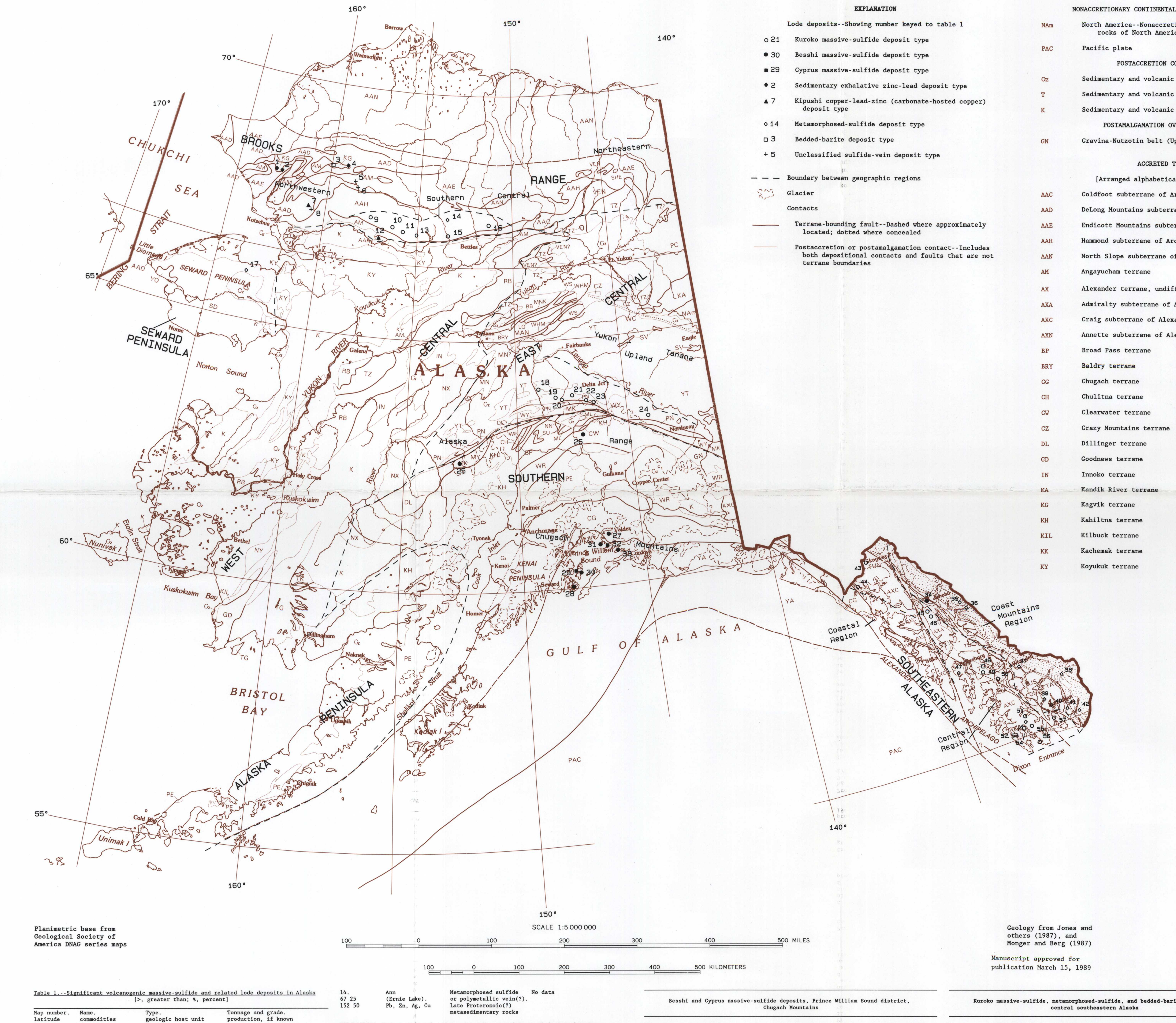

EXPLANATION

Lode deposits--Showing number keyed to table 1

- ○ 21 Kuroko massive-sulfide deposit type
- ● 30 Besshi massive-sulfide deposit type
- ■ 29 Cyprus massive-sulfide deposit type
- ◆ 2 Sedimentary exhalative zinc-lead deposit type
- ▲ 7 Kipushi copper-lead-zinc (carbonate-hosted copper) deposit type
- ◇ 14 Metamorphosed-sulfide deposit type
- □ 3 Bedded-barite deposit type
- + 5 Unclassified sulfide-vein deposit type

