114P002

820526

MASSIVE SULPHIDE POTENTIAL

OF THE

NORTHWESTERN CORDILLERA OF BRITISH COLUMBIA

AND THE SIGNIFICANCE OF THE ALTA BASIN

GEDDES RESOURCES LIMITED

G. HARPER
JANUARY 23, 1992

TABLE OF CONTENTS

ILLUSTRATIONS

TABLES

INTRODUCTION

Historically the majority of base metals production in British Columbia has been derived from carbonate or shale hosted massive sulphide deposits in the eastern two belts of the Cordillera and porphyry deposits in the central and western belts of the Cordillera. Future base metals production is likely to come increasingly from volcanogenic type massive sulphide deposits (VMS) located in the central and western belts. While lacking the large surface expression of most porphyry deposits and therefore the relative ease of discovery they are extremely attractive targets because of their generally substantially higher grade, polymetallic composition and tendency for several deposits to occur in proximity.

Geologic characterisation and understanding of VMS deposits as a class has largely developed in the last thirty years. There is now an excellent understanding of their mode of occurrence and approaches to exploration. Westmin Resources Limited have used these methods to great effect at their Myra Falls mine on Vancouver Island in discovering numerous VMS deposits allowing continuous production of copper, zinc, lead, gold and silver for more than 25 years with potential for at least another 10 years of production.

The objective of this report is to focus attention on the VMS deposits potential of the western Cordillera of northwestern British Columbia and adjoining Alaska panhandle, particularly an area referred to as the Alta Basin.

VMS OCCURRENCES IN THE NORTHWESTERN CORDILLERA

Figure 1 shows the western two belts of the Cordillera, the Insular and Coast Crystalline Belts from latitude 56 to 60 degrees north. Important VMS environments are identified and their location either in the Insular Belt (Alexander Terrane) and/or marginal to the Coast Crystalline Belt is apparent.

Earliest production from what are now considered to be VMS deposits was from the Tulsequah Chief and Big Bull mines in British Columbia from 1951 to 1957. Ore milled aggregated 1,029,089 tons (933,583 tonnes) with a recovered grade of 1.32% Cu, 6.06% Zn, 1.31% Pb, 0.02% Cd, 0.09 oz/ton Au and 3.30 oz/ton Ag (Souther J.G., 1971). Recent underground exploration on the Tulsequah Chief property has defined an additional resource of 8.6 million tons (7.8 million tonnes) grading 1.6% Cu, 6.5% Zn, 1.2% Pb, 0.08 oz/ton Au and 3.2 oz/ton Ag, very similar grades to those previously exploited (Northern Miner, 1991). In Figure 2 the locations of the Tulsequah Chief and Big Bull mines are shown as well as the Ericksen-Ashby deposit. At the latter VMS lenses have been explored indicating at least 900,000 tonnes of mineralisation grading 3.79% Zn, 2.23% Pb and 6.27 oz/ton Ag (Anglo Canadian, 1980).

MASSIVE SULPHIDE POTENTIAL OF THE NORTHWESTERN CORDILLERA OF BRITISH COLUMBIA AND THE SIGNIFICANCE OF THE ALTA BASIN

SUMMARY

Ten areas of polymetallic, volcanogenic, massive sulphide deposits and prospects have been identified in the coastal belt of British Columbia and Alaska between latitudes 56 and 60 degrees north. With individual sizes ranging up to more than 100 million tonnes this class of deposits in this area has the potential to be a major source of metals production extending well into the twenty first century. One mine, Greens Creek in Alaska, recently started production and in its first year became the largest silver producer in the USA. Environmental permitting for development of the Windy Craggy deposits in the Alta Basin of B.C. is underway. When this mine starts production it will be the second largest copper producer in Canada and with potential to be one of the largest cobalt producers in the world.

These VMS deposits are within the Alexander Terrane of the Insular Belt and inliers within the adjoining Coast Crystalline Belt. The typical geological environment of these deposits, where not masked by metamorphism, is a mafic volcanic sequence with either interbedded or underlying carbonate-rich sediments. The sequence is likely to be of Triassic age. The area of highest known potential is the Alta Basin in the Haines Triangle of British Columbia. This volcano-sedimentary basin covers some 500 square kilometres and could host more than half a billion tonnes of ore.

