Introduction

The Valdez quadrangle contains numerous metallic and nonmetallic deposits and occurrences in diverse geologic settings. This report briefly summarizes the geology, mineralogy, and probable origins of the different types of deposits and occurrences. The table and accompanying map are based on an extensive literature search, on consultations with colleagues, and on our first-hand knowledge gained from recent field studies in the quadrangle supported by the Alaska Mineral Resource Appraisal Program (AMRAP) (Winkler, Silberman and others, 1981). Maps and summaries of mineral deposits prepared by Cobb and Matson (1972), MacKevett and Holloway (1977) and Cobb (1979) provided much of the data base. U.S. Bureau of Mines (1980) maps depicting locations of mining claims and commodities claimed provided additional information. Disparities exist in the data base, which ranges from detailed information on deposits that are documented by modern studies to vague mention of deposits in the old literature. This report focuses on locating and briefly describing the known deposits in the Valdez quadrangle. A companion report (Winkler, Miller and others, 1981) integrates the basic geological, geophysical, geochemical, and telegeological data to produce an assessment of the quadrangles' potential mineral resources. However, the significance of some deposits may be inferred from information in the table, particularly under the heading "brief description".

The term "deposit", as used herein, refers to both mines and prospects; in general, each contains or has contained indications of ore minerals in sufficient quantity to encourage exploration. Claims may or may not be active. A mine has recorded production, although in some cases ore may not have been shipped. A prospect has had some exploration, but lacks evidence of production. Probably many of the placer gold deposits that are listed as prospects have had at least meager unrecorded production. An occurrence, on the other hand, is an unexplored site that apparently contains only minor amounts of ore minerals. We did not visit some of the occurrences shown on the U.S. Bureau of Mines (1980) map of claims; without further information, these occurrences should be regarded as minor. Undoubtedly some occurrences that we show are more significant than was apparent from our brief reconnaissance and they may merit more detailed examination. Numerous, apparently insignificant, minor occurrences are not included in the table and map, nor are unevaluated occurrences of apparently anomalous concentrations of metals in rock geochemical samples (Miller, 1981). Deposits of non-metallic or energy commodities generally are not shown in the table and map, either because they have little potential or because they are integral constituents of extensive rock units which cannot be represented as a point source.

METAL COMMODITIES

Chromium

Thin layers, lenses, and disseminations of chromite are present in many places in the quadrangle in layered ultramafic and mafic plutons. Prospects in partly serpentinized dunite and peridotite at Bernard and Dust Mountains (42, 43) in the Tonsina ultramafic body have been re-evaluated recently, but, despite proximity to transportation (the [illegible]

Copper

[illegible]

Veins and associated deposits

[illegible]

Submarine volcanogenic deposits

[illegible] chalcopyrite, sphalerite, and galena to increase in proportion in the sedimentary rocks.

The Midas Mine in Solomon Gulch (32), the outstanding example of this type of deposit in the quadrangle, produced more than 500 tons of copper during its approximately eight years of production (1911-1919); its ore is not depleted. Prospects several kilometers to the east near Sulphide Gulch (33A, B) probably have greater tonnage but are significantly lower grade. Additional occurrences at Wortmanns and Tsina Glaciers (78, 79) that we examined during our field work appear also to be large, but low-grade deposits. Proximity to the Richardson Highway may enhance the potential of some or all of these deposits.

Copper-molybdenum porphyry

Two sulfide-bearing quartz vein systems that are associated with plutons have been located in the Valdez quadrangle. The larger of these systems (61), which is exposed along the bluffs of the Chitina River near its mouth, has been explored cursorily and consists of disseminations and small concentrations of chalcopyrite and molybdenite in an Upper Jurassic biotite granodiorite pluton near its contact with greenstone of the Skolai Group. The smaller of these systems (84), which is exposed in the canyon at the west end of Heavenly Ridge apparently is unexplored. It may not be a true porphyry, inasmuch as it consists largely of sulfide-impregnated quartz veins in conspicuously iron-stained volcanic breccia of the Talkeetna Formation near its contact with a small Tertiary(?) dacite plug. Iron-staining is widespread in the Talkeetna Formation in the adjacent area, and may indicate the presence of other undiscovered occurrences. Analyses of stream-sediment samples from drainages in the area show the presence of some anomalous concentrations of molybdenum, copper, and zinc.