Boundary between geographic regions

Glacier

Contacts

Terrane-bounding fault--Dashed where approximately located; dotted where concealed

Postaccretion or postamalgamation contact--Includes both depositional contacts and faults that are not terrane boundaries

NONACCRETIONARY CONTINENTAL ROCKS AND OCEANIC PLATE

NAm	North America--Nonaccretionary Phanerozoic continental rocks of North America
PAC	Pacific plate

POSTACCRETION COVER DEPOSITS

Cz	Sedimentary and volcanic rocks (Cenozoic)
T	Sedimentary and volcanic rocks (Tertiary)
K	Sedimentary and volcanic rocks (Upper Cretaceous)

POSTAMALGAMATION OVERLAP ASSEMBLAGE

GN	Gravina-Nutzotin belt (Upper Jurassic to mid-Cretaceous)

ACCRETED TERRANES

[Arranged alphabetically by map symbol]

AAC	Coldfoot subterrane of Arctic Alaska terrane
AAD	DeLong Mountains subterrane of Arctic Alaska terrane
AAE	Endicott Mountains subterrane of Arctic Alaska terrane
AAH	Hammond subterrane of Arctic Alaska terrane
AAN	North Slope subterrane of Arctic Alaska terrane
AM	Angayucham terrane
AX	Alexander terrane, undifferentiated
AXA	Admiralty subterrane of Alexander terrane
AXC	Craig subterrane of Alexander terrane
AXN	Annette subterrane of Alexander terrane
BP	Broad Pass terrane
BRY	Baldry terrane
CG	Chugach terrane
CH	Chulitna terrane
CW	Clearwater terrane
CZ	Crazy Mountains terrane
DL	Dillinger terrane
GD	Goodnews terrane
IN	Innoko terrane
KA	Kandik River terrane
KG	Kagvik terrane
KH	Kahiltna terrane
KIL	Kilbuck terrane
KK	Kachemak terrane
KY	Koyukuk terrane
LG	Livengood terrane
MAN	Manley terrane
MK	McKinley terrane
ML	Maclaren terrane
MN	Minchumina terrane
MNK	Minook terrane
MY	Mystic terrane
NN	Nenana terrane
NX	Nixon Fork terrane
NY	Nyack terrane
PC	Porcupine terrane
PE	Peninsular terrane
PN	Pingston terrane
PW	Prince William terrane
RB	Ruby terrane
SD	Seward terrane
SE	Saint Elias terrane
SHE	Sheenjek terrane
ST	Stikinia terrane
SU	Susitna terrane
SV	Seventymile terrane
TA	Tracy Arm terrane
TG	Togiak terrane
TK	Tikchik terrane
TUS	Southern Taku terrane
TUN	Northern Taku terrane
TUC	Central Taku terrane
TZ	Tozitna terrane
VEN	Venetie terrane
WC	Woodchopper Canyon terrane
WF	West Fork terrane
WHM	White Mountains terrane
WR	Wrangellia terrane
WS	Wickersham terrane
WY	Windy terrane
YA	Yakutat terrane
YO	York terrane
YT	Yukon-Tanana terrane

EDITOR'S NOTE

This map is one of several planned or published products of a study of the distribution and setting of volcanogenic massive-sulfide occurrences in the Western United States. The term "volcanogenic massive-sulfides" refers to occurrence types that are inferred to be associated with the development of ancient island arc or rift systems in a mainly subaqueous environment. Most massive-sulfide occurrences shown on this map were probably deposited in ancient island arc and rift environments and are considered to be either "proximal" or "distal" with respect to their emplacement near centers of submarine volcanic activity.

INTRODUCTION AND PURPOSE

This map and accompanying text is a compilation of the significant volcanogenic massive-sulfide and related lode deposits of Alaska as of early 1987. The map and accompanying text are parts of (1) a U.S. Geological Survey Bulletin entitled "Significant Metalliferous Lode Deposits and Placer Districts of Alaska" ...

Table 1.--Significant volcanogenic massive-sulfide and related lode deposits in Alaska

...

38. Alamo. 55 45, 130 45. Ag, Au, Cu, Zn. Metamorphosed sulfide. Paleozoic(?) paragneiss. Grab samples and drill core containing as much as 0.2 to 0.7% Cu, 0.2 g/t Au, 50 g/t Ag, and minor Zn

DESCRIPTION: Disseminated and veinlike(?) masses of chalcopyrite, pyrite, pyrrhotite, and sphalerite in zone as much as 25 m wide in Paleozoic(?) paragneiss of the informally named Coast plutonic-metamorphic complex of Brew and Ford (1984a, b) near foliated granodiorite. SOURCES: Berg and others, 1977.