Greens Creek, 25 kilometres southwest of Juneau, Alaska, is the only presently producing VMS mine. Prior to start-up in February 1989 total reserves were 3.5 million tons (3.2 million tonnes) grading 9.7% Zn, 3.0% Pb, 0.18 oz/ton Au and 24 oz/ton Ag. By early 1991 after mining more than 660,000 tons (600,000 tonnes) reserves stood at 6.3 million tons (5.7 million tonnes) grading 12.4% Zn, 4.2% Pb, 0.13 oz/ton Au and 15.1 oz/ton Ag (Walker S., Nov. 1991). In its first full year of production Greens Creek became the largest silver producer in the United States of America; a reflection of the high grade of the VMS ore.

VMS style mineralisation has been located at the Dream prospect in Alaska and at the Mt. Henry Clay prospect spanning the Alaska - British Columbia border. Reserves have not been announced for either of these prospects. Other VMS style prospects and deposits in Alaska shown on Figure 1 are listed and described in Table 1 (Alaska's Mineral Industry, 1989).

By far the largest VMS type deposits defined are those within Windy Craggy mountain in the Haines triangle in the extreme northwest corner of British Columbia. After three years of intensive drilling (1988 - 1990) parts of these huge deposits have been defined and reserves announced (Geddes Resources Limited, 1991).

Zone	Tonnes x 000s	Cu %	Zn %	Co %	Au g/t	Ag g/t
SOUTH	117,450	1.44		0.075	0.16	3.37
NORTH	148,250	1.44	0.25	0.066	0.23	4.16
RIDGE	5,790	1.33	0.21	0.044	0.20	4.12
Other	25,949	0.76				
Total	297,439	1.38				

Limited regional exploration of this area has identified numerous other anomalies of which only two have had any drill testing.

GENERAL GEOLOGICAL CHARACTERISTICS OF THE OCCURRENCES

Descriptions of the geological settings of each of these VMS districts is available in the literature and will not be repeated here. Likewise no attempt is made to classify any of them into the more specific classes of VMS deposits documented. Some general characteristics stand out as common to several or all of them, which may have implications in furthering exploration and development.

1) Although intermediate to mafic volcanic rocks or their metamorphosed equivalents are present in the vicinity of the deposits they are not necessarily the host rocks. The local host rocks tend to be argillaceous sediments.

2) The associated volcanics do not include felsic sequences.

3) The hosting sediments tend to be lime-rich and the underlying stratigraphy includes substantial thicknesses of limestones and limey sediments.

4) Structural geology of the deposits environment is complex with the dominant structural effect being polyphase folding.

5) The iron sulphide component of the massive sulphides includes a significant proportion of pyrrhotite. In some deposits pyrrhotite is predominant over pyrite.

6) The structural deformation has influenced distribution of grades of some of the "commercial" metals in the deposits, particularly gold and silver.

7) Host rocks age is most likely to be Triassic.

Still in the Alexander Terrane but 250 kilometres northwest of the northern limit of Figure 1 is the location of the Kennecott deposits. VMS deposits had not been recognised as a class when these deposits were mined out. These extremely rich copper deposits were described recently as:

> "Major stratiform Cu-Ag massive sulphide deposits localized near contact between Chitistone Limestone and Nikolai Greenstone of Triassic age; contained some of highest grade Cu lodes mined in North America. From 1911 to 1938, produced more than 1.2 billion lb Cu and 10 million oz Ag from 4.8 million tons ore." (Alaska's Mineral Industry, 1989.)

These deposits consisted almost entirely of supergene mineralisation, dominantly chalcocite, with an average grade greater than 12% Cu and 2 oz/ton Ag (Berg and Cobb, 1967). While no equivalence of deposits mineralogy can be concluded, there is similarity in respect of characteristics 1, 2, 3 and 7 and it is reasonable to speculate that the Kennecott deposits should be added to the VMS ranks of the area.

