number of undiscovered mineral deposits within much of the studied area were given elsewhere by Bliss (1989).

GEOLOGICAL SETTING

Chugach terrane

The northern part of the Cordova quadrangle is underlain by rocks of the Upper Cretaceous Valdez Group which make up the southern part of the Chugach terrane. The rocks are composed dominantly of flyschoid metasedimentary units, with approximately 20 percent tholeiitic basaltic metatuff and metabasalt. Plafker and others (1989) indicated that the Kluane arc in British Columbia and southeast Alaska was the likely source for detritus which formed the metasedimentary rocks. The Valdez Group rocks generally range in metamorphic grade from zeolite to greenschist facies. The dynamic metamorphism has imposed a pronounced fabric throughout the rocks of the Valdez Group. Regional metamorphism and widespread deformation were coeval with accretion of the Valdez Group to the southern Alaska continental margin in latest Cretaceous or earliest Tertiary time.

Prince William terrane

Rocks of the Orca Group, constituting the Prince William terrane, were accreted to and subducted below the Valdez Group along the Contact fault system (Landlock-Gravina-Bagley faults on maps A and B) by about 51 Ma. The Orca Group is a Late Paleocene through early middle Eocene (Plafker and others, 1985) deep-sea fan complex most likely also derived from an uplifting arc in British Columbia and southeast Alaska (Plafker and others, 1989). Subordinate amounts of compositionally variable, tholeiitic to calc-alkalic basalt, including pillow basalt, as well as basaltic breccia and tuff are common in many parts of the Orca Group. The complexly folded and faulted Orca Group rocks have been regionally metamorphosed mostly to zeolite through lower greenschist facies, but do not show the regional fabric exhibited by the rocks of the Valdez Group.

Anatectic granodiorite, and lesser granite and tonalite, of the Sanak-Baranof plutonic belt (Hudson and others, 1979) intrude both Orca and Valdez Group metasedimentary units. In the northeast corner of the study area, anatexis associated with this magmatic episode has formed the migmatitic rocks of the informally named Chugach metamorphic complex (Hudson and Plafker, 1982). Radiometric ages of 50-55 Ma indicate that intrusion of the plutons was roughly coeval with accretion of the youngest rocks in Prince William terrane. The plutons have areas as large as about 150 km².

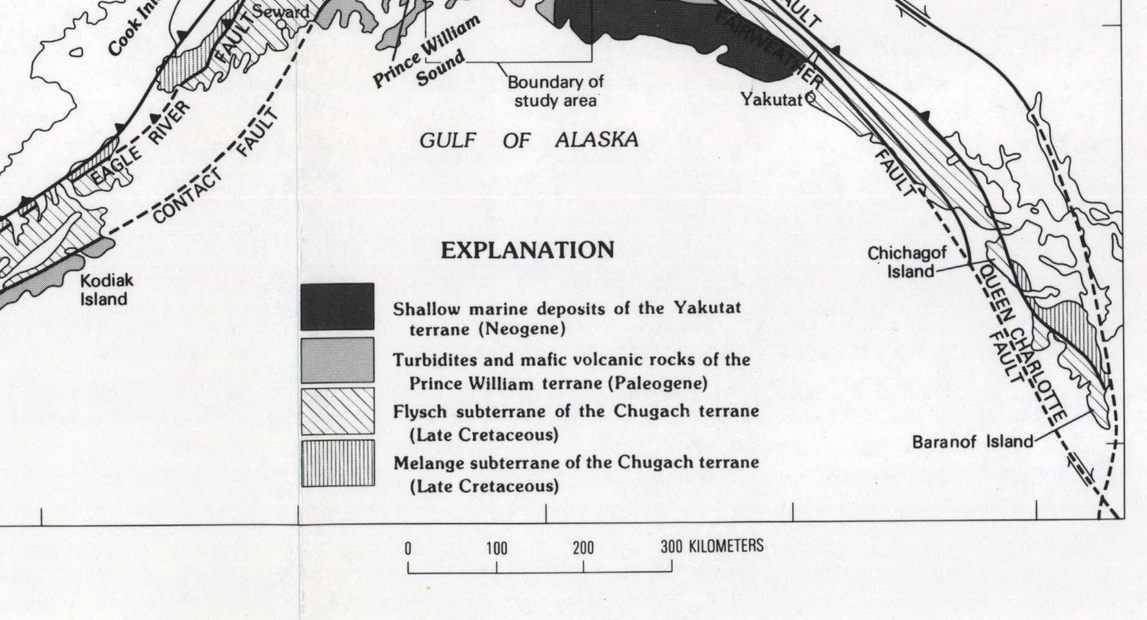


Figure 1. Geologic framework of the study area. Geology modified from Plafker and others (1977) and Winkler and others (1984).

