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TEXT AND TABLES DESCRIBING AREAS OF METALLIFEROUS MINERAL RESOURCE POTENTIAL IN THE KETCHIKAN AND PRINCE RUPERT QUADRANGLES, ALASKA

TO ACCOMPANY

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TEXT AND TABLES DESCRIBING AREAS OF METALLIFEROUS MINERAL RESOURCE POTENTIAL IN THE KETCHIKAN AND PRINCE RUPERT QUADRANGLES, ALASKA

(Explanatory text and tables to accompany U.S. Geological Survey open-file report 78-73M)

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INTRODUCTION

This report comprises this pamphlet and a companion map that describe areas of metalliferous mineral resource potential in the Ketchikan and Prince Rupert quadrangles of southeastern Alaska. The report is the result of a multidisciplinary mineral appraisal of the area carried out in 1975-77 by the U.S. Geological Survey under its Alaska Mineral Resource Assessment Program (AMRAP) (U.S. Geological Survey, 1977b). The purpose of the report is to provide a complete and current inventory of the known and potential metallic resources of the area using the best geologic and mineral resource data available to us.

The map shows 16 areas, numbered 1-9, herein considered favorable for resources of specific metal commodities. The location and shape of the areas are determined mainly by the distribution of the known deposits, and by geological, geochemical, and geophysical conditions favorable for the occurrence of specific types of mineral deposits. The areas on the map are keyed numerically to tables 1 and 2 (p. 12-44 and p. 45-46). These tables describe the known and inferred types of deposits in each area, summarize available data on geology, geochemistry, and geophysics, on production, resources, and status of geologic knowledge, and provide the resource estimates that are the basic objectives of this study. Table 3 (p. 47) furnishes grade and tonnage models for the specific types of deposits described in table 2, and thus is an integral part of the resource estimate.

Background information for this report is published separately as a folio of open-file reports (table 4, p. 48). These reports provide the basic data gathered by the team of earth scientists that participated in the AMRAP investigation of the area, and constitute the foundation of the resource estimate.

Estimates of resources of nonmetallic mineral commodities and of geothermal energy are beyond the scope of this report. However, the folio of basic data includes descriptions of known deposits of selected nonmetallic minerals, and sources of geothermal energy have been described in other publications (Waring, 1917). Fossil fuels such as coal, oil, and natural gas are not known in the Ketchikan and Prince Rupert quadrangles.

METHODOLOGY

Much of the information that follows is adapted from a series of regional reports describing the mineral resources of mainland Alaska (Eberlein and others, 1978; Hudson and DeYoung, 1978; and MacKevett and others, 1978).

To meet its goal of assessing the metalliferous mineral endowment of the Ketchikan and Prince Rupert quadrangles, this report integrates the fundamental mineral deposit, geological, and related information in the folio of basic data (table 4), and utilizes a probabilistic method of mineral resource appraisal. In essence, favorable mineral resource areas are outlined on the basis of known deposits, and of geologic favorability for undiscovered or speculative deposits of specific types. The outer limit of most areas is determined by the mapped extent of rock units that permit the occurrence of the deposit type(s). The mineral resource assessment thus is a function of favorable geology, coupled in most cases with supplementary geochemical and geophysical data. Numerical predictions of deposits at 3 arbitrary levels of confidence (90%, 50%, and 10%) are given, along with the information on which the predictions are based. Predictions of probable grades and tonnages are possible for specific types of mineral deposits for which information from better-known such deposits elsewhere in the Cordillera can be used to generate models (table 3). In some cases, the basic data are insufficient to justify more than qualitative resource estimates. However, for certain areas and deposit types, the data are adequate to subjectively predict a number of undiscovered deposits and their probable tonnage and grade. No attempt is made to rank the areas with respect to their relative degrees of favorability or economic value, but the general potential and rank of a specific area can be inferred from the descriptions in the tables.

The estimated number of deposits associated with a 90% level of confidence generally is related to the number of known deposits of that type in the delineated area, but the actual estimate depends largely on the degree to which the "known" deposits have been explored. In the Ketchikan and Prince Rupert quadrangles, only one deposit modeled in the grade-tonnage table has been sufficiently explored to include in the 90% category (Quartz Hill). One "potentially significant" deposit of magnetite in ultramafic rocks also is predicted at the 90% level, but this mineral deposit type has not been modeled in the grade-tonnage table. For all of the other known deposits, information on grade and tonnage is too scant to include them in the 90% category, and our predictions at the 50% and 10% confidence levels are based mainly on the geologic facts and assumptions described in column 14 of table 1.

This approach to mineral resource assessment uses mineral deposit types as a basis for the estimates and therefore relies heavily on knowledge of geology. Thus, a more confident assessment can be made in cases where all deposit types and geologic controls are known with assurance. Mineral resource assessment, however, is an iterative process, for as the geologic and mineral resource information base grows, or as new types of deposits are recognized, successive assessments can be expected to be more complete and precise.

Resource potential of the parts of the Ketchikan and Prince Rupert quadrangles not included in the areas of mineral resource potential--Except possibly for an area near Very Inlet, the parts of the Ketchikan and Prince Rupert quadrangles not identified as mineral resource potential areas contain only a few scattered mineral occurrences, show scant or inconclusive geochemical or geophysical evidence of significant mineralization, or contain only small occurrences of nonmetallic minerals. Although there are no deposits containing metalliferous minerals known near Very Inlet, the area is marked by an approximately 25 km^2 cluster of anomalous geochemical values that occur both in stream sediment (Be, Cr, Ni, Co) and rock (Cr, Mo, Ni, Pb, Zn) samples (Koch and Elliott, 1978b,c). Although this area thus is geochemically favorable, it is not shown on the map as an area of mineral resource potential because it does not meet any of the other criteria used in this report to define such areas (tables 1 and 2).

The fact that we have excluded large parts of the Ketchikan and Prince Rupert quadrangles from the areas of mineral resource potential is not a prediction that these excluded areas contain no metalliferous mineral resources, only that they do not qualify for inclusion on the basis of the geological and related data that are at our disposal.

Definitions and terms--In this report, a mineral deposit is broadly defined as a natural concentration of valuable or potentially valuable minerals. No size, grade, tonnage, or commercial value is implied.

The terms "deposit" and "occurrence" refer respectively to relatively large, well-explored, or once-productive mineral deposits at one extreme, and to sparse specks or veinlets of metalliferous minerals at the other (anomalous amounts of metals reported only in geochemical analyses are not considered to be "occurrences"). In this report, our use of these terms generally implies this distinction, but there is considerable overlap because the natural variations in mineral deposits do not permit their mutually exclusive use.

The terms "level(s) of confidence", "level(s) of (geologic) certainty", "(geologic) probability", and "(percent) chance" are used interchangeably in this report.

Description of the tables

Tables 1-3 summarize information on geology, geochemistry, and geophysics, on production, resources, mineralogy, and geologic controls of the known deposits, and on the status of geologic knowledge. They also list the criteria used to draw the areas of mineral resource potential, and wherever possible, provide predictive estimates of numbers of undiscovered deposits, and their grades and tonnages.

Table 1 contains 16 columns, some of which in turn are subdivided. The columns and subdivisions are explained individually below.

Column 1. Map area--The number in this column corresponds to the number of one or more areas of mineral resource potential on the map.

2. Summary of criteria for determining boundary of area--This brief statement lists the most important criteria that were used to determine the location and shape of the mineral resource potential areas. More detailed and specific information about these criteria is given in column 6 of this table and in table 2.

3. Resources--In this report, resources are considered to be useful or potentially useful commodities contained in mineral deposits. Resources listed for each area are compiled mainly from the lists of commodities that are reported in the mineral deposits known in that area. Unless queried, the enumerated resources do not include commodities reported only in geochemical analyses, or whose reported occurrence has not been verified or field checked. Commodities presumed to be the primary resources are listed first, followed by potential byproducts in parentheses; within each group, commodities are listed in alphabetical order, without implying abundance or commercial value.

4. Mineral deposit classification (Type, Morphology)--The predominantly genetic nomenclature used in this report to classify types and morphologies (overall characteristics) of mineral deposits generally reflects concepts of mineral deposit classification and ore genesis published recently by various investigators, especially those working in the North American Cordillera. Typical, but not necessarily definitive, examples of such information for several of the deposit types used in this report include: Lowell and Guilbert (1970) and Canadian Institute of Mining and Metallurgy (1976) for porphyry copper and molybdenum deposits; and Large (1977) and Hutchinson (1973) for volcanogenic sulfide deposits.

Classifying mineral deposits in complexly metamorphosed and intruded geologic terrane such as that in the Ketchikan-Prince Rupert region is difficult and often equivocal. For example, any hypogene deposit in metamorphic rocks may have undergone, or resulted from, the metamorphism; it may be due to a later process entirely unrelated to the metamorphism; or it may in fact be the end product of a combination of events. Only detailed studies of possibly metamorphosed mineral deposits can resolve their genesis, history, and (presumably) their unequivocal classification. No such studies have been carried out on any of the mineral deposits known in the Ketchikan and Prince Rupert quadrangles. Column 5 therefore objectively describes the form or habit of the known mineral deposits; that is, whether they occur as veins, disseminations, irregular masses, etc.

For AMRAP resource assessment, however, it is necessary to classify mineral deposits genetically according to mineral deposit types (table 3), and we have done this wherever possible, using all the geologic evidence at our disposal. Hence, mineral deposits that occur as widespread disseminated sulfides, or as pods, lenses, and layers of massive sulfides that are parallel to the compositional or structural layering in specific geologic units are herein interpreted as syngenetic, meaning that they were originally deposited along with the enclosing hostrocks, and are classified accordingly, regardless of subsequent metamorphism or intrusion. The chief departure from this method of classification is for quartz vein deposits, for which the available geologic information is adequate only for geometric description, plus some speculation about their possible origin.

Column 5. Form of mineralization--In contrast to the general morphology of the deposit, which may have genetic implications, this column describes objectively the form in which the metalliferous minerals occur, namely whether in veins, as disseminated particles or crystals, in masses without significant gangue minerals, etc.

6. Criteria--This matrix lists eight geological, geochemical, and geophysical features that were used to delineate the areas of mineral resource potential, or may otherwise have some bearing on the location of their boundaries. For some areas certain features do not occur or the relevant data are absent. Features that are common throughout an area, or have proven or possible widespread relevance, are designated by the letter W; those having restricted or local distribution within an area are designated by the letter L. The abbreviated information in this matrix is explained more fully in table 2.

7. Hostrock (Lithology, Form, Age)--This column describes the country rocks that host the mineral deposits and occurrences known in each area. In large part, the information is summarized from the geologic map in the folio of basic data for this report (table 4). Because both the premetamorphic and metamorphic features of the rocks commonly influence mineral deposit classification and interpretation of ore genesis, the protoliths and premetamorphic character of metamorphic rocks are described wherever possible. For the same reason, the column also shows the premetamorphic and metamorphic ages of the geologic units. For metamorphosed hostrocks, the known or presumed age of the protolith is listed first, followed by a semicolon, then by the known or presumed age(s) of the metamorphism.