The geology of the northwest Cordillera includes environments which have the characteristics to host VMS deposits with sizes and/or grades comparable with any in the world.

THE ALTA BASIN

Reconnaissance mapping of the Haines triangle by the Geological Survey of Canada was completed in 1979 (Dodds C.J., 1979). One of the features of the area, located in the quadrant north of the confluence and between the **AL**sek and **TA**tshenshini Rivers, is a synclinorium or basin referred to as the **AL TA** basin (Figure 3). It trends north-northwesterly with a length of some 25 kms. and width of 20 kms. The oldest rocks, defining the basin edge, are limestones and marbles of Devonian age to the west and Ordovician - Devonian age in the east. These grade up into a Devonian to Triassic "transition" sequence of argillites, siltstones and limestones. In turn these grade up into a Triassic sequence of mafic volcanics with interbedded limey argillites and siltstones. Folding was the dominant structural cause with deformation in more than one orientation. Subsequently felsic intrusions have rimmed the basin. Faulting has had a minor role in the structural evolution of the basin even though the Border Ranges and Fairweather Faults to the west end Denali Fault to the east juxtapose totally different geological terranes.

Exploration, albeit cursory to date, has had a remarkable degree of success in identifying mineralisation (Figure 4). Water and sediment samples from the two creeks that drain the majority of the basin (Henshi and Tats Creeks) are anomalous in base metals. Airborne geophysical surveys have identified numerous large conductors and magnetic anomalies. Prospecting located polymetallic massive sulphide boulders up to 2 metres in diameter in moraine and alluvial gravels in Frobisher, Henshi and Tats creeks valleys. Mapping and prospecting identified polymetallic mineralisation in outcrop on Windy Craggy mountain, north of Frobisher valley, adjacent to East Arm Glacier at the head of Henshi Creek and northwest, north and east of Tats Lake. Common characteristics of most of these mineralised locations are:

- their stratiform, VMS style affinity,
- coincidence with geophysical anomalies,
- occurrence within or at the upper or lower contact of the "transition" sequence.

Detailed exploration at Windy Craggy mountain has demonstrated convincingly the occurrence of several, 100 million tonne plus VMS deposits. Limited exploration in the East Arm Glacier area suggests the possibility of one or more 100 million tonne plus VMS deposits there as well. Other anomalies have the strength and dimensions to yield more of these gigantic deposits. Implications are that the 90 - 100 km. length of the basin perimeter determined by the "transition" unit is highly prospective for VMS deposits. The ultimate resource contained in the Alta Basin could be five hundred million to a billion tonnes of polymetallic ore, making this one of the areas of most abundant mineralisation in the world.