Yakutat terrane

Younger, bedded sedimentary rocks of the Yakutat terrane crop out in the southeast corner of the Cordova quadrangle and on Kayak and southern Wingham Islands in the Middleton Island quadrangle. A late Paleocene and Eocene marine regression is indicated by the coal-bearing alluvial-plain to deltaic sandstone, shale, and coal of the Kulthieth Formation, the deltaic concretionary siltstone of the Tokun Formation, and the pro-delta siltstone of the Stillwater Formation (Winkler and Plafker, 1981; Plafker, 1987). These rocks are locally metamorphosed to laumontite facies but are commonly unmetamorphosed. A latest Eocene to early Miocene(?) transgression is indicated by the organic-rich, shale-dominated Poul Creek Formation. Interbedded basaltic pyroclastic and flow rocks, and probably related intrusive mafic plugs, dikes, and sills, are common within the Poul Creek Formation. Oligocene(?) and younger clastic rocks of the Redwood and Yakataga Formations were deposited in a continental shelf environment, with an influx of glacially derived material from the Chugach and Saint Elias Mountains beginning in the middle Miocene and continuing through the Pleistocene (Plafker, 1987). Nelson and others (1985) report an age of 6.2 Ma for a dacite plug that intrudes the Yakataga and Poul Creek Formations at the southern tip of Kayak Island

MINERAL RESOURCE POTENTIAL

Gold-bearing quartz veins (gold, silver)

Gold-bearing quartz veins are widespread in Valdez Group rocks in quadrangles adjacent to the Cordova quadrangle. These include occurrences within the Valdez (Valdez quadrangle), Girdwood (Anchorage quadrangle), Port Wells, Hope-Sunrise, and Moose Pass (Seward quadrangle) districts (Johnson, 1914, 1915; Park, 1933; Tuck, 1933). The veins occur in shear zones, joints, and saddle reefs within the sedimentary units of the Valdez Group and within adjacent dikes and stocks. Mineralized quartz commonly contains pyrite, arsenopyrite, chalcopyrite, sphalerite, galena, and electrum; various forms of carbonate are common as gangue. Gold is the only metal that has been produced from these deposits. However, in places this deposit type contains economic concentrations of Ag and therefore should also be considered to contain resources of silver. An estimated 132,000 oz of lode gold and 133,000 oz of related placer gold have been recovered from these districts (Nelson and others, 1984).

These gold-bearing quartz veins have been commonly referred to as orogenic, metamorphic-hosted veins (Bohlke, 1981), low-sulfide gold-quartz veins (Berger, 1986), or mesothermal veins (Nesbitt and others, 1986). Many of the more productive deposits of this deposit type, such as the Juneau gold belt and the California Mother Lode, are spatially associated with major crustal lineaments. Gold lodes within the Valdez Group show no such association and this may explain their very low tonnage, although they generally are very high grade.

Mitchell (1979) first suggested a model of metamorphic dewatering and hydraulic fracturing within the Valdez Group to explain the genesis of the gold-bearing quartz veins. However, Mitchell and others (1981) and Silberman and others (1981) interpreted limited fluid inclusion and stable isotope data from the Hope-Sunrise district as indicative of ore deposition by meteoric water at very shallow crustal levels. They estimated vein formation at temperatures of about 190°C and pressures of 1-25 bars, and classified these as epithermal vein deposits. Pickthorn (1982) and Pickthorn and Silberman (1984) suggested that auriferous veins in the Port Valdez district formed from a mixing of meteoric and metamorphic fluids, and felt that deposition was from a boiling fluid. Goldfarb and others (1986) interpreted fluid inclusion and stable isotope data for gold-bearing veins from throughout the Valdez Group to indicate ore deposition from a nonboiling fluid at temperatures of at least 210-280°C and pressures of at least 1-1.5 kb. They related ore genesis to metamorphic devolatilization within deeper, unexposed parts of the accretionary wedge. The relatively high pressures were interpreted to be more characteristic of mesothermal, not epithermal, environments.

Magnetic and gravity data provide no direct indication of lode gold mineralization. Known gold-bearing quartz veins (1-9, maps A and B) in the Cordova quadrangle are all in areas where the magnetic basement is at least 5-10 km deep and shows variable magnetization. The veins seem to have no association with gravity anomalies, being located in highs, lows, and in the intervening flanks of anomalies.

Geochemical data are the best indicators of areas favorable for the presence of gold-bearing quartz veins. Approximately 20 percent of the area of the Cordova quadrangle that is underlain by Valdez Group metasedimentary and metavolcanic rocks has a moderate potential (certainty level C) for Au and Ag within these types of mesothermal quartz veins (areas G1-G18, map A). These areas of resource potential are defined by the presence of anomalous concentrations of Au, commonly with corresponding Ag anomalies, in heavy-mineral-concentrate samples. Only two small gold-bearing quartz prospects (6 and 9; areas G1 and G14) are known within the areas. The relative inaccessibility of much of the northern part of the Cordova quadrangle has discouraged extensive prospecting in this part of the Valdez Group. The widespread distribution of anomalous concentrations of gold suggests that exploration within this region is likely to identify new occurrences of gold-bearing veins.