8. Age of deposit--This column summarizes the age of the deposit type or types identified or inferred for each area. For unmetamorphosed syngenetic deposits, the age is the same as that of the hostrock. For metamorphosed deposits, the known or presumed original age of the mineralization is listed first, followed by a semicolon, then by the known or presumed age(s) of the metamorphism. The detailed studies required to date ore deposition and ore mineral paragenesis have not been carried out for any of the mineral deposits known in the Ketchikan and Prince Rupert quadrangles. For this reason, the ages of the mineral deposits, especially those that have been metamorphosed along with the hostrocks, are mainly inferred from geologic evidence for ages of multiple metamorphism, deformation, and igneous intrusion.

Column 9. Principal known deposits and occurrences--This column lists the most abundant, most productive or thoroughly explored, or most representative deposits and occurrences known in each area. Numbers in parentheses correspond to numbers assigned to the deposits by Elliott and others (1978), who also furnish a brief description of each deposit.

10. Production and resource information--Available data on ore production, on measured reserves or resources, and on tenor for the deposits known in each area are summarized in this column. Such data are limited, however, because only a few deposits have produced any ore or been thoroughly explored. In addition, most of the deposits that were mined were worked between 1900 and World War II, and there are no exact records of tonnage and grade of ore shipments. Mineral assays reported by early prospectors and mine operators are included only as a rough indication of ore tenor, because such data probably do not represent results of systematic sampling.

11. Geologic controls of mineral resources--These statements describe how the mineral deposits occur in their hostrocks, how the deposits are controlled by geologic features, and, if possible, the genetic relationship between geology and mineral deposit types.

12. Regional geologic setting--Relates the geology of each area to the broad geologic and tectonic elements of southeastern Alaska and neighboring parts of Canada.

13. Status of geologic information--This column briefly describes the level of geologic knowledge of each area, mainly by summarizing recent geologic mapping, geochemical, geophysical, and mineral deposit investigations, and recent industry exploration activity.

14. Summary of mineral resource potential--This key column serves as the transition between the primarily factual and interpretive data presented in the foregoing columns and the primarily subjective predictions in the following columns. It summarizes the available information on mineral resources for each area, and combines these objective data with relevant geologic inferences and assumptions to form the basis for predicting the number of undiscovered deposits, and, wherever possible, their grades and tonnages (columns 15 and 16).

15. Estimated number of deposits (percent chance that there are at least the predicted number)--This column presents numerical estimates of the number of deposits of specific types that may exist within an area. Except for iron deposits in stratified ultramafic rocks and for disseminated lode gold deposits, estimates of the number of deposits are made only for deposits with grades and tonnages comparable to those in the grade-tonnage models (table 3). These estimates are a prediction of the number of deposits likely to occur at high (90%), moderate (50%), and low (10%) levels of geologic certainty. This information is presented in vertical format, with the level of certainty above and estimated number of deposits below. In this report, the estimates of deposits are cumulative; that is, estimates at each successively lower probability include the number of deposits, if any, at the next higher level of probability.

The level of certainty is an arbitrarily chosen percent chance that the estimated number, or more, of the deposits occur in an area. The estimated number of deposits at each level of certainty is established by subjective evaluation of all relevant geological information presented in preceding columns of table 1. Although based on careful geologic reasoning, such subjective evaluations inevitably result in a range of possible estimates. In general, however, the nature of the geologic information makes the 90% level estimate the easiest to construct, and the 10% level estimate the most difficult. For example, in area 1, we predict a 90% chance of at least one porphyry molybdenum deposit having certain grade and tonnage characteristics because the area contains the Quartz Hill porphyry molybdenum deposit. Although still under exploration, a highly confident prediction is justified by results of extensive company diamond drilling. On the other hand, in area 2, the predicted 10% probability of 2 or more volcanogenic massive sulfide deposits having certain grade and tonnage characteristics rests on geologic inferences drawn from information ranging from diamond drilling to unverified reports by prospectors. In cases such as this, where the geologic information is less conclusive, estimating the number of deposits is more difficult.

The reasons for predicting the number of deposits are given in column 14. Because predicting a number of deposits of a specific type depends in large part on whether grades and tonnages for that type have been modeled in table 3, "0" is used in an explicit way. Thus, a "0" predicts that no deposits of types for which grades and tonnages are modeled in table 3 are likely to occur. A "--" indicates that no prediction is made because the probable grades and tonnages for this deposit type have not been modeled in table 3.

Column 16. Grades and tonnages for this deposit type (see table 3)--The expected grade and tonnage of a mineral deposit of a specified type is indicated in this column by reference to a model for this deposit type in table 3. An entry of "insufficient data" is made for deposit types for which there are no such models in table 3.

Table 2 presents the relevant data for eight of the criteria used to define the areas of metalliferous mineral resource potential. These criteria are summarized in column 2 and coded in column 6 of table 1.

Criteria A and B--Geochemically anomalous metals in stream sediment (A) and rock (B) samples are shown by their standard chemical symbols. Threshold values for each anomalous metal are listed in footnotes 4 and 5 at the end of table 1. Metals that charaterize an area's mineral deposit type(s) are underlined; other anomalous metals may indicate overlapping or unidentified areas of other types of mineral deposits, or lithologies having high background levels of these elements. For both criteria A and B the metals are listed in alphabetical order.

Criterion C--Except for area 9, iron-oxide alteration refers to more or less surficial rust-colored coating of country rocks assumed to result from weathering or hydrothermal alteration of iron-bearing sulfide or oxide minerals. In area 9, this alteration consists of widespread impalpable ferric oxide that locally produces a pink, purple, or red color throughout the rocks. Such alteration is especially common near the base of the Puppets Formation and in adjacent underlying geologic units, and is herein regarded as a syngenetic or deuteric feature that accompanied deposition of the Puppets Formation. In area(s) 5, the ultramafic rocks weather bright red or orange due to oxidation of iron and magnesium silicate minerals.

Criterion D--This number is the total number of mines, prospects, and mineral occurrences known in the area and depicted on the mineral deposit map in the folio of basic data (Elliott and others, 1978).

Criterion E--Lists the metalliferous minerals identified in the mineral deposits known in the area. Barite, a nonmetallic mineral having both genetic and potential commercial significance, occurs in many of the mineral deposits in area(s) 9. The most important or widespread mineral or minerals are listed first in probable order of abundance, followed by a semicolon, then by minor or locally important minerals listed in random order.

Criterion F--Summarizes the principal hostrocks for the mineral deposits known in each area. For many areas, the distribution of these rocks coincides with the boundaries of the areas because we infer a close geologic correlation between lithology and type of mineral deposit.

Criterion G--Summarizes correlations, where present, among aeromagnetic features, lithologic units, and areas of mineral resource potential. Based primarily on geologic interpretation of an aeromagnetic contour map (Griscom, 1978; and U.S. Geological Survey, 1977a), the magnetic features are especially useful in delineating the boundaries of mineral resource areas containing mineral deposit types associated with highly magnetic mafic and ultramafic rocks. On the other hand, some areas are underlain by geologic units that contain scant ferromagnetic minerals and which are characterized by relatively low aeromagnetic intensity compared to neighboring geologic units.

Criterion H--Except for a few color anomalies in area 2 that probably indicate weathered or hydrothermally altered zones in pyrite-bearing paragneiss, the mineral resource significance of features seen on Landsat images of the Ketchikan and Prince Rupert quadrangles is inconclusive. Table 2 includes this criterion, not because Landsat data were used to delineate the boundaries of the areas of mineral resource potential, but because the distribution of at least some of the features suggests that they could be related to the occurrence of mineral deposits in ways that are still imperfectly understood. For example, some linear features coincide with trends of rock units, schistosity, faults, joints, and dikes mapped during our geologic studies of the quadrangles, whereas others of equal intensity show no correlation with any geological data that we recognized during the fieldwork. Still other lineaments appear to align with, intersect at, or form boundaries of, clusters or crude belts of some of the mineral deposits known in the quadrangles.

Table 3 describes the grade and tonnage models used in this report. The following description of table 3 is quoted or paraphrased from a report by Hudson and DeYoung (1978, p. 53, 55).

A specified deposit type can be characterized as having a restricted range of size, which, if known, can be used in conjunction with an estimate of the number of occurrences of deposits of this type to produce a resource estimate. This estimate describes the amount of the commodity or commodities contained in deposits of the specific type that may occur in a specific area. The range in size of a particular deposit type may be considered as the range of tons of metal contained in deposits of that type. More information is provided by examining the range of tons of ore and the range of ore grade of deposits. For instance, 100,000 metric tons of copper might be distributed in 100 million tons of ore (a grade of 0.1% copper) or in 10 million metric tons of ore (a grade of 1.0% copper).

Information about expected grades and tonnages of several mineral deposit types has been prepared for use in mineral resource assessment studies of Alaska and summaries of distribution of ore tonnage and ore grade for these deposit types are presented in table 3. The collection and analysis of data used to construct the statistical sample for each deposit type follows the procedure used by Singer and others (1975) in their analysis of different types of copper deposits. The data used to prepare table 3 are from mineral deposits elsewhere in the North American Cordillera that belong to one of the Alaskan deposit types and that have available grade and tonnage estimates, derived, where possible, by combining estimates of past production and present resources. For some deposit types, the information available permitted estimating range of contained metal, but not ore grade and ore tonnage. The summary statistics in table 3 show the median value of the tonnage, grade, or contained metal of a particular deposit type (column 6) and the range within which 80% of the deposits are expected to be (this range is between the values given in columns 5 and 7). For instance, 80% of porphyry copper deposits are expected to contain between 20 and 30 million metric tons of ore, 10% are expected to contain more than the upper limit, and 10% are expected to contain less than the lower limit. These suppositions are based upon the observation that the grade and tonnage can be characterized by a lognormal statistical distribution. A more complete description of this type of analysis is contained in Singer and others (1975).

Only 6 of the 11 grade and tonnage models of table 3 have been referenced in the descriptions of mineral resource potential areas in table 1. This is because not all of the deposit types modeled have analogs in the Ketchikan and Prince Rupert quadrangles. On the other hand, the iron deposits in stratified ultramafic rocks and disseminated lode gold deposits known in the quadrangles (table 1) are not represented in table 3 because information on the size of these deposit types was insufficient for statistical analysis.