CONCLUSIONS

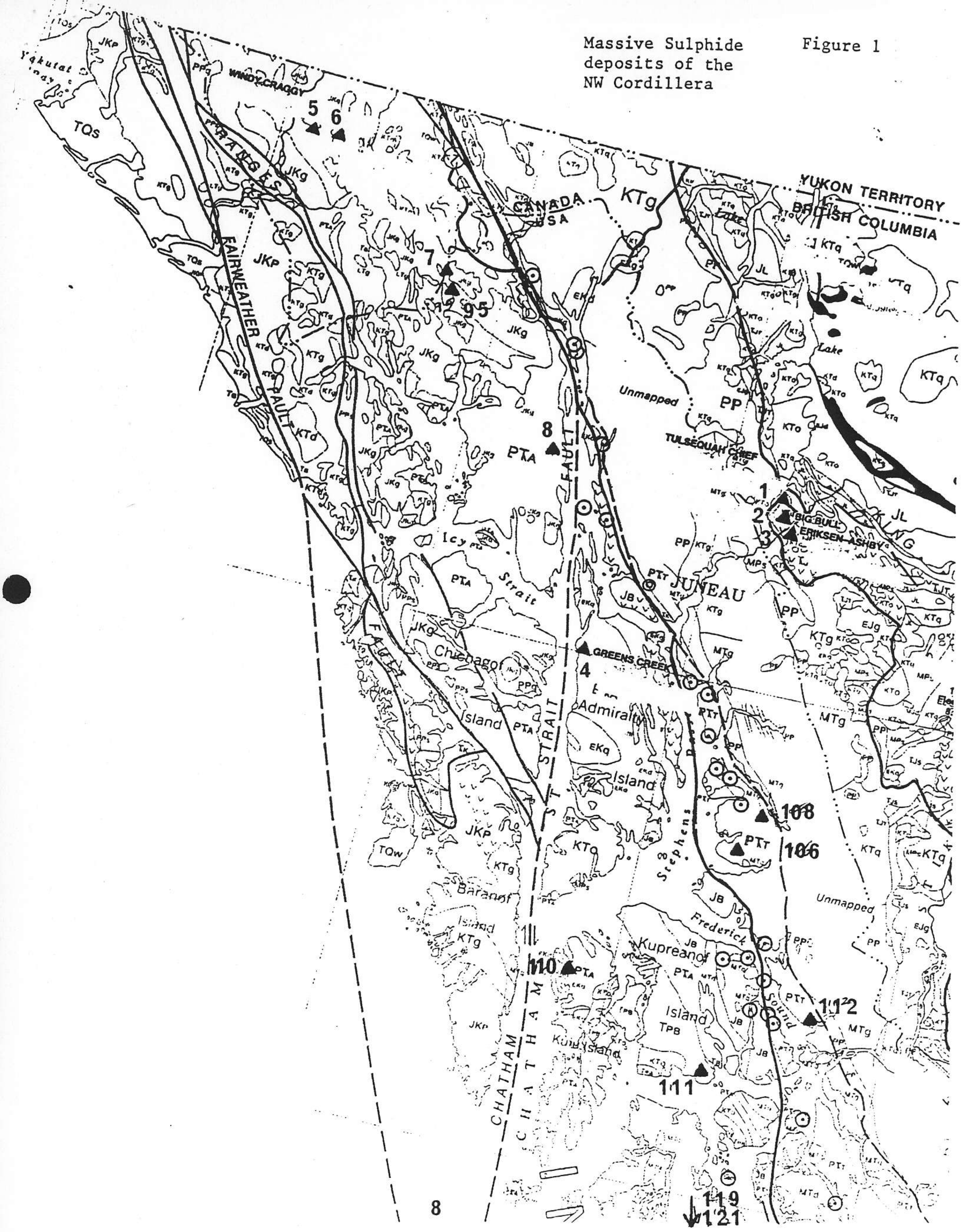
The Alexander Terrane of the Insular Belt of the Cordillera in northwestern British Columbia and neighbouring Alaska contains several areas with deposits and prospects of volcanogenic type, polymetallic, massive sulphides. The typical geological environment of these VMS deposits, where not masked by metamorphism, is a mafic volcanic sequence with either interbedded or underlying carbonate-rich sediments. The sequence is likely to be of Triassic age and to have suffered several phases of fold deformation.

The massive sulphides tend to have a high pyrrhotite to pyrite ratio and therefore a strongly magnetic character. Base metals present include copper, lead and zinc as the primary sulphides and also as supergene-enriched sulphide and oxide minerals. Minor metals present may include gold, silver, cobalt and cadmium. Barite is enriched in the vicinity of some of the deposits. Size and/or grade are comparable with those of VMS deposits anywhere in the world, making this type of deposit an attractive exploration target in this area. Proximity to tidewater provides an economic inducement.

The largest deposits identified to date are in the Haines Triangle of British Columbia. They are localised within a volcano-sedimentary basin, the Alta Basin, covering some 500 square kilometres. Three deposits have been extensively drilled and while still not fully delimited have reserves of almost 300 million tonnes. One other prospect, with a similar magnitude geophysical anomaly, has received initial drill testing confirming polymetallic mineralisation. Another ten or more anomalies in the Alta Basin require investigation.