The remaining parts of the Valdez Group (area G19) are assigned a low potential (certainty level C) for silver and gold in quartz lodes. The Valdez Group itself is permissive for the existence of these resources. But the lack of anomalous silver and gold values within geochemical reconnaissance samples provides little support for the presence of precious metal mineralization.

Rocks of the Orca Group generally lack gold-bearing quartz veins. However, one small gold mine (1) and two adjacent prospects (2, 3) are in Orca Group metasedimentary rocks north of McKinley Lake. Sediment and concentrate samples collected in the vicinity of these occurrences have anomalous concentrations of silver, arsenic, and gold. The mine and prospects are approximately 3 km from a large granitic stock that may have provided heat or fluids during the formation of quartz veins. Sedimentary rocks of the McKinley Peak area (area G20) are thus recognized to have a high potential (certainty level D) for resources of silver and gold in quartz veins.

Three concentrate samples collected within the headwaters region of the Rude River contained microscopically visible gold grains and (or) anomalous gold and silver concentrations (Goldfarb and others, 1989). All three of the samples were collected at sites underlain by Orca Group metasedimentary rocks just south of the Contact fault system. One site, however, is within a drainage basin that extends into Valdez Group rocks at higher elevations. These samples might indicate another region having gold-bearing quartz lodes within Orca Group rocks. The three corresponding watersheds (areas G21-G23) have a moderate potential (certainty level B) for gold and silver resources.

Gold- and silver-rich quartz stringers in a shear zone in Orca Group sedimentary rocks at Wilson Point near the head of Nelson Bay (8) were reported by Schrader (1900). Jansons and others (1984) reported gold concentrations no greater than 0.05 ppm and silver values of <0.1 ppm for a number of samples of brecciated graywacke containing networks of quartz veinlets. Concentrate and sediment samples collected several kilometers northeast and southwest of the prospect lacked anomalous concentrations of precious and base metals. The area surrounding Wilson Point (area G24) is thus recognized to have a low resource potential (certainty level C) for gold and silver.

Three gold-bearing vein prospects (4,5, and 7) are also reported from the Ellamar region. Capps and Johnson (1915) report gold-bearing quartz in Orca Group greenstone (5) and slate (4) on the eastern side of Bligh Island. The veins in the slate also contained pyrite, sphalerite, and chalcopyrite, an assemblage very characteristic of the massive-sulfide bodies on the adjacent mainland. It is therefore possible that these veins represent some remobilization from nearby volcanogenic sulfide occurrences. Many of the mines and prospects in the Ellamar region contain both massive sulfide bodies and sulfide-bearing quartz stockworks. However, because no massive sulfide occurrences are known from Bligh Island, this area (area G25) is identified as only having a low resource potential (certainty level C) for silver and gold in quartz veins.

Quartz stringers in Orca Group greenstone and slate, containing gold, pyrrhotite, chalcopyrite, galena, and sphalerite, also were identified at the Banzer prospect (7) near Graveyard Point (Capps and Johnson, 1915) in area G26. In addition, a concentrate sample collected from the southwest shore of Fish Bay, about 7 km east of the Banzer prospect, had anomalous concentrations of silver, arsenic, and gold. The sample, collected from a watershed draining Valdez Group metasedimentary rocks, is the only concentrate sample collected between Port Fidalgo and Galena Bay that contained an anomalous amount of gold. Based on the presence of the geochemical anomaly and the known vein occurrence, much of the area surrounding Billygoat Mountain (area G26) has a low resource potential (certainty level C) for gold and silver.

Placer gold (gold)

Approximately half of the gold produced from areas underlain by Valdez Group rocks has come from placer deposits (Nelson and others, 1984). However, almost all of the placer gold was recovered on the Kenai Peninsula and in the Girdwood district (Tysdal, 1978), more than 100 km to the west of the Cordova and Middleton Island quadrangles. No gold is known to have been recovered from placer sources in these quadrangles, even though the northern part of the Cordova quadrangle is underlain by Valdez Group rocks. Much of this region is characterized by very steep topography and active alpine glaciation. The majority of the concentrates containing gold that were collected in this area represent material from medial and lateral moraines. Where gold was detected in stream-sediment concentrate samples, the sample locality was usually in a fluvioglacial environment. Unlike the fluviatile environments of placer districts to the west, fluvioglacial settings such as in the Cordova quadrangle are usually unfavorable for the development of economic placers. Glaciation generally destroys pre-existing placers and glacial moraines and outwash gravels generally do not concentrate gold (Boyle, 1979). Despite favorable geology for gold lodes, the unfavorable geomorphology suggests that most areas in the Cordova quadrangle underlain by Valdez Group rocks (that is, north of the Contact fault system) have a low potential (certainty level B) for gold resources in placers (area PG1).