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TABLES 1 - 4 FOLLOW

TABLE 1. METALLIFEROUS MINERAL RESOURCE DATA FOR KETCHIKAN AND PRINCE RUPERT QUADRANGLES, SOUTHEASTERN ALASKA

MAP AREA	1/SUMMARY OF CRITERIA FOR DETERMINING BOUNDARY OF AREA	2/RESOURCES	MINERAL DEPOSIT CLASSIFICATION 3/TYPE	MINERAL DEPOSIT CLASSIFICATION MORPHOLOGY	FORM OF MINERALIZATION	1/CRITERIA (also see Table 2) (L, local; W, widespread) A: 4/Anomalous metals in stream sed. spls.	B: 5/Anomalous metals in rock samples	C: Observed surficial alteration	D: Known prospects or occurrences	E: Observed metalliferous minerals	F: Favorable hostrock	G: Characteristic magnetic expression	H: Possibly relevant Landsat data	HOSTROCK LITHOLOGY	HOSTROCK FORM	6/AGE	7/AGE OF DEPOSIT	8/PRINCIPAL KNOWN DEPOSITS AND OCCURRENCES
1.	Boundaries of areas are defined by occurrence of altered Miocene epizonal granite stocks, by swarms of quartz-porphyry dikes having an average strike of 240°, and by anomalous amounts of Be, Mo, and Nb in rock and stream sediment geochemical samples	Mo (U)	Porphyry molybdenum	Stockwork	Disseminations, veins, fracture coatings	W	L	L	L	L	W	L	W	Granite, granite porphyry, quartz porphyry	Stocks, dikes	Miocene	Miocene	Quartz Hill (105); Burroughs Bay (26)

PRODUCTION AND RESOURCE INFORMATION [9]	GEOLOGIC CONTROLS OF MINERAL RESOURCES	REGIONAL GEOLOGIC SETTING	STATUS OF GEOLOGIC INFORMATION	SUMMARY OF MINERAL RESOURCE POTENTIAL	ESTIMATED NUMBER OF DEPOSITS (PERCENT CHANCE THAT THERE ARE AT LEAST THE PREDICTED NO.) [10]	GRADES AND TONNAGES FOR THIS DEPOSIT TYPE (SEE TABLE 3)
Quartz Hill deposit is under active company exploration in 1978. Specific data on Mo resources have not been released; according to newspaper and trade journal articles, deposit said to contain more than 250 million tons of rock containing an average of 0.18% MoS_2. Geochemical analyses by USGS of several samples of molybdenite-bearing quartz porphyry dikes at Burroughs Bay occurrence show up to 100 ppm Mo. USGS samples also contain traces of other potentially valuable metals, including uranium (unpub. data)	Molybdenite-quartz veins, molybdenite fracture coatings, and disseminated molybdenite occur in granite porphyry stocks, and in quartz porphyry dikes prob. cogenetic with the stocks (Elliott and others, 1976; Hudson and others, 1977)	Mid-Tertiary (Miocene) granite porphyry and more mafic stocks intrude metamorphosed plutonic and bedded rocks of the Coast Range complex (Berg and others, 1978). Quartz porphyry and lamprophyre dikes that probably correlate with the stocks form swarms that mainly trend approx. 240° (Smith, 1973), parallel to a major regional joint set that controls the emplacement of the dikes	Reconnaissance (1:250,000-scale) geological, geochemical, and geophysical studies of area by USGS completed in 1977. For information about other studies in the area, see "References". Mineral exploration programs by various mining companies currently are underway throughout the area	Although traces of molybdenite occur in many places in Ketchikan-Prince Rupert area, geologic conditions indicate that terrane favorable for mid-Tertiary - porphyry molybdenum deposits is mainly in the Smeaton Bay-Boca de Quadra and Burroughs Bay areas. One large, low-grade, potentially economic deposit is known in a granite porphyry stock at Quartz Hill. If the quartz porphyry dikes are cogenetic with such stocks, then one or more additional deposits may underlie areas marked by swarms of these dikes. The deposit at Burroughs Bay meets the tonnage requirement of the porphyry molybdenum grade-tonnage model (table 3), but its grade is unknown. Its potential for molybdenum resources therefore is arbitrarily assigned a lower level of confidence than the Quartz Hill deposit	90% 50% 10% chance that there are 1 2 3 deposits or more	Porphyry molybdenum model

TABLE 1 (continued)

MAP AREA	1/ SUMMARY OF CRITERIA FOR DETERMINING BOUNDARY OF AREA	2/ RESOURCES	MINERAL DEPOSIT CLASSIFICATION 3/ TYPE	MINERAL DEPOSIT CLASSIFICATION MORPHOLOGY	FORM OF MINERALIZATION	1/ CRITERIA (also see Table 2) (L, local; W, widespread) A: 4/ Anomalous metals in stream sed. spls.	B: 5/ Anomalous metals in rock samples	C: Observed surficial alteration	D: Known prospects or occurrences	E: Observed metalliferous minerals	F: Favorable hostrock	G: Characteristic magnetic expression	H: Possibly relevant Landsat data	HOSTROCK LITHOLOGY	HOSTROCK FORM	HOSTROCK 6/ AGE	7/ AGE OF DEPOSIT	8/ PRINCIPAL KNOWN DEPOSITS AND OCCURRENCES
2.	Boundary of area generally encloses paragneiss unit on Portland Peninsula	a. Au, Cu, Mo (Ag, Pb, Zn)	a. Volcanogenic?	a. Stratabound	a. Massive sulfides, disseminations, veins	a. L	L	W	W	L	W	W	W	a,b. Paragneiss; foliated granodiorite	a,b. Metamorphosed stratified and plutonic rocks	a,b. Mesozoic or late(?) Paleozoic; Eocene	a. Mesozoic or late(?) Paleozoic; Eocene	a. Alamo(22), Red River (108)
		b. Cu, Mo, Pb	b. Quartz fissure veins	b. Individual veins or small stockworks	b. Veins	b. no data	L	no	L	L	W	no	no				b. Unknown	b. Gnat (21)

9/ PRODUCTION AND RESOURCE INFORMATION	GEOLOGIC CONTROLS OF MINERAL RESOURCES	REGIONAL GEOLOGIC SETTING	STATUS OF GEOLOGIC INFORMATION	SUMMARY OF MINERAL RESOURCE POTENTIAL	10/ ESTIMATED NUMBER OF DEPOSITS (PERCENT CHANCE THAT THERE ARE AT LEAST THE PREDICTED NO.)	GRADES AND TONNAGES FOR THIS DEPOSIT TYPE (SEE TABLE 3)
a, No production. The Alamo prospect has been explored by a few shallow diamond drill holes and trenches, but no information on grade and tonnage has been released by the owners. Results of Geological Survey and Bureau of Mines studies of prospects in this area are summarized in Berg and others (1977). The Red River prospect has been drilled by private interests, but information on tonnage and grade has not been made public.	a. Sulfide-bearing quartz veins, disseminated sulfide minerals, and small pods of massive sulfides occur throughout the paragneiss unit, and locally in foliated plutonic rocks near paragneiss contacts. Geochemical studies indicate that the the paragneiss is intrinsically high in Cu, Pb, Zn and possibly Mo, suggesting that these metals are syngenetic in origin, and that at least some of the mineral occurrences formed by redistribution of the minerals during metamorphism. One small contact metamorphic skarn deposit in marble adjacent to foliated plutonic rocks is known at the Marble Copper prospect.	a,b. The paragneiss unit, a major constituent of the Coast Range complex, consists of gneiss and schist derived from interbedded pelitic and minor volcanic and carbonate bedded rocks mainly of late? Paleozoic and Mesozoic age. Unit also includes small amounts of pegmatite and of gneissic quartz diorite and granodiorite. K/Ar studies show that the unit was regionally metamorphosed to sillimanite grade in Early Tertiary (Eocene) time	a,b. See area 1	a. Of 11 known lode mineral occurrences, 8 may be metamorphosed stratabound deposits of volcanic or volcanic-sedimentary origin. Area is geologically favorable for additional occurrences of lodes containing base and precious metals, but mineral resource potential cannot be estimated quantitatively with present information. Assuming a premetamorphic origin for the deposits, and using information from recent unpublished and unverified reports by mineral industry geologists investigating similar mineral deposits in correlative rocks elsewhere in southeatern Alaska, we infer that there is at least a slight chance that there are one or two deposits having tonnage and grade characteristics of the felsic and intermediate volcanogenic massive sulfide model described in table 3	a. 90% 50% 10% chance that there are deposits or more 0 0 2	a. Felsic and intermediate volcanogenic massive sulfide model
b. No production or resource information. Gnat prospect is on a quartz fissure vein containing pyrite, chalcopyrite, molybdenite, and galena	b. The sulfide-bearing quartz veins may be the result of metamorphic remobilization from the paragneiss, but their habit and metal content suggest instead that they may be polymetallic veins related to subjacent plutons			b. Three of the 11 known lodes are sulfide-bearing quartz veins. Available data are insufficient to estimate the potential resources of these veins	b. Insufficient data	b. Insufficient data

TABLE 1 (continued)

MAP AREA	1/ SUMMARY OF CRITERIA FOR DETERMINING BOUNDARY OF AREA	2/ RESOURCES	MINERAL DEPOSIT CLASSIFICATION 3/ TYPE	MORPHOLOGY	FORM OF MINERALIZATION	1/ CRITERIA (also see Table 2) (L, local; W, widespread) A 4/ Anomalous metals in stream sed. spls.	B 5/ Anomalous metals in rock samples	C Observed surficial alteration	D Known prospects or occurrences	E Observed metalliferous minerals	F Favorable hostrock	G Characteristic magnetic expression	H Possibly relevant Landsat data	HOSTROCK LITHOLOGY	HOSTROCK FORM	6/ AGE	7/ AGE OF DEPOSIT	8/ PRINCIPAL KNOWN DEPOSITS AND OCCURRENCES
3.	Boundary of area defined by (1) known mineral occurrences, (2) geochemical anomalies, and (3) favorable hostrocks	Ag, Au, Cu, Mo, Pb, W, Zn	a. Volcanogenic	a. Stratabound	a. Massive sulfides, disseminations, veins	W	W	L	W	W	W	W	L	a. Recrystallized andesitic volcanic and volcaniclastic rocks (Hazelton? Group); recrystallized granodiorite (Texas Creek Granodiorite)	a. Stratified rocks; stock	a. Triassic or Jurassic	a. Triassic or Jurassic; Cenozoic	a,b. Hyder area (1-9)
			b. Porphyry copper (molybdenum)	b. Stockwork	b. Disseminations, veins	---------(no data)-----------								b. Recrystallized granodiorite (Texas Creek Granodiorite)	b. Stocks, sills, dikes	b. Triassic; Cenozoic	b. Triassic; Cenozoic	

9/ PRODUCTION AND RESOURCE INFORMATION	GEOLOGIC CONTROLS OF MINERAL RESOURCES	REGIONAL GEOLOGIC SETTING	STATUS OF GEOLOGIC INFORMATION	SUMMARY OF MINERAL RESOURCE POTENTIAL	10/ ESTIMATED NUMBER OF DEPOSITS (PERCENT CHANCE THAT THERE ARE AT LEAST THE PREDICTED NO.)	GRADES AND TONNAGES FOR THIS DEPOSIT TYPE (SEE TABLE 3)
a,b. Mountain View mine was explored by more than 1100 m of underground workings, but the only ore shipments were for mill tests. 64 tons of sorted ore were shipped from the Fish Creek mine during WW I, but there is no record of any production since then. Most of the other occurrences in the area were explored during WW II by pits, opencuts, and short adits, but there is no record of any production	a,b. Metalliferous minerals, generally accompanied by quartz, occur as veins, disseminations, and small masses in recrystallized plutonic and volcanic rocks, and in recrystallized shear zones that cut these rocks. Localization of metalliferous minerals probably is result of complex processes, including syngenetic deposition of metals along with deposition of volcanic and volcaniclastic rocks of Hazelton? Group, followed by one or more episodes of deformation, intrusion, and regional and (or) contact metamorphism, accompanied by mobilization and redeposition of metals and gangue minerals	a,b. The Hazelton? Group and Texas Creek Granodiorite are part the Intermontane tectonic belt of the Canadian Cordillera (Geol. Assoc. Canada, 1972; Can. Inst. Mining and Metallurgy, 1976), whose southwestern edge crosses the northeastern corner of the Ketchikan quadrangle. The Hazelton?-Texas Creek are herein presumed to correlate with other Triassic-Jurassic volcano-plutonic complexes in the Intermontane belt	a,b. Reconnaissance (1:250,000-scale) and semidetailed (1:63,360-scale) geologic mapping and related studies by USGS (Smith, 1977). Recent exploration by mineral industry	a. Nine mineral occurrences are known and small amounts of ore containing gold, silver, tungsten, and other metals have been produced from at least one. Geologic conditions are favorable for occurrence of additional such small, relatively high-grade metamorphosed volcanogenic deposits. Available data are inadequate to quantitatively estimate resource potential, but do suggest that there is a slight chance that there is at least one deposit having tonnage and grade characteristics of the felsic and intermediate volcanogenic massive sulfide model described in table 3 b. No porphyry copper deposits are known in area, but geologic conditions are permissive for occurrence of such deposits	a. 90% 50% 10% chance that there is 0 0 1 deposit or more b. (no data)	a. Felsic and intermediate volcanogenic massive sulfide model b. ------------

