Open File 2006-4

Mineral Assessment of the Northern Kluane Wildlife Sanctuary, Yukon

D. Héon

YUKON GEOLOGICAL SURVEY

Yukon
Energy, Mines and Resources

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Published under the authority of the Minister of Energy, Mines and Resources,
Government of Yukon
http://www.emr.gov.yk.ca
Printed in Whitehorse, Yukon, 2006.

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In referring to this publication, please use the following citation:
Héon, D., 2006. Mineral Assessment of the Northern Kluane Wildlife Sanctuary Study Area, Yukon. Yukon Geological Survey, Open File 2006-4, 65 p.

Preface

A preliminary mineral assessment of the Northern Kluane Wildlife Sanctuary was undertaken by the Department of Economic Development in 1995. The purpose of this study was to provide mineral potential information to the Department of Renewable Resources and the Land Claims Secretariat of Yukon Government to aid in the review of the proposed boundaries of the Asi Keyi Special Management Area. The Yukon Geological Survey is pleased to release the results of this mineral assessment in this report.

The information is being released as originally prepared and may not conform to current Yukon Geological Survey publication standards. Please note that this report does not include information from any studies that may have been carried out in the area since the mineral assessment was conducted. This report was not previously released to the public due to the confidential nature of the Land Claim negotiation processes.

Preliminary Mineral Assessment of the Northern Kluane Wildlife Sanctuary

Internal Report
prepared by the Department of Economic Development

by Danièle Héon

June 1996

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FOREWORD

This report outlines the results of a preliminary mineral assessment that was undertaken by the Department of Economic Development to provide the Department of Renewable Resources and the Land Claims Secretariat (YTG) with a guide to the mineral potential of the Kluane Wildlife Sanctuary. Given the short time frame allowed for this exercise, this desk-top compilation corresponds only to the first part of phase 1 of the approved methodology for Mineral Assessment for Proposed Territorial Parks. The conclusions of this report were drawn without the benefit of field checking, without evaluating the accuracy of the database and without the opportunity to fill any gaps in the data.

It must be understood that resource assessments are by nature an evaluation of scientific data at one point in time, they represent a snapshot of current geoscientific knowledge in the current economic, geographic and social context, all which are dynamic features and bound to change with time. This preliminary mineral assessment of the Kluane Wildlife Sanctuary outlines the present state of knowledge of the geology and mineral deposits of the Kluane Wildlife Sanctuary.

SUMMARY

The mineral potential of the Northern Kluane Wildlife Sanctuary (KWS) is rated as HIGH.

1- Within the KWS, rocks of the Wrangellia Terrane rate the highest as they include two mineral deposits with proven reserves, one past producer, favorable stratigraphy for a variety of mineral deposits with production history and proven reserves elsewhere in the Cordillera as well as over 45 mineral occurrences within the boundaries of the KWS. Ultramafic hosted Ni-Cu-PGE; Fe, Cu, Au skarn, replacement or basaltic copper, VMS and polymetallic vein deposits are hosted in this belt of extremely high mineral potential that includes the Wellgreen (within the KWS), Kennecott and Denali mines (in Alaska).

2- On a local as well as regional scale, stitching Pennsylvanian and post-accretionnary Cretaceous and Tertiary plutons are also of high potential for a variety of mineral deposit types including porphyry copper, epithermal gold and silver, skarns and polymetallic veins. Sedimentary and volcanic rocks of the Gravina-Nutzotin belt are host to VMS, skarn, and gold and polymetallic vein occurrences such as the Brittania mine in B.C. and the Orange Hill, Treadwell and Yakima deposits in Alaska.

3- The lower part of the Alexander Terrane, which is exposed within the KWS, contains few mineral occurences locally but, at a regional scale, contains numerous important and varied mineral deposits. Examples include the Reid Inlet auriferous vein deposit, the Glacier Creek and Orange Point VMS deposits as well as several intrusive-hosted deposits. The Triassic succession of Alexander Terrane, which hosts the world-class Windy Craggy Cu-Co-Au deposit,is not known to outcrop within the KWS although similar Triassic rocks of the Karmutsen Assemblage do. The “Alexandrian” portion of the KWS occupies the most remote and ice covered corner of the study area. This would explain the paucity of information on the area but also lessens it's exploration appeal.

4- The mineral potential of the Wrangell lavas and related plutons is not well understood. More mapping is needed in order to define the extent of the reported but undocumented felsic end member of this suite. These rocks appear to be of relatively lower mineral potential within the KWS although they host significant mineral deposits and mines in Alaska. A sliver of Coast Plutonic Metamorphic Complex and Kluane Schist occurs within the KWS. Most of the significant deposits occurring in these rocks are generally related to younger plutons intruding them. One exception is the Killerman Lake occurrence which is hosted in the metamorphic rocks of the Kluane Schist.

5- The Amphitheater assemblage and the Quaternary cover are the lowest rating units.

The geology of the area is very complex. Geological map coverage is very poor for the area between the White and Donjek Rivers and needs to be upgraded in order to determine the extent of high potential rocks in that part of Wrangellia. Field checking of the Wrangell lavas is also needed in order to establish their potential for economic mineralization. Aeromagnetic coverage is incomplete for the area, and is non-existent for the area surrounding the Klutlan glacier and the Wellgreen mine. A workplan is proposed to complete the geological coverage, at least within a poorly documented section of Wrangellia.