A low potential (certainty level B) for placer gold characterizes alluvial deposits along the entire Copper River, underlain by both Valdez and Orca Group rocks (area PG1). Reimnitz and Plafker (1976) indicated significant gold concentrations within some of the beach deposits of the Copper River delta. Jansons and others (1984) noted 0.0004-0.005 oz gold/cubic yard of alluvial sand at numerous sites along the Copper River between the mouth of the Tasnuna River and Miles Lake. Aeromagnetic highs at a number of localities along the Copper River identify areas of probable black sand accumulations that also are favorable locations for the accumulation of placer gold (Case and others, 1991). Seven areas are delineated on map A, from the aeromagnetic data, which have a moderate potential for placer gold. Six of these areas (areas PG2-PG5, PG7, and PG8) are determined to have a "B" level of certainty. The Miles Lake area (area PG6) is associated with a relatively substantial magnetic high and thus has a "C" level of certainty.

Eyles (1990) suggested that placer gold along the beaches between Icy Bay and Cape Yakataga, 150 km east of the Cordova and Middleton Island quadrangles, was derived from Miocene rocks of the Yakataga Formation. Beach sand collected by Eyles near the mouth of the White River contained 37 ppm Au. Much of Kayak Island within the present study area is also underlain by rocks of the Yakataga Formation. Reimnitz and Plafker (1976) collected beach sand samples from Hinchinbrook Island on the Cordova quadrangle to Yakutat, 200 km to the west. But most of their samples collected to the west of the Icy Bay-Cape Yakataga area contained only background gold concentrations of ≤10-20 ppb Au. This includes all beach samples probably derived from Yakataga rocks. Two samples from barrier islands on the west side of the Copper River Delta contained 240-250 ppb Au, but they are likely derived from Mesozoic rocks upstream along the Copper River. Based on the data from Reimnitz and Plafker (1976), Goldfarb and others (1984), and Sutley and others (1986), there is low potential (certainty level D) for placer gold on the Kayak Island beaches (area PG9), which contain some material eroded from rocks of the Yakataga Formation.

Volcanogenic massive sulfides (copper ± silver, gold, and zinc)

Volcanogenic massive sulfide occurrences (Winkler and others, 1977) compose the majority of the mines and prospects in the Cordova quadrangle. Most of the occurrences are hosted by Orca Group metasedimentary and metavolcanic rocks. Ore bodies at the two largest past copper producers on the quadrangle, the Ellamar (10) and Schlosser (33) mines, are hosted by metasedimentary rocks. Ore bodies at the next largest producer, the Threeman mine (27), are within Orca Group greenstone. No past producing massive-sulfide occurrences are known to be hosted by Valdez Group rocks in the northern part of the quadrangle. However, massive-sulfide bodies in Valdez Group sedimentary rocks near pillow basalt sequences occur at the Midas mine, only 1.5 km north of the quadrangle boundary. These occurrences can be classified as either Besshi-type or Cyprus-type massive sulfides respectively (Steve Nelson, oral commun., 1984; Crowe and others, in press), depending on whether mineralization is hosted by metasedimentary or metavolcanic units.

Mineral occurrences consist of sulfide pods, stringers, and disseminations. Characteristics of the various occurrences have been described by Capps and Johnson (1915) and Moffit and Fellows (1950). In many places, the sulfides have been remobilized into shear zones along with silica during deformation and regional metamorphism. Occurrences hosted both by sedimentary and volcanic rocks consist of chalcopyrite, pyrrhotite, cubanite, sphalerite, pyrite, and lesser galena. The ore from most mines also contained economic concentrations of silver and gold. The Ellamar mine produced almost 16 million lbs of copper, plus 192,000 oz of silver and 51,000 oz of gold (Jansons and others, 1984). Areas identified as favorable for massive-sulfide occurrences should be viewed as having potential for Cu resources, as well as for by-product Ag, Au, and Zn resources.

Magnetic expression over areas of volcanogenic massive sulfide occurences (10-50) and associated volcanic sequences is quite variable (Case and others, 1991). Magnetic anomalies have a wide range in amplitude, depending on original magnetite content and thickness of the rocks, and subsequent diminution of magnetization by hydrothermal alteration or metamorphism. These variables, in turn, influence the reliability of depth estimates to volcanic rocks which are based on the horizontal extents of steepest magnetic gradients. Most estimated depths to volcanic rock sources are shallow (<2 km) or intermediate (2-5 km), but some anomalies at sites of mineral occurrences have sources of 5-10 km or greater. Specific mineral occurrences show no relation to regional gravity anomalies; about one-half of the occurrences are on or near major regional gravity highs and half near the troughs or flanks of gravity lows.