TABLE 1 (continued)

MAP AREA	1/SUMMARY OF CRITERIA FOR DETERMINING BOUNDARY OF AREA	2/RESOURCES	MINERAL DEPOSIT CLASSIFICATION 3/TYPE	MORPHOLOGY	FORM OF MINERALIZATION	1/CRITERIA (also see Table 2) (L, local; W, widespread) A 4/Anomalous metals in stream sed. spls.	B 5/Anomalous metals in rock samples	C Observed surficial alteration	D Known prospects or occurrences	E Observed metalliferous minerals	F Favorable hostrock	G Characteristic magnetic expression	H Possibly relevant Landsat data	HOSTROCK LITHOLOGY	FORM	6/AGE	7/AGE OF DEPOSIT	8/PRINCIPAL KNOWN DEPOSITS AND OCCURRENCES
4.	Boundary of area defined by (1) known mineral occurrences, (2) high geochemical background level of zinc, and (3) outcrop area of pyritic metapelite and subordinate metavolcanic and carbonate rocks, of felsic? dikes and sills, and of presumably correlative undivided metamorphic rocks	Au, Zn (Ag, Cu, Mo, Pb)	a.Volcanogenic?	a.Stratabound; stratiform?	a.Disseminations, veins, massive sulfides	W	W	L	W	W	W	no	no	a.Pyritic argillite, phyllite, and subordinate greenschist, muscovite schist, and marble; intruded by metamorphosed aplite, aphanite, and granodiorite, and by unmetamorphosed granodiorite and gabbro	a.Stratafied rocks; dikes, sills, stocks	a.Mesozoic or late Paleozoic, and Cenozoic (Miocene); Cretaceous and Cenozoic	a.Mesozoic or late Paleozoic; Mesozoic and? Cenozoic	a.Lucky Four (Hump Island (41), Mahoney (76), Londevan (78), Moth Bay (83), Sea Level (group) (84-98), Reliance (Roe Point)(104)
			b.Porphyry molybdenum?	b.Deposit confined to sill(?)	b.Disseminations	L	L	L	L	L	L	no	no	b.Felsic aplite	b.Sill(?)	b.Cretaceous?	b.Cretaceous?	b.Swan Lake (50.1)

9/ PRODUCTION AND RESOURCE INFORMATION	GEOLOGIC CONTROLS OF MINERAL RESOURCES	REGIONAL GEOLOGIC SETTING	STATUS OF GEOLOGIC INFORMATION	SUMMARY OF MINERAL RESOURCE POTENTIAL	10/ ESTIMATED NUMBER OF DEPOSITS (PERCENT CHANCE THAT THERE ARE AT LEAST THE PREDICTED NO.)	GRADES AND TONNAGES FOR THIS DEPOSIT TYPE (SEE TABLE 3)
a. About 400-500 tons of ore was mined in 1947 at Mahoney mine; 100 tons of flotation concentrates contain- 2 oz Au, 347 oz Ag, 214 lbs Cu, 42,086 lbs Pb, and 74,819 lbs Zn were shipped to smelters in U.S. and Canada. Resources at Mahoney mine are estimated to be 2,500 tons of ore averaging 6%-7% Pb and about 28% Zn. An unknown, but small amount of ore was stockpiled at the Londevan property, but not shipped. No production reported from Moth Bay mine; measured and indicated resources consist of 100,000 tons of material containing 7.5% Zn and 1% Cu; about 3,600 tons contain- 2% Zn and 0.5% Cu; and about 10,000 tons containing nearly 3% Cu and little or no Zn. About 100,000 tons of lower grade material is inferred.	a. The wide diversity of metalliferous lodes and of host-rocks suggests complex ore genesis, further complicated by subsequent episodes of deformation, metamorphism, and intrusion. For example, metalliferous minerals locally occur in layers and lenses approximately conformable with compositional layering in phyllite and in schist and gneiss country rocks respectively at the Mahoney and (reportedly) at the Reliance (Roe Point) prospects; sulfide minerals occur mainly in quartz veins associated with aplite dikes and sills at the Londevan and Sea Level properties; and sulfides occur both in quartz veins and as disseminations throughout schist aplite and other intrusive rocks at the Lucky Four and Moth Bay lodes.	a,b. Country rocks are part of a 10-20 km wide belt of relatively low grade regionally metamorphosed bedded and intrusive rocks that crop out southwest of the Coast Range complex for several hundred km for the length of southeastern Alaska. The belt is distinguished mainly by absence of autochthonous rocks with premetamorphic ages older than late Paleozoic (Berg and others, 1972). K/Ar studies show Cretaceous regional metamorphic ages. Miocene plutons locally produce contact metamorphic aureoles that overprint the regional metamorphism. Stratified rocks include phyllite and schist derived from	a,b. Reconnaissance (1:250,000-scale) geological, geochemical, and geophysical studies by USGS completed in 1977. Recent exploration by mining interests	a. Area contains at least 36 mineral occurrences rang- from simple mineral showings to once-active mines. Based mainly on geology and geochemistry, most of these lodes are herein interpreted as metamorphosed syngenetic deposits of volcanic or volcanic-related origin. Most occurrences known in area are along or near easily accessible coast, suggesting that inland areas have not been fully explored. Area thus presumably has potential for discovery of additional deposits containing Zn, Pb, and locally Ag, Au, and Cu, but available data are inadequate to quantitatively estimate this potential. From what is known within area, and inferred from unverified recent reports of mining companies investigating mineral	a. 90% 50% 10% chance that there are 0 1 2 deposits or more	a. Felsic and intermediate volcanogenic sulfide model

TABLE 1 (continued)

MAP AREA	1/ SUMMARY OF CRITERIA FOR DETERMINING BOUNDARY OF AREA	2/ RESOURCES	MINERAL DEPOSIT CLASSIFICATION 3/ TYPE	MINERAL DEPOSIT CLASSIFICATION MORPHOLOGY	FORM OF MINERALIZATION	1/ CRITERIA (also see Table 2) (L, local; W, widespread) A: 4/ Anomalous metals in stream sed. spls.	B: 5/ Anomalous metals in rock samples	C: Observed surficial alteration	D: Known prospects or occurrences	E: Observed metalliferous minerals	F: Favorable hostrock	G: Characteristic magnetic expression	H: Possibly relevant Landsat data	HOSTROCK LITHOLOGY	HOSTROCK FORM	6/ AGE	7/ AGE OF DEPOSIT	8/ PRINCIPAL KNOWN DEPOSITS AND OCCURRENCES
4.(cont)																		

Next page is 23

9/ PRODUCTION AND RESOURCE INFORMATION	GEOLOGIC CONTROLS OF MINERAL RESOURCES	REGIONAL GEOLOGIC SETTING	STATUS OF GEOLOGIC INFORMATION	SUMMARY OF MINERAL RESOURCE POTENTIAL	10/ ESTIMATED NUMBER OF DEPOSITS (PERCENT CHANCE THAT THERE ARE AT LEAST THE PREDICTED NO.)	GRADES AND TONNAGES FOR THIS DEPOSIT TYPE (SEE TABLE 3)
				potential for significant resources of porphyry molybdenum is herein considered low because: (1) Molybdenite has not been observed in these plutons; (2) Molybdenite content at Swan Lake occurrence is low; and (3) Geochemical studies do not indicate presence of porphyry molybdenum deposits similar to the one at Quartz Hill Most of area is relatively remote and probably has not been fully explored		

TABLE 1 (continued)

MAP AREA	1/ SUMMARY OF CRITERIA FOR DETERMINING BOUNDARY OF AREA	2/ RESOURCES	MINERAL DEPOSIT CLASSIFICATION 3/ TYPE	MINERAL DEPOSIT CLASSIFICATION MORPHOLOGY	FORM OF MINERALIZATION	1/ CRITERIA (also see Table 2) (L, local; W, widespread) A: 4/ Anomalous metals in stream sed. spls.	B: 5/ Anomalous metals in rock samples	C: Observed surficial alteration	D: Known prospects or occurrences	E: Observed metalliferous minerals	F: Favorable hostrock	G: Characteristic magnetic expression	H: Possibly relevant Landsat data	HOSTROCK LITHOLOGY	HOSTROCK FORM	6/ AGE	7/ AGE OF DEPOSIT	8/ PRINCIPAL KNOWN DEPOSITS AND OCCURRENCES
5.	Boundaries of areas determined by outcrops, or aeromagnetic expression, of ultramafic bodies of significant size	Fe (Pt)	Ultramafic	Stratiform	Layers, lenses, disseminations	L	L	L	W	L	W	W	L	Pyroxenite	Zoned ultramafic plutons	Jurassic or Cretaceous	Jurassic or Cretaceous	Duke and Percy Islands area (56-58; 159-173); Alava Bay (100)

9/ PRODUCTION AND RESOURCE INFORMATION	GEOLOGIC CONTROLS OF MINERAL RESOURCES	REGIONAL GEOLOGIC SETTING	STATUS OF GEOLOGIC INFORMATION	SUMMARY OF MINERAL RESOURCE POTENTIAL	10/ ESTIMATED NUMBER OF DEPOSITS (PERCENT CHANCE THAT THERE ARE AT LEAST THE PREDICTED NO.) 90% 50% 10% chance that there is deposit or more	GRADES AND TONNAGES FOR THIS DEPOSIT TYPE (SEE TABLE 3)
No production. Duke and Percy Islands ultramafic bodies have been diamond drilled by private interests, but data on potential iron resources have not been released. "Acid soluble" iron content of pyroxenite on Duke Island ranges from about 8-18 wt percent and averages about 12 wt percent (261 samples); total Fe:Ti ratio reportedly is similar to that at Union Bay, where it is about 13:1 (Taylor and Noble, 1969). Magnetite content ranges from about 10-20 wt percent. Platinum-group metal content of 22 samples from Duke Island average 0.037 ppm Pt (10 samples), 0.033 ppm Pd (16 samples), and 0.010 ppm Rh (6 samples) (Clark and Greenwood, 1972). Small amounts of chromite occur in the dunite and peridotite zones of the ultramafic bodies	Titaniferous magnetite occurs mainly in hornblende-magnetite clinopyroxenite units of zoned ultramafic plutons	Several ultramafic plutons ranging in size from dikes to stocks intrude various Paleozoic and Mesozoic country rocks in area. These plutons are part of a NW-trending belt of Upper Mesozoic ultramafic rocks that mainly crop out SW of the Coast Range complex for the length of SE Alaska. Many of the larger bodies are concentrically zoned from a dunite core to pyroxenite rim. Body on Duke Island is especially noted for rhythmic layering. Nearly all of these plutons produce significant thermal aureoles in surrounding country rocks. K/Ar dating indicates a Cretaceous, or on Duke Island, a Jurassic or Cretaceous, emplacement age	Diamond drilling, and detailed geological, geophysical, and chemical studies by mining interests of Duke and Percy Island bodies. Alava Bay body also investigated by industry. Other occurrences mapped by USGS during recent reconnaissance geological and geophysical studies. Area on Cleveland Peninsula is inferred from aeromagnetic survey	Ketchikan and Prince Rupert quadrangles contain several small outcrop areas of ultramafic rocks, one area inferred from aeromagnetics to be underlain by ultramafic rocks, and one major body of magnetite-bearing ultramafic rocks. Because of its size, only the Duke Island body is considered herein to have potential for significant iron resources, and possibly for byproduct platinum-group metals. Smaller bodies at Percy Islands and Alava Bay have been explored by private interests, from which we infer that they may contain relatively small iron resources. Aeromagnetic anomaly on Cleveland Peninsula is continuation of magnetic feature that marks a major body of magnetite-bearing ultramafic rocks at Union Bay, about a km from the western edge of the Ketchikan quadrangle. Although no magnetite-bearing ultramafic rocks are known on Ketchikan side of boundary, the aeromag-	1 -- --	Insufficient data