39. Mahoney. 55 26, 131 31. Ag, Pb, Zn. Metamorphosed sulfide. Upper Paleozoic or Mesozoic flysch. Estimated 2,200 tonnes ore grading 6-7% Pb, and about 28% Zn. Produced several hundred tonnes Zn concentrate

DESCRIPTION: Sphalerite and galena in discontinuous tabular to lenticular layers as much as 40 cm thick in fine-grained, dark-silver-gray, upper Paleozoic or Mesozoic micaceous phyllite of the informally named Coast plutonic-metamorphic complex of Brew and Ford (1984a, b). Originally described as a steeply dipping vein; reinterpreted here as stratabound deposit partly remobilized during subsequent metamorphism and deformation. Several open cuts and 100 m of underground workings. Minor production from 1947 to 1949. SOURCE: Robinson and Twenhofel, 1953; H.C. Berg, written commun., 1984.

40. Moth Bay. 55 18, 131 21. Cu, Zn. Metamorphosed sulfide. Upper Paleozoic or Mesozoic metaflysch. Estimated 91,000 tonnes grading 7.5% Zn and 1% Cu. Additional 181,000 tonnes grading 4.5% Zn, 0.75% Cu

DESCRIPTION: Discontinuous lenses and layers of massive pyrite, pyrrhotite, and minor chalcopyrite and galena. Local disseminated pyrite. Host rocks are light-brown-gray, upper Paleozoic or Mesozoic muscovite-quartz-calcite schist, minor pelitic schist and quartz-feldspar schist (possibly metachert). Layers and lenses of massive-sulfide minerals as much as 1 m thick parallel to compositional layering of schist. Host rocks part of the informally named Coast plutonic-metamorphic complex of Brew and Ford (1984a, b). Several open cuts and about 230 m of underground workings. SOURCES: Robinson and Twenhofel, 1953; Berg and others, 1978; H.C. Berg, written commun., 1984.

41. Reliance (Roe Point). 55 17, 130 57. Cu, Zn. Metamorphosed sulfide. Paleozoic(?) schist. No data

DESCRIPTION: Massive layers and disseminated pyrite, pyrrhotite, chalcopyrite, and sphalerite in rust-weathering Paleozoic(?) schist of the informally named Coast plutonic-metamorphic complex of Brew and Ford (1984a, b). About 30 m of underground workings. SOURCE: Wright and Wright, 1908.

42. Red River. 55 04, 130 31. Cu, Mo. Metamorphosed sulfide. Paleozoic(?) paragneiss. No data

DESCRIPTION: Disseminated grains and small masses of pyrite, pyrrhotite, magnetite, and molybdenite occurring slong layering in Paleozoic(?) paragneiss of the informally named Coast plutonic-metamorphic complex of Brew and Ford (1984a, b) intruded by pegmatite and gneissic granodiorite. Layers range from a few centimeters to 30 m thick. SOURCE: Berg and others, 1978.

...

53. Moonshine. 55 11, 132 23. Ag, Pb, Zn, Cu. Metamorphosed sulfide. Lower Paleozoic metasedimentary rocks. Produced as much as 46,500 g Ag. Grab samples contained 20-83% Pb, 411 — 1,030 g/t Ag

DESCRIPTION: Galena, sphalerite, minor chalcopyrite, and accessory pyrite and siderite in well-defined fissure veins or reniform pods as much as a few meters wide in a dolomitized vein breccia cutting obliquely across marble and metasedimentary rocks. Gangue of quartz, siderite, and calcite. Local diabase dikes crossing fissure and wallrocks. Several tunnels and shafts. Minor production between 1900 and 1909. Wallrocks part of the pre-Middle Ordovician Wales Group in Alexander belt. SOURCES: Wright, 1909; Herreid and others, 1978.

54. Lime Point. 55 03, 132 38. Ba. Bedded barite. Lower Paleozoic metasedimentary rocks. Estimated 4,500 tonnes grading 91% barite

DESCRIPTION: Interlayered lenses of barite and dolomite as much as 2 m thick in lower Paleozoic marble of the pre-Middle Ordovician Wales Group in Alexander belt. Local faulting and folding and andesite dikes intruded along faults. One short adit. Test shipments; no production. SOURCES: Twenhofel and others, 1949; Herreid and others, 1978.