A significant gravity high, termed the Prince William Sound high (Case and others, 1966), follows the northern border of the Cordova quadrangle and roughly defines a belt of mafic volcanic rocks which are, in places, associated with many of the massive- sulfide deposits (Barnes and Morin, 1990). The high bends to the southwest in the adjacent Seward quadrangle where it coincides with many of the copper occurrences known in Prince William Sound, especially those on Knight Island. In the northwest corner of the Cordova quadrangle, the high is exceptionally strong in the Ellamar region (that is, it has closure there, on top of the already high ridge). East of Ellamar, the gravity high is fairly well defined from Solomon Gulch eastward to the Bremner townsite along the Copper River. The 35 km width of the high and its gentle bounding gradients suggest, however, that most of the dense rocks causing the anomaly are relatively deep, perhaps at depths of 5-10 km (Barnes and Morin, 1990). Only near the toe of Wortmann's Glacier is a very strong gradient, with an anomaly amplitude possibly as high as 60 mGal a few km north of the Cordova quadrangle boundary, suggestive of a large volume of very dense material close to the surface.

More than 20 massive-sulfide mines and prospects (10-32) delineate the Ellamar region, an area from the Landlock fault west to tidewater, and between Ellamar and Billygoat Mountains. Occurrences are present in both Orca Group metavolcanic and metasedimentary rocks. This area is also defined by drainage basins having stream sediment containing 150-330 ppm Zn. Data in Goldfarb and others (1989) indicate that 150 ppm Zn represents an approximate threshold value for stream sediment in the Cordova and Middleton Island quadrangles. Corresponding heavy-mineral-concentrate samples lack anomalous values, indicative of the dominance of hydromorphic rather than clastic dispersion of metals. Anomalous zinc values are lacking for sediment collected in watersheds underlain by similar Orca Group greenstone near Mount Freemantle and north of Galena Bay, and both areas lack massive-sulfide occurrences. This indicates that anomalous concentrations of zinc in sediment in the Ellamar region are indicative of sulfide occurrences and are not just representative of a high geochemical background for the volcanic units (Goldfarb and others, 1989). Thus, based on the abundance of known mines, prospects, and occurrences and the anomalous zinc in sediments, the Ellamar region (area C1, map B) has a high potential (certainty level D) for copper (± silver, gold, and zinc) resources.

Three sediment samples from creeks draining a ridge southwest of Silver Lake and east of the Landlock fault contain 160-170 ppm Zn. These concentrations are similar to those for anomalous samples from the Ellamar region on the opposite side of the fault. However, these three samples are from watersheds underlain solely by Valdez Group metasedimentary rocks (area C2). Dumoulin (1987) suggested that the Jack Bay fault, which is farther to the north, rather than the Landlock fault, represents the contact between the Valdez and Orca Groups on the western side of the Cordova quadrangle. If that is the case, then these additional anomalous sediment samples could also reflect erosion from occurrences hosted by Orca Group rocks. Whereas the specific source for the zinc anomalies remains uncertain, their proximity to the Ellamar region suggests a moderate potential (certainty level B) for undiscovered massive-sulfide occurrences.

The southeastern side of Port Fidalgo contains three mines (33-35), including the Schlosser mine which produced about 1,900 metric tons of copper and a minor amount of silver (Jansons and others, 1984). The massive-sulfide occurrences in the area are hosted by both metasedimentary and metavolcanic Orca Group rocks, though predominantly by the former. Sediment samples containing 150-240 ppm Zn define an area of resource favorability from Irish Cove to Whalen Bay. The only two concentrate samples between Port Fidalgo and Cordova that contain anomalous amounts of gold were collected in this area, on opposite sides of St. Matthews Bay. Capps and Johnson (1915) reported that considerable Au was present in the more sphalerite-rich part of the Dickey Copper Company mine. Jansons and others (1984) noted that massive- sulfide ore from the Schlosser mine contained as much as 5.8 ppm Au. This area may, therefore, be especially favorable for by-product gold in volcanogenic, copper-dominant massive-sulfide bodies or for gold remobilized into epigenetic quartz stockworks. The area (C3) is interpreted to have a high potential (certainty level D) for copper (± silver, gold, and zinc) massive-sulfide mineral occurrences.