TABLE 1 (continued)

MAP AREA	1/ SUMMARY OF CRITERIA FOR DETERMINING BOUNDARY OF AREA	2/ RESOURCES	MINERAL DEPOSIT CLASSIFICATION 3/ TYPE	MINERAL DEPOSIT CLASSIFICATION MORPHOLOGY	FORM OF MINERALIZATION	1/ CRITERIA (also see Table 2) (L, local; W, widespread) 4/ Anomalous metals in stream sed. spls. A	5/ Anomalous metals in rock samples B	Observed surficial alteration C	Known prospects or occurrences D	Observed metalliferous minerals E	Favorable hostrock F	Characteristic magnetic expression G	Possibly relevant Landsat data H	HOSTROCK LITHOLOGY	HOSTROCK FORM	6/ AGE	7/ AGE OF DEPOSIT	8/ PRINCIPAL KNOWN DEPOSITS AND OCCURRENCES
5.(cont)																		

9/ PRODUCTION AND RESOURCE INFORMATION	GEOLOGIC CONTROLS OF MINERAL RESOURCES	REGIONAL GEOLOGIC SETTING	STATUS OF GEOLOGIC INFORMATION	SUMMARY OF MINERAL RESOURCE POTENTIAL	10/ ESTIMATED NUMBER OF DEPOSITS (PERCENT CHANCE THAT THERE ARE AT LEAST THE PREDICTED NO.)	GRADES AND TONNAGES FOR THIS DEPOSIT TYPE (SEE TABLE 3)
				netic data suggest that they may occur at fairly shallow depth. Although available data are not adequate for us to numerically estimate iron resources, we infer from various published sources (for example, Taylor and Noble, 1960) that at least one potentially significant deposit of titaniferous magnetite occurs in the pyroxenite zone of the Duke Island ultramafic complex		

TABLE 1 (continued)

MAP AREA	1/ SUMMARY OF CRITERIA FOR DETERMINING BOUNDARY OF AREA	2/ RESOURCES	3/ MINERAL DEPOSIT CLASSIFICATION: TYPE	MINERAL DEPOSIT CLASSIFICATION: MORPHOLOGY	FORM OF MINERALIZATION	1/ CRITERIA (also see Table 2) (L, local; W, widespread): A 4/ Anomalous metals in stream sed. spls.	B 5/ Anomalous metals in rock samples	C Observed surficial alteration	D Known prospects or occurrences	E Observed metalliferous minerals	F Favorable hostrock	G Characteristic magnetic expression	H Possibly relevant Landsat data	HOSTROCK: LITHOLOGY	HOSTROCK: FORM	6/ AGE	7/ AGE OF DEPOSIT	8/ PRINCIPAL KNOWN DEPOSITS AND OCCURRENCES
6.	Boundary of area determined by location of auriferous quartz veins and sulfide disseminations in greenschist and phyllite in Helm Bay area of Cleveland Peninsula	Au (Ag, Cu, Pb, Zn)	a. Auriferous quartz veins	a. Vein and stringer lodes (stockwork?)	a. Veins	no data	L	no	W	W	W	no	W	a,b. Greenschist, phyllite, and minor diorite and diorite porphyry	a,b. Metamorphosed stratified rocks, dikes, and stocks	a, b. Mesozoic or late Paleozoic; Cretaceous?	a. Unknown	a,b. Helm Bay area
			b. Disseminated lode gold deposits	b. Disseminated lodes	b. Sulfide disseminations	no data	L	no	L	W	W	no	no				b. Mesozoic or late Paleozoic; Cretaceous?	

9/ PRODUCTION AND RESOURCE INFORMATION	GEOLOGIC CONTROLS OF MINERAL RESOURCES	REGIONAL GEOLOGIC SETTING	STATUS OF GEOLOGIC INFORMATION	SUMMARY OF MINERAL RESOURCE POTENTIAL	10/ ESTIMATED NUMBER OF DEPOSITS (PERCENT CHANCE THAT THERE ARE AT LEAST THE PREDICTED NO.)	GRADES AND TONNAGES FOR THIS DEPOSIT TYPE (SEE TABLE 3)
a,b. Although there are no exact records, thousands of ounces of gold, with some byproduct silver, probably were produced from the Helm Bay lodes, mainly from the Gold Standard mine, which operated intermittently from about 1898 to WW II. Some gold was produced from several other lodes in the district, but their aggregate production probably was less than that of the Gold Standard	a,b. Auriferous pyrite, a little free gold, and minor amounts of arsenopyrite, galena, chalcopyrite, sphalerite, bornite, and reportedly telluride minerals occur mainly in quartz veins and stringers in phyllite and greenschist, and locally in metamorphosed diorite and diorite porphyry country rocks. Pyrite and arsenopyrite(?) are disseminated throughout the phyllite and schist, locally in crystals as large as 2-3 cm. The occurrence of disseminated sulfide minerals suggests a syngenetic origin roughly contemporaneous with the deposition of the volcanic and sedimentary protoliths of the greenschist and phyllite country rocks. The quartz veins and accompanying metalliferous minerals, however, probably are segregations formed during an unidentified metamorphic or hydrothermal event. The	a,b. The country rocks are part of a 10-20 km wide belt of low grade regionally metamorphosed bedded and intrusive rocks that crop out SW of the Coast Range complex for several hundred km along the length of S.E. Alaska. Based on lithology, the rocks in Helm Bay area are correlated with Mesozoic or upper Paleozoic units on SW Revillagigedo Island (also see discussion of area 4)	a,b. Reconnaissance (1:250,000-scale) geological, geophysical, and geochemical studies by USGS completed in 1977. Recent prospecting and assessment work by private interests	a. Area 6 includes the 11 prospects and mines known at Helm Bay, and a small area of correlative country rocks to the SW. This area probably has been thoroughly prospected for auriferous quartz veins, and there probably is little chance of discovery of significant numbers of additional such veins. Assuming that the combined known and undiscovered auriferous quartz veins in the Helm Bay area contain gold in amounts roughly equal to that already mined, then the area may contain one or more deposits having contained-metal characteristics of the vein gold model described in table 3	a. 90% 50% 10% chance that there are 0 1 2 deposits or more	a. Vein gold model
				b. The potential for resources of gold in disseminated deposits may be significant. For example, samples of pyrite from phyllite and marble collected	b. 90% 50% 10% chance that there is -- 1 -- deposit or more	b. Insufficient data

TABLE 1 (continued)

MAP AREA	1/ SUMMARY OF CRITERIA FOR DETERMINING BOUNDARY OF AREA	2/ RESOURCES	MINERAL DEPOSIT CLASSIFICATION 3/ TYPE	MINERAL DEPOSIT CLASSIFICATION MORPHOLOGY	FORM OF MINERALIZATION	1/ CRITERIA (also see Table 2) (L, local; W, widespread) A: 4/ Anomalous metals in stream sed. spls.	B: 5/ Anomalous metals in rock samples	C: Observed surficial alteration	D: Known prospects or occurrences	E: Observed metalliferous minerals	F: Favorable hostrock	G: Characteristic magnetic expression	H: Possibly relevant Landsat data	HOSTROCK LITHOLOGY	HOSTROCK FORM	6/ AGE	7/ AGE OF DEPOSIT	8/ PRINCIPAL KNOWN DEPOSITS AND OCCURRENCES
6. (cont)																		

9/PRODUCTION AND RESOURCE INFORMATION	GEOLOGIC CONTROLS OF MINERAL RESOURCES	REGIONAL GEOLOGIC SETTING	STATUS OF GEOLOGIC INFORMATION	SUMMARY OF MINERAL RESOURCE POTENTIAL	10/ESTIMATED NUMBER OF DEPOSITS (PERCENT CHANCE THAT THERE ARE AT LEAST THE PREDICTED NO.)	GRADES AND TONNAGES FOR THIS DEPOSIT TYPE (SEE TABLE 3)
	age of regional metamorphism in probably correlative rocks on SW Revillagigedo Island is Cretaceous, but there is no evidence that the quartz lodes at Helm Bay formed at that time			by the USGS on the coast about 1.8 km NNE of Camaano Point (field locality 75Bg125) contained up to 7.5 ppm Au, 2 ppm Ag, more than 1% As, and 1,000 ppm Sb. Although available data are insufficient to numerically estimate gold resources in disseminated lode deposits in the Helm Bay area, geologic conditions indicate a moderate likelihood that at least one such deposit is present		

TABLE 1 (continued)

MAP AREA	1/SUMMARY OF CRITERIA FOR DETERMINING BOUNDARY OF AREA	2/RESOURCES	MINERAL DEPOSIT CLASSIFICATION 3/TYPE	MINERAL DEPOSIT CLASSIFICATION MORPHOLOGY	FORM OF MINERALIZATION	1/CRITERIA (also see Table 2) (L, local; W, widespread) A 4/Anomalous metals in stream sed. spls.	B 5/Anomalous metals in rock samples	C Observed surficial alteration	D Known prospects or occurrences	E Observed metalliferous minerals	F Favorable hostrock	G Characteristic magnetic expression	H Possibly relevant Landsat data	HOSTROCK LITHOLOGY	HOSTROCK FORM	6/AGE	7/AGE OF DEPOSIT	8/PRINCIPAL KNOWN DEPOSITS AND OCCURRENCES
7.	Boundary of area determined by outcrops of marble and by location of known antimony prospect	Sb	Epithermal replacement	Fault? breccia	Veins, disseminations, irregular masses	L	L	no	L	L	L	no	L	Silicified and dolomitized marble	Folded and faulted layers	Mesozoic or late Paleozoic; Cretaceous?	Unknown	Camaano Point (40)