55. Niblack. 55 04, 132 09. Cu, Au, Ag. Kuroko massive sulfide. Lower Paleozoic metavolcanic rocks. Produced about 636,000 kg Cu, 34,200 g Au, 466,500 g Ag

DESCRIPTION: Lenticular masses and disseminations of chalcopyrite, pyrite, and lesser sphalerite, galena, hematite, and magnetite in mainly quartz-sericite schist derived from pre-Ordovician(?) felsic volcanic or volcaniclastic rocks. Felsic metavolcanic rocks interlayered with intermediate to mafic metavolcanic rocks and lesser slate. Host rocks part of the pre-Middle Ordovician Wales Group in Alexander belt. Workings consist of a 100-m shaft and about 1.6 km of underground workings. Main mining from 1902 to 1909. Recent development. SOURCE: Herreid, 1964.

56. Barrier Islands. 54 48, 132 27. Ag, Au, Cu, Pb, Zn, Ba. Kuroko massive sulfide. Lower Paleozoic metavolcanic rocks. Grab samples contained as much as 10% Zn, 0.15% Pb, 30 g/t Ag, and 0.25 g/t Au

DESCRIPTION: Disseminated to massive pyrite and minor sphalerite, galena, and arsenopyrite in zones as much as a few meters long and 3 m thick. Sulfide minerals also form rinds of pillows in metavolcanic rocks. Hosted by Ordovician and Silurian felsic to intermediate metavolcanic rocks and metagraywacke of Alexander belt. SOURCE: Gehrels and others, 1983.

57. Driest Point and nearby area on Gravina Island. 55 11, 131 36. Cu, Pb, Ba. Kuroko massive sulfide(?). Triassic metavolcanic and metasedimentary rocks. No data

DESCRIPTION: Disseminated to massive pyrrhotite, pyrite, and minor sphalerite in zones as much as a few meters thick in carbonaceous sedimentary rocks and chert at contact of Upper Triassic metarhyolite with slate and limestone. Vein deposits containing disseminated galena, chalcopyrite, and pyrite in veins in shear zones as much as 3 m wide. Gangue of quartz, calcite, and barite in Triassic metarhyolite. Host rocks part of Alexander belt. Vein deposits probably formed during Cenozoic remobilization of older massive-sulfide deposit. SOURCE: Berg and others, 1981.

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This deposit type consists of stratabound, massive sulfide minerals hosted mainly by dolomitic breccia. The depositional environment consists mainly of strong fluid flow along faults or karst(?)-breccia zones. Generally no rocks of unequivocal igneous origin are related to the deposit. The deposit minerals include pyrite, bornite, chalcocite, chalcopyrite, carrollite, sphalerite, and tennantite, and minor renierite and germanite. Local dolomite, siderite, and silica in various forms, all as alteration products, may be present. Notable examples of carbonate-hosted copper deposits in Alaska are the Ruby Creek and Omar deposits in the Brooks Range. In parts of Alaska, Kipushi copper-lead-zinc deposits such as that at Ruby Creek are generally associated with Kuroko massive-sulfide deposits such as those nearby to the north in the Ambler district.

Metamorphosed Sulfide Deposit
(Nokleberg and others, 1987)

This deposit type consists of stratabound, massive to disseminated sulfide minerals hosted by moderately to highly metamorphosed and deformed metavolcanic or metasedimentary rocks. Metamorphism and deformation have obscured protoliths of host rocks and deposits so as to preclude classification into more specific deposit types. The interpreted host rocks for these deposits are mainly felsic to mafic metavolcanic rocks and metasedimentary or metavolcanic schist and gneiss. The deposit minerals include chalcopyrite, sphalerite, galena, gold, and bornite, in some cases with pyrite, magnetite, and hematite. Alteration is usually difficult to recognize because of metamorphism. These deposits are mainly in regional metamorphic rocks in southeastern Alaska, either in the informally named Coast plutonic-metamorphic complex of Brew and Ford (1984a, b) or in the Alexander belt. Notable examples of metamorphosed sulfide deposits are the Sweetheart Ridge, Sumdum, Groundhog Basin, and Moth Bay deposits, all in southeastern Alaska.

Bedded-Barite Deposit
(G.J. Orris in Cox and Singer, 1986)

This deposit type consists of stratiform, massive barite interbedded with marine, chert-rich and calcareous sedimentary rocks, mainly dark chert, shale, mudstone, and dolomite. The depositional environment consists mainly of epicratonic marine basins or embayments, or submerged volcanic arcs, and associated smaller local basins. Many bedded-barite deposits are associated with sedimentary exhalative zinc-lead or Kuroko massive-sulfide deposits. Alteration consists of secondary barite veining and local, weak to moderate sericite replacement. Associated minerals include minor witherite, pyrite, galena, and sphalerite. Notable examples of bedded-barite deposits in Alaska are the Nimiuktuk deposit in the northwestern Brooks Range and the Castle Island mine in southeastern Alaska.