Other locations having massive-sulfide favorability occur in a northeast-trending belt that is approximately 150 km in length, extending from the southern tip of Montague Island on the Seward 1° x 3° quadrangle to the lower elevations of the Rude River watershed in the Cordova quadrangle (Goldfarb and others, 1985). This belt is defined mostly by heavy-mineral-concentrate samples containing anomalous concentrations of barium and abundant barite. Less consistent barium anomalies in concentrate in the headwaters of the Rude River suggest that the belt may extend to the Contact fault system. Abundant chalcopyrite and some sphalerite also were noted in many of the barite-rich samples. The belt is underlain by interbedded metasedimentary and metavolcanic rocks of the Orca Group. Small massive-sulfide occurrences are clustered in the center of the belt, in the vicinity of Cordova.

Four areas within the belt (C4-C7) are recognized to have moderate potential (certainty level D) for copper (± silver, gold, and zinc) resources. All of these areas contain anomalous zinc in stream sediment and known sulfide-bearing prospects. Specific characteristics of the areas are as follows: (C4)--Disseminated pyrrhotite and copper values of almost 500 ppm are found in greenstone on central Hawkins Island (47). Four sediment samples collected in the area contained 150-220 ppm Zn, and two of the samples also were strongly anomalous in Mn. (C5)--Pyrite and pyrrhotite are found in shear zones and as disseminations in slate on the northeast side of Hawkins Island (45, 46). Two NURE sediment samples collected nearby contained greater than 200 ppm Zn. (C6)--A number of different copper-bearing minerals have been recognized in shear zones between metasedimentary and metavolcanic rocks about 2 km north of the community of Cordova (49). Most sediment samples collected from this area, during both USGS and NURE geochemical surveys, contained 140-245 ppm Zn. (C7)--This, the largest of the four areas, extends from the head of Orca Bay east to Scott Glacier. The many prospects and occurrences in this area (37-44) consist of both massive and disseminated Fe-Cu-Zn-Ag-bearing sulfide minerals.

An additional area (C8) within this barite-rich belt is defined by 5 anomalous stream-sediment samples collected between Lake Elsner and the western half of the ridge between Sherman and Sheridan glaciers. The area is underlain by both Orca Group metasedimentary rocks and Tertiary granitic intrusives. The sediment samples contained 160-260 ppm Zn, with the highest concentration in the one sample from a watershed mapped as only underlain by igneous rocks. Although syngenetic massive-sulfide occurrences can not exist in the igneous rocks, post-magmatic remobilization of syngenetic occurrences from the Orca Group into brittle fracture in granites is possible. This area has a moderate potential for copper (± silver, gold, and zinc) resources based on the geochemical data. Because the area lacks known occurrences and because the most anomalous sample is derived from a watershed that appears to be underlain by igneous rock, the level of certainty is only B.

The east-central part of Hinchinbrook Island (area C9), underlain by both metavolcanic and metasedimentary Orca Group rocks, has a moderate potential (certainty level C) for copper (± silver, gold, and zinc) massive-sulfide mineralization. The only 3 concentrate samples collected from Hinchinbrook and Hawkins Islands that contain microscopically visible chalcopyrite (Goldfarb and Tripp, 1985) were found in this area. Two NURE sediment samples from the area contained more than 11 percent Fe. One USGS sediment sample from Nuchek Creek contained 20 percent Fe, 100 ppm Co, 1000 ppm Cr, 200 ppm Ni, and 500 ppm V. The sample is from a stream that partially drains a volcanogenic manganese occurrence associated with pillow basalts (51). The highly anomalous chromium value may indicate weathering of associated ultramafic rocks. Stratiform manganese occurrences, such as the one on eastern Hinchinbrook Island, commonly occur near base-metal massive-sulfide deposits. Both deposit types may form from fluids being expelled along the same ocean-floor volcanic ridge.

All remaining parts of the barite-rich belt (areas C10-C15) have a low potential (certainty level C) for massive-sulfide mineralization. The geology is favorable for these types of occurrences, because it consists of interbedded metasedimentary and metavolcanic Orca Group rocks. However, these areas lack significant mines and prospects and rarely contain stream-sediment and heavy-mineral-concentrate samples having anomalous base-metal values.

The north-central part of the Cordova quadrangle (area C16) is underlain by interbedded metasedimentary and metavolcanic rocks of the Valdez Group. A broad and generally gentle gravity high (the Prince William Sound high described above) is associated with much of this area (Barnes and Morin, 1990). The area is characterized by a relative abundance of metavolcanic rocks and by concentrate samples that contain at least 20 percent Fe (reflecting abundant pyrite) and some microscopically visible chalcopyrite. The Midas mine, the 4th largest copper producer in the Prince William Sound region and the largest copper deposit hosted by Valdez Group rocks, is about 1.5 km north of this large tract. A number of smaller occurrences also are within the tract itself. Copper- and iron-bearing sulfide minerals are found disseminated in slate and greenstone, as well as in vein quartz in adjacent shear zones, alongside Childs, Grinnell, Shiels, Woodworth, and Wortmann's Glaciers (54-58). Similar occurrences are known within the Brown and Dead Creek watersheds (59-61). Mineralized samples from many of these occurrences commonly contain anomalous concentrations of silver and zinc. A very strong gravity high is centered near the toe of Wortmann's Glacier, a few km north of the Cordova quadrangle (Barnes and Morin, 1990). Existing geological, geophysical, and geochemical data indicate that a favorable environment for copper (± silver, gold, and zinc) resources exists in this area. However, the relative inaccessibility of much of this tract within the rugged and glaciated peaks of the Chugach Mountains has limited the amount of available information. This area, therefore, has a moderate resource potential for massive-sulfide mineralization, but only at a level of certainty of B.