Massive Sulphide deposits of the NW Cordillera

Figure 1



REFERENCES

Alaska's Mineral Industry, 1989, State of Alaska, Division of Business Development, Division of Geological & Geophysical Surveys, Division of Mining, Special Report 44.

Anglo Canadian Mining Corporation, 1980, First Annual Report.

Berg, Henry C. and Cobb, Edward H., 1967, Metalliferous Lode Deposits of Alaska, Geological Survey Bulletin 1246, U.S. Department of the Interior.

Dodds, C.J., 1979, Geology Tatshenshini River Map Area (114P) British Columbia, Open File Report 926, Geological Survey of Canada.

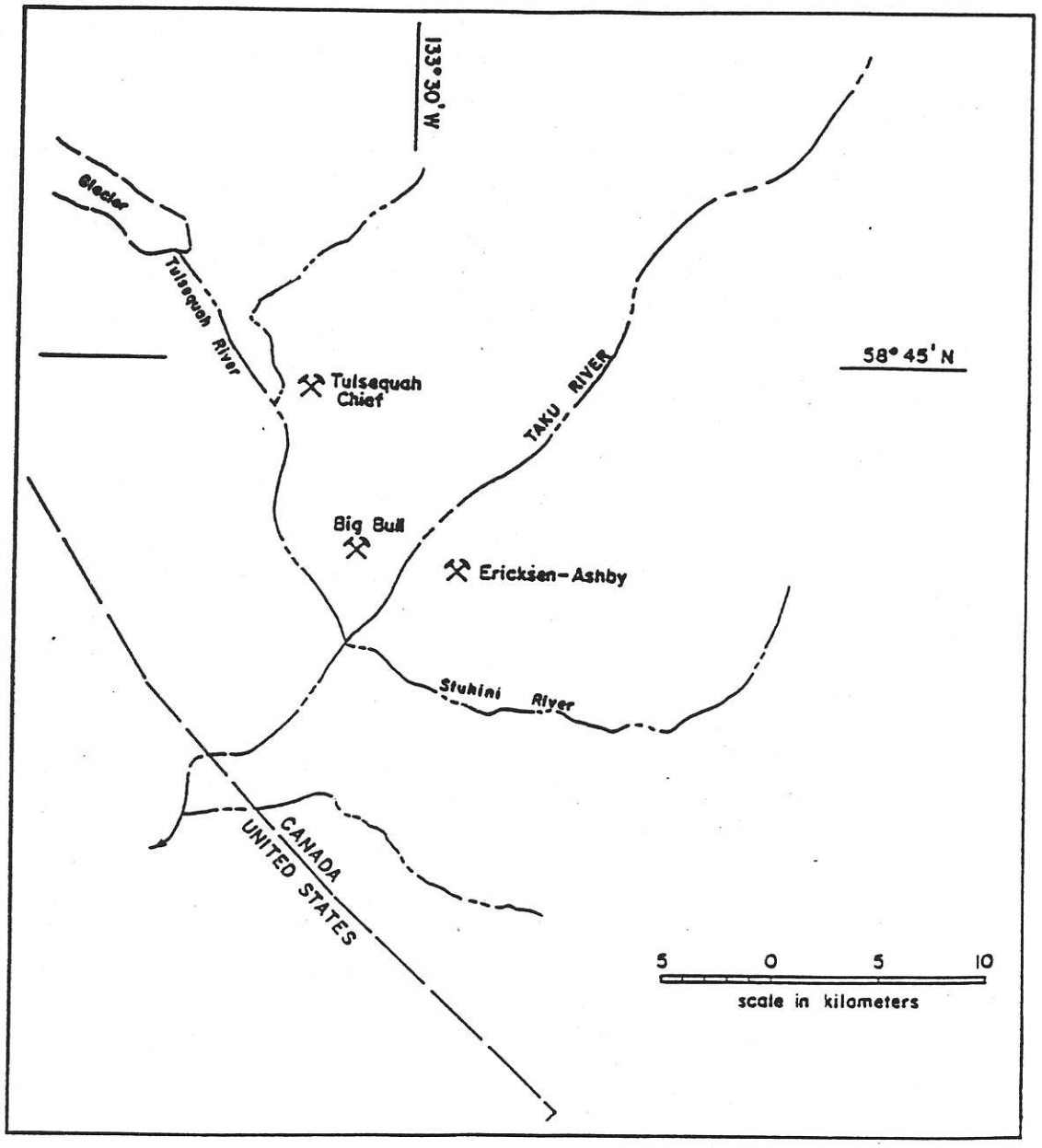
Geddes Resources Limited, 1991, Third Quarter report to Shareholders, October.