Gold

Lode and placer gold deposits are widespread in the Valdez quadrangle, especially in rocks of the Valdez Group or placers derived therefrom. Lode deposits produced most of the 137,600 Troy ounces of gold from the districts of Prince William Sound, part of it as a byproduct in the mining of copper; total production from the Valdez quadrangle alone is unknown. Placer gold deposits are small and have had only minor production (Koschmann and Bergendahl, 1968, p. 32). Trace amounts of placer gold probably are present in most streams in the quadrangle.

Lode deposits

The gold lodes of the Cliff mine (15) on the north shore of Port Valdez were the chief source of production in the quadrangle and are similar to most other lode deposits within rocks of the Valdez Group. The deposits mainly consist of diversely oriented quartz or quartz-calcite veins and adjacent altered zones. The gold-bearing veins generally are thinner than a few tens of centimeters, although they may be as thick as 2 m, and they cannot be traced laterally more than a few hundred meters. Many veins pinch and swell markedly over short distances. The gold is free and is visible in some veins; most veins also contain pyrite, arsenopyrite, chalcopyrite, sphalerite, and galena; a few veins in the Columbia and Shoup Glacier areas also contain stibnite. The veins are genetically related to the waning stage of greenschist facies metamorphism of the Valdez Group; many veins are accompanied by felsic to intermediate dikes which also are mineralized. Altered granite at the Gold King mine (2) has been dated by K-Ar as 51.6 ± 1.5 m.y. and metatuff in the Valdez Group has been dated as 53.5 ± 1.6 m.y. (Winkler, Silberman, and others, 1981). These ages are similar to ages of gold-bearing rocks in the Valdez Group from the Hope district of the Kenai Peninsula to the west (52.7, 53.2 ± 1.6 m.y., Silberman and others, 1981), and presumably indicate an Eocene age of regional lode gold mineralization.

Gold lodes at the Opal mine west of Chitina (45) also consist of polymetallic sulfide-bearing quartz veins that cut, and probably are cogenetic with, a small dated Eocene pluton (52.4 ± 2.6 m.y., Winkler, Silberman, and others, 1981). Gold-bearing quartz veins in the Wrangell Mountains (59, 109, 110, 112) occur in low-grade metamorphic rocks of the Skolai Group. These deposits are poorly studied, but they are related spatially, and probably temporally, to Upper Jurassic plutons.

Placer deposits

Placer deposits are known to be present in nearly all the streams that drain areas of lode gold mineralization in the Valdez Group. In addition, placer gold was produced from the Little Bremner River (71) early this century. Although no lode gold occurrences are known to be present in the drainage, the country rock is the Valdez Group with felsic dikes - that is, rocks that are very similar to those that host lode deposits elsewhere in the quadrangle. Generally the placers contain only very fine gold and are lean. Many of the larger drainages that flow northward from the Chugach Mountains have been diluted additionally by glacial deposits derived from the north (Williams and Johnson, 1981).

Nickel

Peridotite and pyroxenite sills that intrude amphibolite-facies and retrograded greenschist-facies metamorphic rocks of the Haley Creek terrane near Spirit Mountain (52, 106) contain massive and disseminated nickel and copper sulfide minerals, as well as pyrite and pyrrhotite. Arsenic, cobalt, silver, and platinum-group elements (chiefly palladium) are present in some samples from the Spirit Mountain prospect (52), which is the only deposit that has been explored well. Anomalous concentrations of nickel, as well as spot occurrences of high copper, chromium, and cobalt values characterize both the layered ultramafic bodies such as Bernard and Dust Mountains (42, 43) and the serpentinized ultramafic bodies emplaced near or along the Border Ranges (83), Second Lake, and unnamed fault zones along the north flank of the Chugach Mountains. The sheared masses of ultramafic rock are essentially unexplored.

Silver

Silver occurs as a byproduct metal in many sulfide deposits in the Valdez quadrangle. Host rocks for silver-bearing veins range from the late Paleozoic Skolai Group (59) to an Eocene tonalite pluton (45). Up to 150 parts per million (ppm) of silver occurs in polymetallic lodes that are notable principally for gold (e.g., deposits near Columbia, Shoup, and Valdez Glaciers, and near the Tiekel River); silver also is potentially a significant byproduct metal at most of the lode copper deposits, such as the Midas mine (32), which generally contain between 10 and 150 ppm. Up to 20 ppm silver also are present in samples from the Spirit Mountain prospect (52) and from occurrences in shear zones near Barnette Creek (83). Host rocks in these two locations are mafic and ultramafic plutonic rocks.