Volcanogenic Manganese (manganese)

A small volcanogenic manganese deposit (51) was discovered on eastern Hinchinbrook Island in 1980 (Goodfellow and others, 1984). The deposit is in Orca Group mudstone that is interbedded with pillow basalt and breccia. The deposit consists dominantly of manganese silicate and oxide minerals, but Goodfellow and others reported as much as 14.3 percent Fe, 6,700 ppm Ba, and 3,400 ppm Zn for selected ore samples. Based on this information, the area (M1) on eastern Hinchinbrook Island (having a moderate potential for base-metal massive-sulfide occurrences) is also defined as having a high potential (certainty level D) for manganese resources.

Reconnaissance geochemical data also suggest the potential for Mn within the Gravina River watershed (area M2). Six sediment samples collected by the USGS along the river contained ≥5,000 ppm Mn. Several NURE sediment samples from the basin also had anomalous concentrations of manganese, with one sample containing almost 2 percent Mn. Heavy-mineral-concentrate samples had anomalous concentrations of manganese (≥1500 ppm) at 10 sites within the Gravina River watershed and in parts of the adjacent Dead Creek watershed; three of these samples contained at least 1 percent Mn. Manganese is the only element that is present in consistently anomalous concentrations in either sample medium. The area is mainly underlain by metasedimentary rocks of the Valdez Group and contains no known mineral resources. The consistent geochemical anomalies, however, indicate that this area has a low potential (certainty level B) for resources of Mn.

Granitic Uranium (uranium)

The Sheep Bay Granite (area U1), intruding sedimentary rocks of the Orca Group, is the largest exposed pluton in the Cordova quadrangle. A NURE radiometric survey of the Cordova quadrangle indicated that a uranium anomaly existed just north of Sheep Bay (U.S. Department of Energy, 1978). A high degree of differentiation of the granite is reflected by concentrate samples collected around the pluton that contained as much as 300 ppm Bi, 2,000 ppm La, 150 ppm Nb, 2,000 ppm Sn, 1,000 ppm W, 2,000 ppm Y, and >5,000 ppm Th. Microscopic examination of many of these samples indicated that these anomalous values reflect the presence of scheelite, monazite, thorite, and cassiterite. Additionally, NURE stream-sediment samples from streams draining the pluton contained 6-35 ppm U and some uranium/thorium ratios were greater than 1.0.

Scintillometer traverses, in drainages containing the more anomalous sediment samples, identified outcrops having readings as high as 375 cps. Granite samples from four of the most radioactive locations had uranium values of 5.9-8.0 ppm and thorium values of 20-29 ppm. The uranium concentrations are as much as two times greater than those of an average granite (DeVoto, 1978). The anomalous uranium content of the Sheep Bay pluton indicates a low potential (certainty level C) for resources of uranium.

Stratabound Base Metals (barium, zinc, ± silver)

Geochemical data suggest that much of the southeastern corner of the studied area is favorable for the presence of stratabound barium, zinc, and perhaps silver resources. The area is underlain dominantly by continental margin, clastic sedimentary rocks of Eocene to Miocene age. Intercalated mafic volcanic water-laid tuff, breccia, and pillow lava are present within the Poul Creek Formation. Metallic mineral occurrences have not been recognized in any of these younger Tertiary rocks.

Heavy-mineral-concentrate samples collected on Kayak Island within the Middleton Island quadrangle and over much of the southeastern corner of the Cordova quadrangle contained abundant barite and pyrite. Barium concentrations were consistently ≥5000 ppm, and iron values usually ranged between 10-30 percent. Many corresponding stream-sediment samples were also extremely anomalous in barium, and three samples collected from the center of Kayak Island contained 5,000-9,000 ppm Ba. Sediment containing anomalous concentrations of barium in this corner of the study area is being weathered from all younger Tertiary units, except for the Stillwater and Kulthieth Formations. The fact that the most anomalous samples are derived from the extremely chemically-reduced Poul Creek Formation suggests that the barite is derived from epigenetic occurrences. The barite distribution likely reflects original Ba enrichment in underlying, more oxidized pre-Oligocene sedimentary rocks.