Northern Miner, The, 1991, Redfern to own 100% of Tulsequah, Page 3, December 16.

Souther, J.G., 1971, Geology and Mineral Deposits of Tulsequah Map-Area, British Columbia, Geological Survey of Canada, Memoir 362.

Walker, S., 1991, Greens Creek Keeps it Clean, in Engineering and Mining Journal, November, pp 20 - 23.

Location of VMS Deposits in the Tulsequah River Area, B.C.



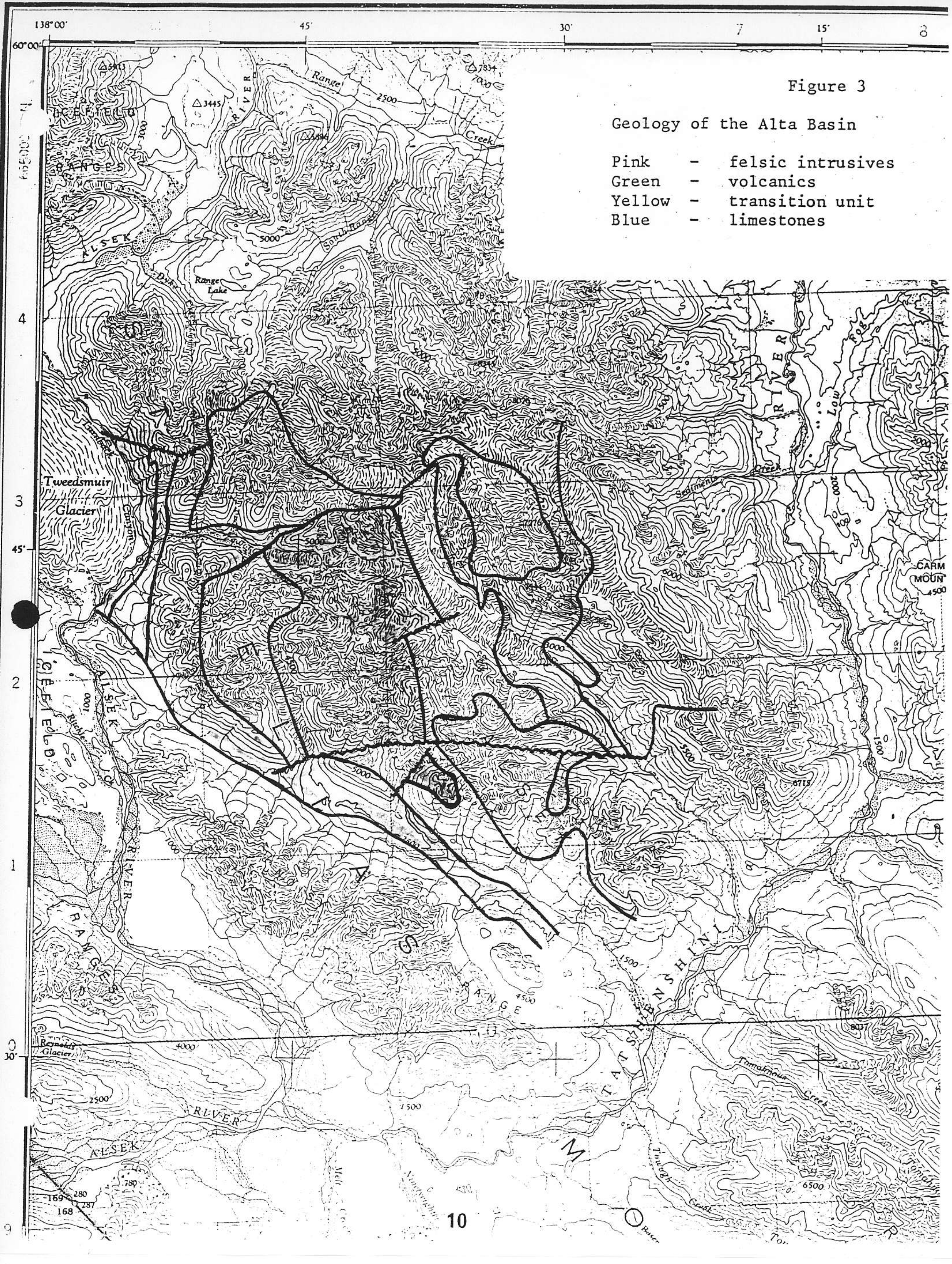


Figure 3

Geology of the Alta Basin

Pink - felsic intrusives
Green - volcanics
Yellow - transition unit
Blue - limestones