Zinc

Zinc is an important potential byproduct of many copper and gold deposits in the quadrangle. In the copper deposits, sphalerite is a common constituent of the sulfide minerals in the Midas mine (32), at prospects near Jack Bay (29, 30) and Sulphide Gulch (33), and at occurrences near Wortmanns and Tsina Glaciers (78, 79). Sphalerite also is present in most of the gold-bearing veins, especially near Columbia (2-4) and Shoup (8, 10-14, 16) Glaciers, at the Cliff mine (15), along Mineral Creek (19-23), near Valdez Glacier (26, 28, 88), near Hurtle Creek (40), and the Tiekel River (60, 94), and the Opal mine (45) west of Chitina. The sphalerite typically is associated with lesser amounts of galena, although galena occurs in some veins from which sphalerite has not been reported (e.g., 36). Minor amounts of silver and cadmium also generally are associated with the sphalerite and galena in the gold-bearing veins.

At Willow Mountain (44), zinc and copper minerals are disseminated through large volumes of iron-stained mafic tuff and breccia of the Talkeetna Formation; exposures at pipeline cuts along the Richardson Highway and at the summit of the mountain near the microwave towers are stained over wide areas. Sphalerite is disseminated in iron-stained calcareous rocks of the Haley Creek terrane, most notably at occurrences along the ridge north of the Uranatina River (80) and at the headwaters of Canyon Creek (81); no concentrations of sphalerite are known. Although the host rocks are strongly cataclasized, the cataclastic foliation parallels lithologic contacts in the rocks; thus, the mineralization, which extends for hundreds of meters parallel to the foliation, is crudely stratiform. These stained zones occur at several horizons and are virtually unexplored.

NONMETALLIC COMMODITIES

The quadrangle contains large resources of limestone, and of sand, gravel, and rock suitable for industrial and construction purposes (see Williams and Johnson, 1980). Known resources of other nonmetallic commodities are negligible. Large-scale utilization of nonmetallic commodities is largely dependent upon proximity to urban or industrial centers, upon high-volume production, and upon low transportation costs. Unless the Copper River Basin or Valdez areas undergo expansion not presently anticipated, nonmetallic commodities probably will be exploited only locally in small quantities.

Limestone

Carbonate rocks are widespread in the quadrangle, especially the northeastern part. Their distribution is depicted in a companion geologic map (Winkler, Silberman, and others, 1981). Limestones within the Skolai Group and the Chitistone Limestone in the Wrangell Mountains, the Chitina River valley, and the northernmost Chugach Mountains generally are rather pure calcium carbonate and thus are well suited to industrial uses. Marbles within the Haley Creek terrane are widespread, but they have more variable compositions: although nearly pure calcium carbonate is present locally, most marbles have sufficient siliceous impurities to impare their value. Elsewhere in the quadrangle, small marble bodies are widely scattered through outcrops of the McHugh Complex along the northern flank of the Chugach Mountains. They vary in purity, however, and are of such limited distribution and size that they do not merit economic consideration.

Sand, gravel, and rock

Sand, gravel, and rock occur widely in the quadrangle, and have had limited local use in construction of roads and similar projects. Sand and gravel are present in large volume in many places in the Copper River Basin and in braided floodplains or glacial moraines within the mountains. Various bedrock formations could provide rock for a variety of industrial uses. These commodities are in ample supply for local demand. It is not likely that they merit exportation, for they are available locally in nearby regions.

ENERGY RESOURCES

Geothermal Resources

Heat flux at the summit crater of Mt. Wrangell has been increasing consistently for the past decade (Benson and Motyka, 1979), causing melting of the summit ice cap, seasonal exposure of bare ground on the north slope of the crater, and intermittent ash falls that darken the summit area. Although the volume of the magma chamber under Mt. Wrangell is estimated to be approximately 50 cubic kilometers (Smith and Shaw, 1975), its potential use as a large-scale source of geothermal power is constrained by its lofty elevation and its remoteness from potential power demand. Areas of abnormally high heat flux are not known at lower elevations on the west flank of the volcano, where development costs would be less prohibitive.

Nuclear Fuels

Weakly anomalous radioactivity was detected in several areas of the quadrangle during an airborne radiometric survey (LKB Resources, 1978). Reconnaissance surveys on the ground with a hand-held scintillometer verified that the sources of radioactivity were Upper Jurassic and Tertiary plutons. Apparently potassium decay is responsible for the radioactivity; no uranium or thorium minerals were found in the plutons nor in any other rocks in the quadrangle. Detailed scintillometer surveys of sections in the lower part of the Wrangell Lava failed to reveal any sources of radioactivity. Hence the potential for uranium or thorium in the quadrangle is poor.