9/ PRODUCTION AND RESOURCE INFORMATION	GEOLOGIC CONTROLS OF MINERAL RESOURCES	REGIONAL GEOLOGIC SETTING	STATUS OF GEOLOGIC INFORMATION	SUMMARY OF MINERAL RESOURCE POTENTIAL	10/ ESTIMATED NUMBER OF DEPOSITS (PERCENT CHANCE THAT THERE ARE AT LEAST THE PREDICTED NO.)	GRADES AND TONNAGES FOR THIS DEPOSIT TYPE (SEE TABLE 3)
No production. Exploration by operator in 1953 showed disseminations and veinlets of stibnite for a total of 30 m along the inferred strike of the mineralized zone. Antimony content of the stibnite-bearing material averaged 1.3%, with local content as much as 8%. Recent intermittent exploration activity by private interests	Disseminations, veinlets and irregular masses of stibnite occur in brecciated and partly dolomitized and silicified marble. Schist and phyllite country rocks adjoining marble do not contain stibnite, but geochemical samples of pyrite from phyllite and marble collected on the coast about 1.8 km NNE of Camaano Point (USGS field locality 75Bg125) contained up to 1,000 ppm Sb, in addition to Ag, As, and Au	Country rocks are part of a belt of low grade metamorphosed dedded and intrusive rocks that crop out S.W. of the Coast Range complex throughout the length of S.E. Alaska. Based on lithology, rocks in Camaano Point area are correlated with Mesozoic or upper Paleozoic units on S.W. Revillagigedo Island	Detailed geochemical investigation of antimony prospect area by USGS in 1952-3 (Sainsbury, 1957). USGS reconnaissance studies of region completed in 1977	Float stibnite has been found on Cleveland Peninsula several km NW of known antimony prospect, suggesting that this area contains other stibnite occurrences similar to the one at Camaano Point. Available data are insufficient to estimate potential antimony resources in area	Insufficient data	Insufficient data

TABLE 1 (continued)

MAP AREA	1/ SUMMARY OF CRITERIA FOR DETERMINING BOUNDARY OF AREA	2/ RESOURCES	MINERAL DEPOSIT CLASSIFICATION 3/ TYPE	MINERAL DEPOSIT CLASSIFICATION MORPHOLOGY	FORM OF MINERALIZATION	1/ CRITERIA (also see Table 2) (L, local; W, widespread) A: 4/ Anomalous metals in stream sed. spls.	B: 5/ Anomalous metals in rock samples	C: Observed surficial alteration	D: Known prospects or occurrences	E: Observed metalliferous minerals	F: Favorable hostrock	G: Characteristic magnetic expression	H: Possibly relevant Landsat data	HOSTROCK LITHOLOGY	HOSTROCK FORM	6/ AGE	7/ AGE OF DEPOSIT	8/ PRINCIPAL KNOWN DEPOSITS AND OCCURRENCES
8.	Boundary of area determined by mapped extent of Gravina Island Formation and unnamed correlative rocks on Annette Island	Ag, Au, Cu, Pb, Zn	a. Aurifer-quartz veins	a. Individual veins and small stockworks	a. Quartz veins, quartz-carbonate veins	no data	L	L	W	L	W	W	W	a,b. Phyllite and greenschist derived from andesitic volcanic and volcaniclastic rocks, fine-grained detrital rocks, and conglomerate. Intruded by metamorphosed diorite, diorite porphyry, and aplite, and by altered, but unmetamorphosed gabbro	a,b. Metamorphosed stratified rocks; dikes, sills, and stocks	a,b. Late Jurassic to mid-Cretaceous, and Cenozoic; Cretaceous and? Cenozoic	a. Cretaceous or Cenozoic	a,b. Ketchikan (59-66; 73-74) and NE Gravina Island (54-57; 67-72) areas
			b. Volcandgenic?	b. Stratabound	b. Sulfide disseminations	no data	L	L	L	W	W	W	W				b. Late Jurassic to mid-Cretaceous; Cretaceous and? Cenozoic	

[9] PRODUCTION AND RESOURCE INFORMATION	GEOLOGIC CONTROLS OF MINERAL RESOURCES	REGIONAL GEOLOGIC SETTING	STATUS OF GEOLOGIC INFORMATION	SUMMARY OF MINERAL RESOURCE POTENTIAL	[10] ESTIMATED NUMBER OF DEPOSITS (PERCENT CHANCE THAT THERE ARE AT LEAST THE PREDICTED NO.)	GRADES AND TONNAGES FOR THIS DEPOSIT TYPE (SEE TABLE 3)
a,b. Gold-bearing quartz veins throughout area were prospected and mined mostly before WW I. Although there are no exact records of production, available information indicates that an aggregate of several thousand tons of ore were mined from the properties. Reported assay values ranged from $3-$400 in gold per ton. Intermittent recent prospecting by mining interests, but data on tonnage and grade of potential resources in vein or disseminated lodes have not been made public	a,b. Vein lodes consist of quartz and quartz-carbonate veins in phyllite and schist country rocks, and locally in diorite, diorite porphyry, aplite, and gabbro. Except for the gabbro, the intrusive rocks are metamorphosed along with the bedded rocks. The veins contain auriferous pyrite and a little free gold; some veins also carry small amounts of arsenopyrite, pyrrhotite, galena, sphalerite, and tetradymite(?). Auriferous pyrite and arsenopyrite(?) also are disseminated throughout the phyllite and greenschist, and the metamorphosed aplite and porphyry. The occurrence of disseminated sulfide minerals suggests a syngenetic origin roughly contemporaneous with the deposition of the Gravina Island Formation and cogenetic plutons. The quartz veins and accompanying metalliferous miner-	a,b. The Gravina Island Formation and its unnamed correlatives on Annette Island are part of the Gravina-Nutzotin belt of metamorphosed Upper Jurassic to mid-Cretaceous volcanic, volcaniclastic, sedimentary, and cogenetic intrusive rocks that crop out from southernmost S.E. Alaska to the eastern Alaska Range (Berg and others, 1972). The belt depositionally overlies older Mesozoic and Paleozoic rocks on the SW and is in structural contact with Mesozoic and upper Paleozoic rocks on the NE. The belt is interpreted as a volcanoplutonic arc produced in conjunction with plate	a,b. Semidetailed (1:63,360-scale) and reconnaissance (1:250,000-scale) geological, geochemical, and geophysical studies by USGS completed in 1977. Sporadic recent prospecting by mining interests	a. Area 8 contains at least 25 known occurrences of gold-bearing quartz veins that were extensively prospected, explored, and locally mined before WW II. Several of these veins were covered by recent airport construction and other developments in the NE Gravina Island-Ketchikan area, but this area presumably was thoroughly explored by the early gold prospectors, and there probably is little chance of discovery of many additional such veins. Assuming that the combined known and undiscovered auriferous quartz veins in area 8 contain gold in amounts roughly equal to that already mined, then the area may contain one or more deposits having contained-metal characteristics of the vein gold model described in table 3	a. 90% 50% 10% chance that there are 0 1 2 deposits or more	a. Vein gold model

TABLE 1 (continued)

MAP AREA	1/ SUMMARY OF CRITERIA FOR DETERMINING BOUNDARY OF AREA	2/ RESOURCES	MINERAL DEPOSIT CLASSIFICATION 3/ TYPE	MORPHOLOGY	FORM OF MINERALIZATION	1/ CRITERIA (also see Table 2) (L, local; W, widespread) A 4/ Anomalous metals in stream sed. spls.	B 5/ Anomalous metals in rock samples	C Observed surficial alteration	D Known prospects or occurrences	E Observed metalliferous minerals	F Favorable hostrock	G Characteristic magnetic expression	H Possibly relevant Landsat data	HOSTROCK LITHOLOGY	FORM	6/ AGE	7/ AGE OF DEPOSIT	8/ PRINCIPAL KNOWN DEPOSITS AND OCCURRENCES
B. (cont)																		

9/ PRODUCTION AND RESOURCE INFORMATION	GEOLOGIC CONTROLS OF MINERAL RESOURCES	REGIONAL GEOLOGIC SETTING	STATUS OF GEOLOGIC INFORMATION	SUMMARY OF MINERAL RESOURCE POTENTIAL	10/ ESTIMATED NUMBER OF DEPOSITS (PERCENT CHANCE THAT THERE ARE AT LEAST THE PREDICTED NO.)	GRADES AND TONNAGES FOR THIS DEPOSIT TYPE (SEE TABLE 3)
	als, however, probably formed during subsequent (Late Cretaceous?) regional metamorphism, or during a hydrothermal event connected with the emplacement of postmetamorphic (Cenozoic) gabbro	convergence at the edge of the NA continent in Late Mesozoic time. Mineral deposits in Alaska associat- in time and position with the Gravina-Nutzotin belt include stratiform iron deposits in zoned ultramafic plutons (see, for example, area 5), porphyry copper deposits in the eastern Alaska Range (Hollister and others, 1975), and the auriferous quartz veins and metamorphosed volcanogenic deposits described herein		b. The potential for resources of gold and possibly other metals in disseminated deposits may be significant. For example, traces of gold were detected by atomic absorption in several geochemical samples of pyrite-bearing phyllite and greenschist collected during USGS studies on NE Gravina Island in 1969-70 (Koch and Elliott, 1978a). Although available data are inadequate to numerically estimate gold resources in disseminated lode deposits in area 8, geological and geochemical studies indicate a moderate likelihood that at least one or two such deposits are present	b. 90% -- ; 50% 1 ; 10% 2 — chance that there are deposits or more	b. Insufficient data

TABLE 1 (continued)

MAP AREA	1/ SUMMARY OF CRITERIA FOR DETERMINING BOUNDARY OF AREA	2/ RESOURCES	MINERAL DEPOSIT CLASSIFICATION 3/ TYPE	MINERAL DEPOSIT CLASSIFICATION MORPHOLOGY	FORM OF MINERALIZATION	1/ CRITERIA (also see Table 2) (L, local; W, widespread) A: 4/ Anomalous metals in stream sed. spls.	B: 5/ Anomalous metals in rock samples	C: Observed surficial alteration	D: Known prospects or occurrences	E: Observed metalliferous minerals	F: Favorable hostrock	G: Characteristic magnetic expression	H: Possibly relevant Landsat data	HOSTROCK LITHOLOGY	HOSTROCK FORM	6/ AGE	7/ AGE OF DEPOSIT	8/ PRINCIPAL KNOWN DEPOSITS AND OCCURRENCES
9.	Boundaries of areas determined by outcrop areas of Puppets Formation, its unnamed correlatives on Annette Island, and, where appropriate, adjacent geologic units	Ag, Au, Cu, Pb, Zn (Ba, U?)	Volcanogenic	Stratabound; fault breccias	Veins, disseminations, and locally massive sulfides	no data	L	L	W	W	W	no	no	Metarhyolite and metadacite flows and tuff (Puppets Fm. and correlatives); various adjacent geologic units	Metamorphosed stratified rocks (Puppets, etc.); metamorphosed stratified and intrusive rocks (adjacent units)	Puppets, etc.: mid?-Paleozoic; Mesozoic or Cenozoic. Adjacent units: Early Paleozoic to Late Triassic; Mesozoic or Cenozoic	Mid?-Paleozoic; Mesozoic or Cenozoic	S. and W. Gravina Island (52-53; 109-129); W. and E. Annette Island (134-136; 142-146)