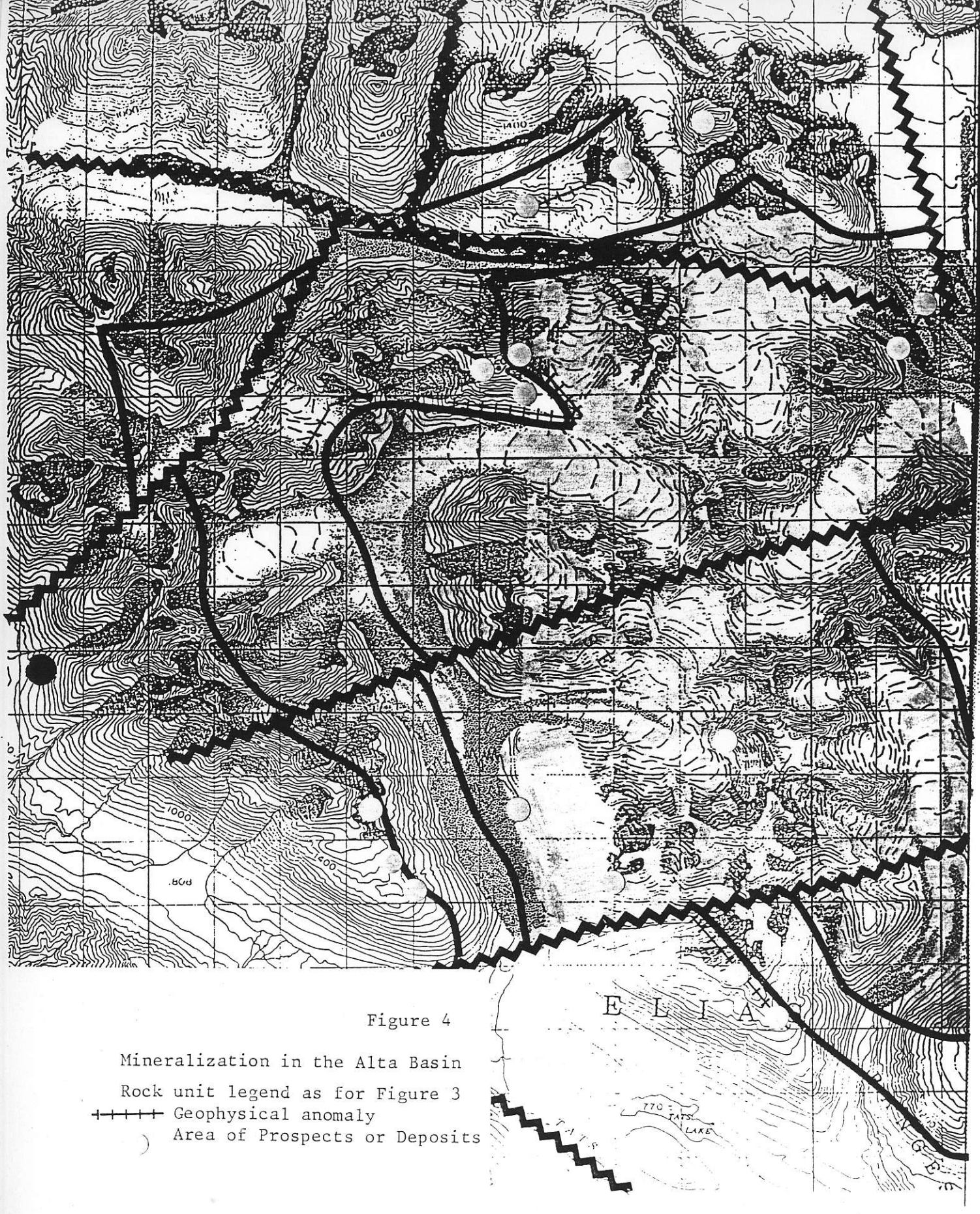


Figure 4

Mineralization in the Alta Basin

Rock unit legend as for Figure 3

Geophysical anomaly

Area of Prospects or Deposits

TABLE 1

References to VMS style prospects shown on Figure 1:

1.	Tulsequah Chief	B.C.
2.	Big Bull	B.C.
3.	Erickson - Ashby	B.C.
4.	Green's Creek	Alaska
5.	Windy Craggy	B.C.
6.	East Arm	B.C.
7.	Mt. Henry Clay	Alaska/B.C.
8.	Dream	Alaska

References extracted from:

Alaska's Mineral Industry, 1989 — Special Report 44

APPENDIX C—Continued

95 **Haines Barite** - Major stratiform Ba-Pb-Zn-Cu-Ag deposit in pillow basalt-dominated section of Paleozoic or Triassic age; consists of 48- to 60-ft-thick zone of 60-percent barite with upper zone (2 to 8 ft thick) of massive sulfides that contain 2 percent Pb, 3 percent Zn, 1 percent Cu, 2 to 4 oz/ton Ag, and 0.12 oz/ton Au. Estimated to contain 750,000 tons of 65 percent barite with metal credits.

106 **Sumdum** - Volcanogenic Cu-Pb-Zn massive sulfide deposit in Mesozoic metamorphic complex with potential strike length of over 10,000 ft. Inferred reserves of 26.7 million tons ore that grade 0.57 percent Cu, 0.37 percent Zn, and 0.3 oz/ton Ag reported.