Petroleum

No petroleum resources are known in the Valdez quadrangle, and the potential for them is poor. Possible source rocks are limited to the Chitistone Limestone, which in places is fetid when freshly broken. Possible reservoir rocks are extremely rare and are limited to sandstone in Jurassic and Cretaceous sedimentary rocks in the Wrangell and northernmost Chugach Mountains, which constitute part of the Matanuska-Wrangell terrane. Generally these sandstones are well indurated with low porosities and permeabilities. Framework grains mostly are volcanogenic, and interstices between grains are plugged with the diagenetic products of their alteration. These sedimentary rocks show no evidence of having generated or harbored petroleum.

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Explanation of Table Headings

MAP NO. AND NAME(S) (if known)--Map no. refers to a specific deposit or a closely-spaced group of deposits on the mineral deposits map and links the map and table. Names of deposits are derived from published sources, general usage, or a conspicuous nearby geographic feature. Names in parentheses are duplicate and generally less valid names for the name preceding the parentheses.

LOCATION--Location refers to the standard township and range land designations referenced to the Copper River Meridian. Some deposits extend into more than one township or range.

CATEGORY--Mineral deposits and occurrences in the Valdez quadrangle are subdivided into five categories that are indicated by the following abbreviations: M = mine with no known post-1950 activity; M = mine with known or probable post-1950 activity; P = prospect with no apparent post-1950 activity; P = prospect with apparent post-1950 activity; O = occurrence.

RESOURCES--Indicates by standard chemical symbols the main mineral commodity or commodities that have been produced or are noteworthy at the deposit or occurrence (subordinate commodities or potential by-products are shown in parentheses).

FORM--Denotes the physical aspect of a deposit: whether it is disseminated or massive, occurs in veins or as replacements, is a lode or a placer.

TYPE--The deposits are classified according to general deposit types, most of which have genetic connotations. In a broad sense, most metal-bearing deposits are hydrothermal; in the cases where deposits do not conform to other types, they are listed as hydrothermal. Due to lack of information, classification for some deposits is arbitrary; it is queried.

BRIEF DESCRIPTION--Briefly summarizes the geology and mineralogy of the deposits and, in a few cases, includes production and historical data.

PRINCIPAL REFERENCES--Cites sources for information used in the table and map, which are included in the list of references cited.

Abbreviations Used

Locations: T = township; R = range; S = south; W = west; N = north; E = east.

Resources: Standard chemical symbols--for example, Au = gold; Pt = platinum-group elements

Dimensions: km = kilometer; m = meter

Minerals:

aspy = arsenopyrite	gn = galena
ba = barite	lim = limonite
bn = bornite	ml = malachite
calc = calcite	mo = molybdenite
cc = chalcocite	po = pyrrhotite
chl = chlorite	py = pyrite
chrys = chrysocolla	qz = quartz
cl = chalcanthite	sb = stibnite
cp = chalcopyrite	sl = sphalerite
cv = covellite	

MINES, PROSPECTS, AND MINERAL OCCURRENCES IN THE VALDEZ QUADRANGLE

MAP NO. AND NAME(S) (if known)	LOCATION	CATEGORY	RESOURCES Minor constituents or potential byproducts in parentheses	FORM	TYPE	BRIEF DESCRIPTION	PRINCIPAL REFERENCES
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

MINES, PROSPECTS, AND MINERAL OCCURRENCES IN THE VALDEZ QUADRANGLE

MAP NO. AND NAME(S) (if known)	LOCATION	CATEGORY	RESOURCES Minor constituents or potential byproducts in parentheses	FORM	TYPE	BRIEF DESCRIPTION	PRINCIPAL REFERENCES
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

MINES, PROSPECTS, AND MINERAL OCCURRENCES IN THE VALDEZ QUADRANGLE

MAP NO. AND NAME(S) (if known)	LOCATION	CATEGORY	RESOURCES Minor constituents or potential byproducts in parentheses	FORM	TYPE	BRIEF DESCRIPTION	PRINCIPAL REFERENCES
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

MAP AND SUMMARY TABLE DESCRIBING MINERAL DEPOSITS IN THE VALDEZ QUADRANGLE, SOUTHERN ALASKA

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1981