9/ PRODUCTION AND RESOURCE INFORMATION	GEOLOGIC CONTROLS OF MINERAL RESOURCES	REGIONAL GEOLOGIC SETTING	STATUS OF GEOLOGIC INFORMATION	SUMMARY OF MINERAL RESOURCE POTENTIAL	10/ ESTIMATED NUMBER OF DEPOSITS (PERCENT CHANCE THAT THERE ARE AT LEAST THE PREDICTED NO.)	GRADES AND TONNAGES FOR THIS DEPOSIT TYPE (SEE TABLE 3)
Gold- and copper-bearing lodes throughout area 9 first were extensively prospected around 1890. Many of the properties, especially those on S. and W. Gravina Island, were explored by shallow shafts and short drifts, and although there are no records of production, the extent of some of the workings and size of the tailings piles suggest that ore may have been shipped from at least some of the properties. Ore grades, largely reported by early prospectors primarily interested in gold, range up to hundreds of dollars per ton in contained metals, chiefly gold and copper, but including silver, zinc, and lead. At one property on S. Gravina Island, the owner reported an average grade per ton of 11% Cu,	Deposits occur as breccia lodes, individual or groups of fissure veins, and as disseminations and small masses of metalliferous minerals. Gangue minerals are quartz, carbonate, and barite; metalliferous minerals include pyrite, chalcopyrite, hematite, and traces to locally significant amounts of several other minerals (see table 2). Hostrocks are mid?-Paleozoic felsic to intermediate metavolcanic rocks, and adjacent rock units that range in age from early? Paleozoic to Late Triassic. The diverse mineralogy, structural settings, forms of mineralization, and hostrocks suggest a complex history of mineralization, beginning with syngenetic deposition of metalliferous minerals along with the mid?-Paleozoic volcanic rocks, followed by one or more episodes of metamorphism, faulting, and	The Puppets Formation, its correlatives, and adjacent rock units that host mineral deposits in area 9 are part of the Alexander terrane (Berg and others, 1972), a discrete tectonic block of pre-upper Mesozoic rocks that crop out from Annette Island on the south, through the southeastern Alaska panhandle and parts of British Columbia and Yukon, to the eastern Alaska Range, a distance of about 1,000 km. The block has been interpreted as a fragment of allochthonous continental crust that originated far to the south of its present position, and was swept along with other fragments of crust against the North American continent by major northward transform faulting in Late Mesozoic time (Jones	Semidetailed (1:63,360-scale) geologic mapping studies by USGS completed 1972-77. Investigations by USGS of trace element geochemistry of Puppets Formation, its correlatives, and Annette pluton are currently underway. Extensive recent industry exploration, including diamond drilling and trenching, of copper lodes on S. and W. Gravina Island	The 4 areas of resource potential contain a combined total of about 44 known mineral occurrences, half of which are on S. Gravina Island, where lodes known since before the turn of the century have attracted considerable recent exploration by several mining companies for copper and other metals. These companies have not released data on tonnage and grade of any properties, but from the amount of exploration activity we infer that some of the lodes may have significant potential for copper and possibly other resources, including barite. On this basis, we estimate that the S. Gravina Island area may contain at least one deposit having the grade and tonnage characteristics of the felsic and intermediate volcanogenic massive sulfide model described in table 3. The area on W. Gravina Island contains only a few known deposits, but recent prospecting	90% 50% 10% chance that there are 0 1 2 deposits or more	Felsic and intermediate volcanogenic massive sulfide model

TABLE 1 (continued)

MAP AREA	[1] SUMMARY OF CRITERIA FOR DETERMINING BOUNDARY OF AREA	[2] RESOURCES	MINERAL DEPOSIT CLASSIFICATION [3] TYPE	MINERAL DEPOSIT CLASSIFICATION MORPHOLOGY	FORM OF MINERALIZATION	[1] CRITERIA (also see Table 2) (L, local; W, widespread) A [4] Anomalous metals in stream sed. spls.	B [5] Anomalous metals in rock samples	C Observed surficial alteration	D Known prospects or occurrences	E Observed metalliferous minerals	F Favorable hostrock	G Characteristic magnetic expression	H Possibly relevant Landsat data	HOSTROCK LITHOLOGY	HOSTROCK FORM	[6] AGE	[7] AGE OF DEPOSIT	[8] PRINCIPAL KNOWN DEPOSITS AND OCCURRENCES
9.(cont)																		

PRODUCTION AND RESOURCE INFORMATION [9]	GEOLOGIC CONTROLS OF MINERAL RESOURCES	REGIONAL GEOLOGIC SETTING	STATUS OF GEOLOGIC INFORMATION	SUMMARY OF MINERAL RESOURCE POTENTIAL	ESTIMATED NUMBER OF DEPOSITS (PERCENT CHANCE THAT THERE ARE AT LEAST THE PREDICTED NO.) [10]	GRADES AND TONNAGES FOR THIS DEPOSIT TYPE (SEE TABLE 3)
$6 in gold, and slight silver values in a mineralized "ledge" (probably a breccia lode) about 1 m thick and 30 or more m long. Results of recent exploration, including diamond drilling, by mining interests indicate widespread small, but potentially commercial amounts of copper (chalcopyrite) in several rock units on southern and western Gravina Island. Recent geochemical analyses by the USGS of mineralized rock samples from several localities on Gravina and Annette Islands show the following metal contents: 1.5-70 ppm Ag; 0.10-43 ppm Au; 700 ppm to more than 2% Cu; 1.5% Pb; and more than 1% Zn. Some samples also contain anomalous amounts of several other metals	intrusion, accompanied by mobilization and redistribution of metals and gangue. For example, examination by the USGS of copper lodes on S. Gravina Island suggests that the lodes may be localized at or near the intersections of subhorizontal thrust faults and high-angle faults that postdate the thrusts. The lodes are mainly steeply-dipping fissure veins and mineralized breccia zones in hydrothermally altered (dolomitized, silicified, and jasperized) metamorphosed volcanic, sedimentary, and intrusive country rocks that range in age from Silurian or older to Triassic. The age of the lodes, based partly on lack of deformation of the orebodies and partly on regional structural factors, is inferred to be late Mesozoic or Cenozoic. The lodes are herein presumed to have formed by hydrothermal mobilization of metalliferous and gangue minerals from older, presumably syngenetic	and others, 1972 and 1977). The Alexander terrane is bounded on the NE by the Gravina-Nutzotin belt, and on the SW by several tectonostratigraphic units. In SE Alaska, much of the terrane is truncated on the SW by the Queen Charlotte and Chatham Strait faults. Recent geological, geochemical, and isotopic dating studies by the USGS suggest that the Puppets Formation and its correlatives may be cogenetic with trondhjemite of the Silurian Annette pluton		activity reportedly has disclosed numerous additional occurrences of copper minerals, chiefly chalcopyrite. Some resources therefore probably are present, but their potential cannot be evaluated with present information. After considerable prospecting activity before 1900, Annette Island was closed to commercial mineral exploration when it became an Indian Reservation in 1891. Recently, however, several mineral surveys have been carried out by private consultants under contract to Bureau of Indian Affairs or to the Metlakatla People. Results of these surveys have not been made public. Recent USGS studies indicate that the lodes on Annette are similar to those on S. Gravina Island. Although potential copper and other metal resources thus may be present, the limited information available necessitates assigning a lower probability to this potential. Although only the types of mineral deposits described above are known in area 9, locally high geochemical values in certain metals (table 2), combined with the occurrence of appropriate rock types, are permissive for the occurrence of several other		

TABLE 1 (continued)

MAP AREA	1/ SUMMARY OF CRITERIA FOR DETERMINING BOUNDARY OF AREA	2/ RESOURCES	MINERAL DEPOSIT CLASSIFICATION 3/ TYPE	MORPHOLOGY	FORM OF MINERALIZATION	1/ CRITERIA (also see Table 2) (L, local; W, widespread) 4/ Anomalous metals in stream sed. spls. A	5/ Anomalous metals in rock samples B	Observed surficial alteration C	Known prospects or occurrences D	Observed metalliferous minerals E	Favorable hostrock F	Characteristic magnetic expression G	Possibly relevant Landsat data H	HOSTROCK LITHOLOGY	FORM	6/ AGE	7/ AGE OF DEPOSIT	8/ PRINCIPAL KNOWN DEPOSITS AND OCCURRENCES
9.(cont)																		

9/ PRODUCTION AND RESOURCE INFORMATION	GEOLOGIC CONTROLS OF MINERAL RESOURCES	REGIONAL GEOLOGIC SETTING	STATUS OF GEOLOGIC INFORMATION	SUMMARY OF MINERAL RESOURCE POTENTIAL	10/ ESTIMATED NUMBER OF DEPOSITS (PERCENT CHANCE THAT THERE ARE AT LEAST THE PREDICTED NO.)	GRADES AND TONNAGES FOR THIS DEPOSIT TYPE (SEE TABLE 3)
	deposits mainly in the mid?-Paleozoic volcanic rocks into favorable structural sites. The origin of the hydrothermal event has not been identified. Recent studies by the USGS also indicate that the pre-middle? Paleozoic volcanic and intrusive units may also have carried syngenetic deposits, but the identity of any such deposits is obscured by the mid?-Paleozoic volcanic and later events			types of mineral deposits, including porphyry copper, vein gold, and mafic volcanogenic (table 3). However, locally high geochemical values in Ni, Co, and Cr may be mainly related to the occurrence of mafic volcanic and intrusive country rocks that commonly have high background levels of these elements		

FOOTNOTES FOR TABLE 1.

1/ More specific information about the criteria for each area is summarized in Table 2. Sources of data for the various criteria are: Berg and others (1978), geology; Koch and Elliott (1978a-c) and Koch and others (1978a-h), geochemistry; Elliott and others (1978), descriptions of mineral deposits and occurrences; Griscom (1978) and U.S. Geological Survey (1977a), aeromagnetics; Steele and Albert (1978), Landsat imagery

2/ Metalliferous commodities are shown by standard chemical symbols; barite, a nonmetallic mineral, is shown as Ba. Presumed primary resources are listed first, followed by potential byproducts in parentheses; within each group commodities are listed in alphabetical order, without implying abundance or commercial value. Queried where presence of commodity is inferred from indirect evidence or based on unverified reports.

3/ Classification of mineral deposits used in this report generally reflects concepts of mineral deposit classification and ore genesis published recently by various investigators, especially those working in the North American Cordillera. Typical, but not necessarily definitive, examples of such sources for several of the deposit types used in this report include: Lowell and Guilbert (1970) and Canadian Inst. of Mining and Metallurgy (1976), porphyry copper and molybdenum deposits; Large (1977) and Hutchinson (1973), volcanogenic sulfide deposits. Question mark indicates speculative or suspected mineral deposit type.