108 **Tracy Arm** - Strata-bound Cu-Zn-Pb massive sulfide prospect in Mesozoic schist; over 1,100 ft long and up to 12 ft thick. Reported grades of 1.5 percent Cu, 3.9 percent Zn, 0.76 oz/ton Ag, and 0.013 oz/ton Au.

110 **Cornwallis Peninsula** - Volcanogenic Cu-Pb-Zn-Ag-Ba massive sulfide deposit of Triassic(?) age; reported grades of up to 20 percent Pb-Zn and 23 oz/ton Ag.

111 **Castle Island** - Stratiform barite deposit of Triassic age hosted in carbonate and pillow basalt; about 856,000 tons of raw and refined barite produced from 1963 to 1980; also contains Zn, Pb, and Cu sulfides. Reported to be mined out.

112 **Ground Hog Basin** - Area contains several stratiform massive sulfide prospects in Mesozoic schist and gneiss whose origins are unknown. Reported grades of up to 8 percent Pb, 29 oz/ton Ag, and 0.5 oz/ton Au. Area also contains potential for porphyry Mo deposits.

119 **Copper City** - Stratiform Cu-Zn-Ag-Au massive sulfide deposit hosted in late Precambrian Wales Group. Reported grades of up to 12.7 percent Cu, 2.7 percent Zn, 2.5 oz/ton Ag, and 0.2 oz/ton Au.

121 **Niblack** - Volcanogenic Cu-Pb-Au-Ag massive sulfide deposit hosted in Precambrian(?) Wales Group or Ordovician to Silurian Descon Formation; produced more than 1.4 million lb Cu, 11,000 oz Au, and 15,000 oz Ag.