In three areas (B1-B3) in the southeast part of the map, heavy-mineral-concentrate samples also contain anomalous concentrations of zinc in the form of sphalerite, and less consistently anomalous concentrations of zinc occur in corresponding stream sediment. These areas include all of Kayak Island, the north and west sides of the Don Miller Hills, and the lower elevations of the Dick Creek watershed. Concentrate samples from various parts of Kayak Island and from streams on the west side of Dick Creek contain as much as >2 percent Zn. One NURE stream-sediment sample from the Don Miller Hills contained 521 ppm Zn. Anomalous silver values, and less consistently anomalous copper, molybdenum, and lead values, are associated with zinc-rich concentrate samples from Kayak Island and the Dick Creek watershed.

The specific source for the anomalous amounts of zinc is uncertain. In the Don Miller Hills and on Kayak Island, the anomalies show a strong correlation with outcrops of the pyritic and glauconitic Poul Creek Formation. A soil geochemical survey of Kayak Island by Pickthorn and others (1985) suggested that the Zn might be associated with mafic volcanic rocks within the Poul Creek Formation. In the Dick Creek area, the geochemical anomalies are associated with concretionary siltstone of the Tokun Formation.

The geochemical anomalies indicate that these three areas are permissive for the existence of zinc, barium, and perhaps silver resources. The presence of organic-rich shale, a lithology commonly observed elsewhere to be metalliferous, and the association with submarine mafic volcanic rocks indicate that the Poul Creek Formation may be especially favorable for metal enrichment. However, three days of follow-up investigations of geochemical anomalies on Kayak Island failed to identify any mineral occurrences. Because of this, the lower Dick Creek watershed, north and west Don Miller Hills, and Kayak Island are recognized as having only a low potential (certainty level B) for zinc, barium, ± silver resources.

Coal

Coal beds ranging from thin stringers to 20-m-thick lenses have been mapped within rocks of the Kulthieth Formation. Approximately 20,000 tons of coal were produced from these beds (62, 63) during the early 1900's (Nelson and others, 1984). Various estimates for the amount of remaining coal in the Kulthieth Formation range between 36 million and 3 billion tons (Nelson and others, 1984).

Coal rank varies from low volatile bituminous to anthracite and some of the coal is of coking quality (Barnes 1951, 1967). The discontinuous and highly deformed nature of the coal beds, together with environmental concerns related to open-pit mining, may hinder their mining potential. But because of the known coal occurrences and past production, areas underlain by rocks of the Kulthieth Formation (area CL1) are recognized to have a high resource potential (certainty level D) for coal resources.

Petroleum

The southeastern part of the study area is permissive for the occurrence of petroleum resources. Approximately 154,000 barrels of paraffin-base crude oil were produced from shallow wells in the Katalla area (64) between 1902 and 1933 (Miller, 1975). Many other unsuccessful wells have been drilled onshore within the Tertiary sedimentary rocks and offshore in the adjacent Gulf of Alaska. Oil and gas seeps are widespread on the mainland between the Martin River and the Gulf of Alaska and at one locality on Kayak Island. No gravity anomalies are recognized in the data from this region.

The petroleum potential of the northern Gulf of Alaska region is discussed by Plafker (1987). Most of the Tertiary sedimentary rocks, both onshore and offshore, have total organic contents in excess of 1 percent. The Poul Creek Formation on Kayak Island could be a very favorable source rock for generation of hydrocarbons, as it contains as much as 6.76 percent organic carbon. However, rocks of the Poul Creek Formation and post-Eocene Formations are too thermally immature for petroleum production. Only Eocene and older units are likely to have reached the elevated temperatures that are necessary to convert significant amounts of kerogen to liquid petroleum.

If petroleum was generated at deeper levels, younger sandstone units, higher in the sedimentary sequence, theoretically might be important reservoirs. However, data from Griscom and Sauer (1990) indicate that favorable offshore sediment below the Orca Group and west of the Kayak fault would be at depths of 10-14 km. Any overlying petroleum traps west of the Kayak fault would therefore still be at great depths.

At shallow depths, Eocene and older source rocks could underlie all of the mainland to the east of the Ragged Mountain fault and to the south of the Chugach fault. In addition, the entire offshore region south and east of Kayak Island in the Middleton Island quadrangle has similar petroleum potential. The fact that oil and gas seeps occur on the west side of Ragged Mountain, along the Ragged Mountain fault, indicates that favorable source rocks have been underthrust at least 6 km landward below Orca Group rocks and are relatively near the surface (Plafker, 1987). However, because the deep exploratory oil wells have been unsuccessful, mainly due to structural complexities and the lack of suitable reservoir rocks, the southeast part of the study area (area O1) has only a moderate potential (certainty level C) for petroleum resources.

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