ABBREVIATIONS AND CONVERSION FACTORS USED IN THIS REPORT

The following abbreviations and symbols are used. Standard chemical symbols for elements, for example, Au, gold; Cu, copper; Fe, iron; U, uranium

PGE: Platinum-group elements--minerals and alloys

REE: Rare-earth elements

mm, cm, m, km: millimeter, centimeter, meter, kilometer

g, kg, t: gram, kilogram, tonne

g/t, g/m^3: grams per metric ton, grams per cubic meter

tonne: metric ton

%: percent

sq: square

The following conversion factors were used to convert weight and volume from U.S. Customary to metric quantities:

1 cubic yard = 0.765 cubic meter

1 troy ounce per short ton = 34.29 grams per metric ton

1 part per million = 1 gram per metric ton

1 pound = 0.454 kilogram

1 troy ounce = 31.10 grams

1 short ton = 0.907 metric ton

1 flask (76.0 pounds mercury) = 34.7 kilograms

SUMMARY OF VOLCANOGENIC MASSIVE-SULFIDE AND RELATED LODE DEPOSITS OF ALASKA

BROOKS RANGE

The northwestern Brooks Range contains several sedimentary exhalative Zn-Pb deposits and one bedded-barite deposit (map, table 1). The southern flank of the central Brooks Range contains an extensive suite of major Kuroko massive-sulfide deposits and one major carbonate-hosted Kipushi copper-lead-zinc deposit. Significant lode mineral deposits in the Brooks Range and Seward Peninsula are further summarized by Einaudi and Hitzman (1986).

The northwestern Brooks Range contains a belt of large sedimentary exhalative zinc-lead and bedded-barite deposits that extends along strike for more than 200 km (map, table 1). The largest zinc-lead-silver deposits are Lik, which contains an estimated 25 million tonnes of ore (Forrest, 1983; Forrest and others, 1984), and Red Dog Creek, which contains an estimated 85 million tonnes of ore and ranks within the top 20 percent, based on size, of known deposits of this type (Moore and others, 1986). Both deposits have high concentrations of zinc, lead, and silver (table 1). A somewhat similar deposit at Drenchwater Creek is in both sedimentary and volcaniclastic rocks (table 1). The Nimiuktuk bedded-barite deposit contains an estimated 1.5 million tonnes of barite (table 1). Substantial potential exists for finding additional deposits in the northwestern Brooks Range (Nokleberg and Winkler, 1982; Lange and others, 1985).

The sedimentary exhalative zinc-lead and bedded-barite deposits in the northwestern Brooks Range are in a tectonically disrupted and strongly folded assemblage of Mississippian and Pennsylvanian chert, shale, limestone turbidite, minor tuff, and sparse intermediate to silicic volcanic rocks, mainly keratophyre, named the "Kuna Formation" (Mull and others, 1982). The Kuna Formation forms the basal unit of the Kagvik sequence (Churkin and others, 1979) and the Kagvik terrane (Jones and others, 1987). This unit, as well as younger late Paleozoic and early Mesozoic chert and shale, are interpreted either as a deep-water, allochthonous oceanic assemblage (Churkin and others, 1979; Nokleberg and Winkler, 1982; Lange and others, 1985) or as an assemblage deposited in an intracratonic basin (Mull and others, 1982; Mayfield and others, 1983). The sedimentary exhalative zinc-lead and bedded-barite deposits are interpreted to have formed either in an incipient submarine continental-margin arc or in the early stages of a long-lived, sediment-starved, epicontinental basin (Nokleberg and others, 1987, 1988).

The eastern part of the northwestern Brooks Range contains a belt of sulfide-vein deposits: Story Creek, Whoopee Creek, Frost, and Omar (map, table 1). These sulfide-vein deposits are summarized in this report because they may be, in part, remobilized from volcanogenic massive-sulfide deposits. The sulfide-vein deposits generally consist of sphalerite and galena, minor quartz, and minor carbonate gangue in veins and fractures that cut the Mississippian Kayak Shale of the Endicott Group at ...

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METALLOGENIC MAP OF SIGNIFICANT VOLCANOGENIC MASSIVE-SULFIDE AND RELATED LODE DEPOSITS IN ALASKA

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