4/ Anomalous values for stream-sediment geochemical samples used in this report are equal to or greater than the following (AA, atomic absorption analyses; all others are semiquantitative spectrographic analyses) (in ppm): Ag, .5; Au (AA), .02; Be, 3; Co, 70; Cr, 300; Cu(AA), 60; La, 200; Mo, 5; Nb, 20; Ni, 100; Pb(AA), 20; V, 500; Y, 70; Zn(AA), 100; Zr, 500

5/ Anomalous values for rock geochemical samples used in this report are equal to or greater than the following (data for starred commodities are for Gravina Island only) (AA, atomic absorption analyses; all others are semiquantitative spectrographic analyses) (in ppm): *Ag, 0.5; *As, 200; *Au(AA), .05; *Ba, 1500; Be, 3; *Bi, 10; Co, 50; Cr, 200; Cu(AA), 85; Mo, 5; Nb, 15; Ni, 50; Pb(AA), 15; *Sb, 200; *Sn, 150; *W, 50; Zn(AA), 120

6/ For metamorphosed hostrocks, known or presumed (queried) age of protolith is listed first, followed by known or presumed (queried) age(s) of metamorphism

7/ For metamorphosed deposits, known or presumed (queried) original age is listed first, followed by known or presumed (queried) metamorphic age(s)

8/ Number in parentheses corresponds to number assigned to deposit by Elliott and others (1978)

9/ Unless otherwise specified, data are summarized from Elliott and others (1978)

10/ Except for iron deposits in stratified ultramafic rocks and for disseminated lode gold deposits, estimates of number of deposits are made only for deposits with grades and tonnages comparable to those used in the grade-tonnage models listed in table 3 (Eberlein and others, 1978; Hudson and DeYoung, 1978; MacKevett and others, 1978). For the stratiform iron and disseminated gold lodes, data are insufficient to prepare such grade and tonnage models; for these deposits, estimates of number of deposits indicate potential for deposits of "significant", but indeterminate, grades and tonnages

TABLE 2. SUMMARY OF SELECTED CRITERIA USED TO DEFINE AREAS OF METALLIFEROUS MINERAL RESOURCE POTENTIAL

AREA	CRITERIA
1.	1/A. Be, Mo, Nb; Ag, Ni, Pb, V
	1/B. Be, Mo, Nb; Pb
	C. Local iron-oxide staining
	D. 2
	E. Pyrite and molybdenite; minor or local galena and chalcopyrite(?)
	F. Mid-Tertiary epizonal granite stocks and associated quartz porphyry dike swarms
	G. Mid-Tertiary granite stocks are less magnetic than adjacent granitic rocks of the Coast Range complex
	H. Northeast-trending lineaments are parallel to swarms of quartz-porphyry and lamprophyre dikes, and to a major regional joint set that controls the emplacement of the dikes
2.	For deposit type a:
	1/A. Cu, Mo, Pb, Zn; Y
	1/B. Cu, Mo, Pb, Zn
	C. Iron-stained zones in the paragneiss
	D. 8
	E. Pyrite, chalcopyrite; minor or local galena, molybdenite, sphalerite
	F. Paragneiss
	G. Paragneiss is relatively nonmagnetic
	H. Iron-oxide color anomalies occur in northern part of area; arcuate features occur in southern part of area; north- to northwest-trending lineaments occur throughout area
	For deposit type b:
	A. No data
	1/B. Cu, Mo, Pb
	D. 3
	E. Pyrite, chalcopyrite, molybdenite; minor or local galena
	F. Sulfide-bearing quartz veins occur in paragneiss and in foliated plutonic rocks
3.	1/A. Ag, Au, Cu
	1/B. Be, Co, Mo, Nb
	C. Iron-oxide and other alteration zones
	D. 9
	E. Pyrite, chalcopyrite; local galena, sphalerite, tetrahedrite, freibergite, molybdenite, scheelite
	F. Hazelton? Group metavolcanic rocks are favorable for volcanogenic deposits. Texas Creek Granodiorite is permissive for porphyry copper deposits
	G. A magnetic low coincides with the area
	H. A lineament corresponds to Fish Creek fault zone and associated mineral occurrences
4.	For deposit type a:
	1/A. Co(?), Cu, Mo, Ni(?), Pb, Zn; Cr
	1/B. Co(?), Cu, Mo, Ni(?), Zn; Cr
	C. Local iron-oxide stained zones, especially associated with schistose dikes and sills, and with pyritic phyllite or argillite
	D. Approximately 36
	E. Pyrite; minor or local sphalerite, galena, chalcopyrite, native gold, bornite, covellite, pyrrhotite
	F. Pyrite-bearing dark gray to black phyllite or argillite and pelitic schist; locally intruded by more or less schistose aplite and aphanite dikes and sills
	For deposit type b:
	1/A. Cu, Mo, Zn
	1/B. Mo
	C. Local iron-stained zones, mainly associated with paragneiss inclusions near the contacts of the sill(?)
	D. 1
	E. Molybdenite
	F. 10-20 m thick felsic sill(?) containing traces of disseminated molybdenite

TABLE 2.(cont)

AREA	CRITERIA
5.	1/A. Co, Cr 1/B. Co, Cr, Ni; Zn C. Ultramafic rocks commonly weather red or orange and are relatively free of vegetation cover D. Approximately 21 E. Titaniferous magnetite; minor chromite F. Ultramafic plutons G. Strong magnetic highs H. Circular features occur near some ultramafic plutons
6.	A. No data 1/B. Au; Ag, As, Sb D. 12 E. Widespread pyrite and arsenopyrite?; minor or local free gold, chalcopyrite, galena, sphalerite, bornite, tellurides(?) F. Greenschist and phyllite; minor metamorphosed diorite and diorite porphyry plutons H. Helm Bay area is bounded on northeast by a well-defined northwest-trending lineament
7.	A. Geochemical investigation at Camaano Point antimony prospect (Sainsbury, 1957) showed concentrations of antimony in soil and decomposed bedrock overlying the stibnite lode B. Samples of pyrite-rich phyllite and marble collected by USGS on coast about 1.8 km north-northeast of Camaano Point (field locality 75Bg125) contain up to 1,000 ppm Sb, 2 ppm Ag, 7.5 ppm Au, and more than 1% As D. 1 E. Stibnite F. Brecciated, silicified, and dolomitized marble H. Antimony prospect lies near northwest-trending lineament
8.	A. No data 1/B. Ag, Au, Cu, Pb, Zn C. Local iron-oxide staining and other alteration D. 25 E. Widespread pyrite and? arsenopyrite; minor or local free gold, chalcopyrite, galena, sphalerite F. Gravina Island Formation and its correlatives on Annette Island G. Magnetic low centered over this area probably reflects low magnetite content of Gravina Island Formation and its correlatives H. Many prospects lie near well-defined northwest-trending lineaments that coincide with mapped faults
9.	A. No data 1/B. Ag, As, Au, Ba, Bi, Cu, Mo, Ni(?), Pb, Sn, Zn; Be, Co, Cr, Nb, Sb, W C. Iron-oxide alteration and widespread disseminated hematite; intense dolomitization and local silicification, including formation of "jasper" D. Approximately 44 E. Widespread pyrite, chalcopyrite, hematite, and barite; minor or local arsenopyrite, bornite, chalcocite, covellite, galena, malachite, sphalerite, and tetrahedrite F. Felsic to intermediate metavolcanic and volcaniclastic rocks of Puppets Formation and unnamed correlative rocks rocks, and, locally, adjacent geologic units

1/ Underlined elements geochemically characterize or possibly characterize (queried) the mineral deposit type(s) listed for area in Table 1. Other anomalous elements may indicate (a) overlapping identified areas of other types of mineral deposits; (b) unidentified areas of other types of mineral deposits; or (c) lithologies intrinsically high in these elements

[1]TABLE 3. GRADE AND TONNAGE MODELS

[Related data occur on line from column to column; all data in metric units; NS, not significant; *, significant at 5-percent level; **, significant at 1 percent level]

Deposit Type	Tonnage and grade variables (units in parenthesis)	Number of deposits used in developing model	Correlation coefficient of listed variable with variable on line with it in column 2	90 percent of deposits have at least	50 percent of deposits have at least	10 percent of deposits have at least
Porphyry Copper	Tonnage of ore (millions of tons)	41		20	100	430
	Average copper grade (percent)	41	with tonnage of ore = -0.07 NS	0.1	0.25	0.55
	Average molybdenum grade (percent Mo)	41		0.0	0.008	0.031
Island Arc Porphyry Copper	Tonnage of ore (millions of tons)	41		20	100	430
	Average copper grade (percent)	41	with tonnage of ore = -0.07 NS	0.1	0.3	0.55
	Average molybdenum grade (percent Mo)	41		0.0	0.008	0.031
	Average gold grade-locally significant but not determined					
Porphyry Molybdenum	Tonnage of ore (millions of tons)	31		1.6	24	340
	Average molybdenum grade (percent Mo)	31	with tonnage of ore = -0.05 NS	0.065	0.13	0.26
Podiform Chromite	Tonnage of Cr_2O_3 (tons)	268		15	200	2,700
Copper Skarn	Tonnage of ore (millions of tons)	38		0.08	1.4	24
	Average copper grade (percent)	38	with tonnage of ore = -0.44**	0.86	1.7	3.5
	Average gold grade locally significant, but not determined					
Mafic Volcanogenic	Tonnage of ore (millions of tons)	37		0.24	2.3	22.0
	Average copper grade (percent)	37	with tonnage of ore = -0.13 NS	1.1	2.2	4.1
	Average zinc grade excluding deposits without reported grades (percent)	19	with tonnage of ore = 0.03 NS	0.3	1.3	5.5
	Average gold grade-locally significant but not determined					
Felsic and Intermediate Volcanogenic Massive Sulfide	Tonnage of ore (millions of tons)	89		0.19	1.9	18.0
	Average copper grade (percent)	89	with tonnage of ore = -0.41**	0.54	1.70	5.40
	Average zinc grade excluding deposits without reported grades (percent)	41	with tonnage of ore = 0.25 NS	1.40	3.80	10.00
	Average lead grade excluding deposits without reported grades (percent)	14	with tonnage of ore = -0.02 NS	0.20	0.95	4.80
	Tonnage contained gold excluding deposits without reported gold (tons)	38	with tonnage of ore = 0.78**	0.27	2.90	32.00
	Tonnage contained silver excluding deposits without reported silver (tons)	46	with tonnage of ore = 0.82**	5.00	80.00	1300.00
Nickel Sulfide	Tonnage of ore (millions of tons)	48		0.23	1.20	5.90
	Average nickel grade (percent)	48	with tonnage of ore = -0.03 NS	0.32	0.61	1.20
	Average copper grade (percent)	48	with tonnage of ore = 0.03 NS with nickel grade = 0.04 NS	0.18	0.47	1.20
Mercury	Tonnage of contained mercury (tons)	165		0.09	3.10	120.00
Vein Gold	Tonnage of contained gold (tons)	43		0.29	3.30	33.00
Skarn/Tactite Tungsten	Tonnage of ore (millions of tons)	31		0.024	0.63	17
	Average tungsten grade (percent W)	31	with tonnage of ore = -0.34 NS	0.24	0.51	1.10

[1]This table was prepared by D.A. Singer, W.D. Menzie, and J.H. DeYoung, Jr. of the Office of Resource Analysis of the U.S. Geological Survey and originally published in a series of reports describing the mineral resources of mainland Alaska (for example, Eberlein and others, 1978; Hudson and DeYoung, 1978; and MacKevett and others, 1978). For this report, mineral deposit types that occur, or are inferred to occur, in the Ketchikan and Prince Rupert quadrangles, are enclosed by heavy black lines

TABLE 4. Reports prepared as a foundation for the mineral resource assessment of the Ketchikan and Prince Rupert quadrangles

USGS open-file report	SUBJECT
77-359 (USGS, 1977a)	Aeromagnetic contour map
78-73 A (Berg and others, 1978)	Geologic map
B (Elliott and others, 1978)	Mineral deposit map
C (Koch and others, 1978a)	Geochemical anomaly map: Cu
D " b	" Pb
E " c	" Zn
F " d	" Mo
G " e	" Au and Ag
H " f	" Cr
I " g	" Co
J " h	" Ni
K (Griscom, 1978)	Aeromagnetic interpretation map
L (Steele and Albert, 1978)	Landsat interpretation map
78-156A (Koch and Elliott, 1978a)	Analyses of rock geochemical samples, Ketchikan quadrangle
B " b	Analyses of rock and stream sediment geochemical samples, Prince Rupert quadrangle
C " c	Analyses of stream sediment geochemical samples, Ketchikan quadrangle