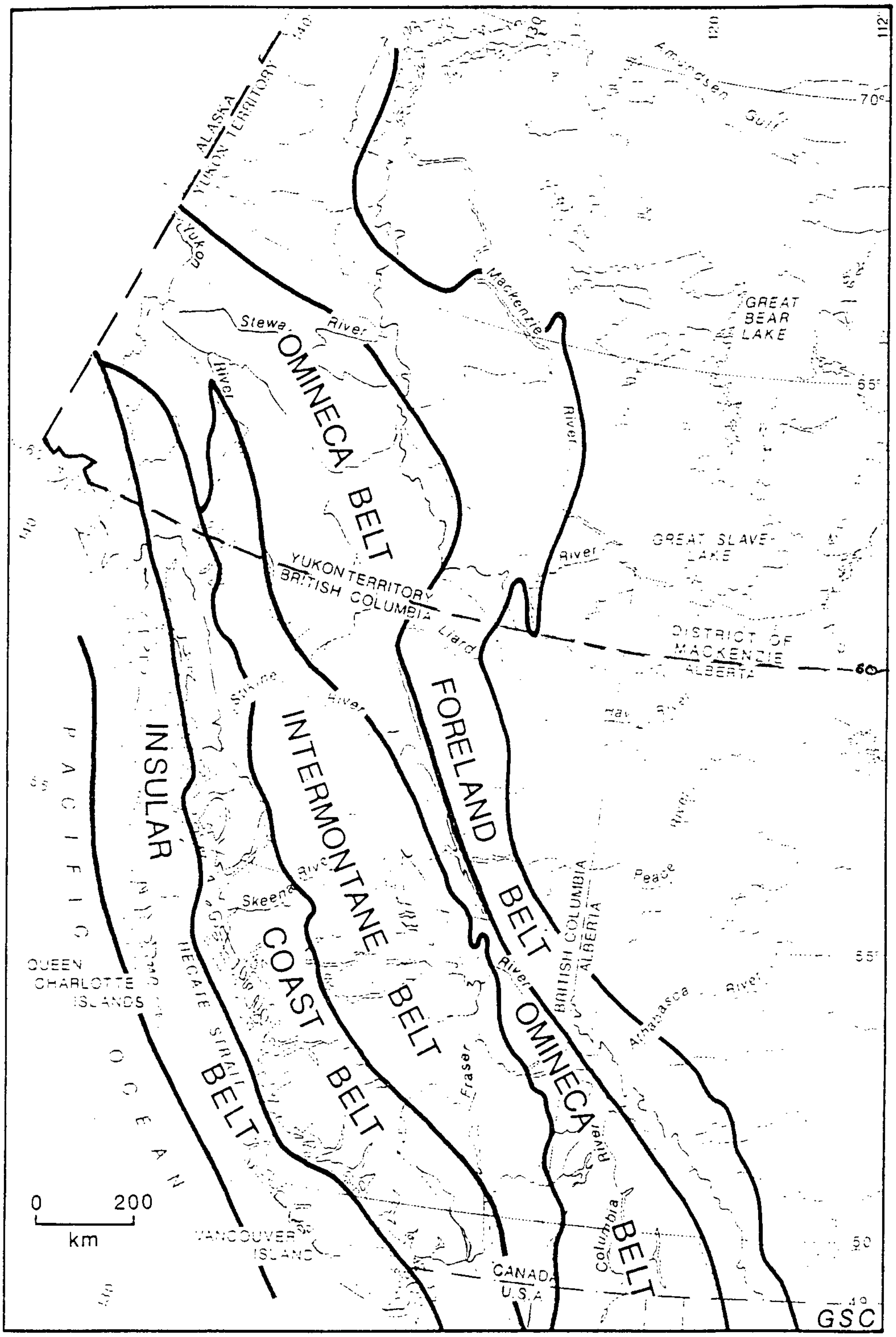
1. Introduction

The northern section of the Kluane Wildlife Sanctuary (KWS) is located in the northern Cordillera on the eastern boundary of the St-Elias Mountains, on map sheets 115F+G. The Sanctuary is bounded to the south by Kluane National Park, to the northeast by the Alaska Highway, to the west by the Yukon/Alaska border and to the northwest by the White River. It covers a surface area of 5 235 sq. km. A variety of geological features is represented in the KWS and are reflected in the physiography of the area. The characteric high relief of the St-Elias Mountains is caused by the combined action of Miocene uplift with the erosive power of ice sheets and glaciers capping these mountains. This uplift is believed to be caused by the oblique subduction of the Pacific plate beneath the present margin of western North America. Displacement along northwest trending faults provide a control for the development of drainages, as best demonstrated by the Shakwak trench which developped on the Denali fault.

The northern Cordillera has been subdivided into five morphogeological belts, each characterized by unique lithology (or rock sequences), structural style and morphology (fig.1). Each one of the belts is further subdivided into tectonic assemblages that represents specific depositional or volcanic settings and/or response to one or more tectonic event (fig.2).

Rocks that underlie the KWS are mostly part of the Insular morphogeological belt or superterrane and also include a thin wedge of Coast Belt. In the study area, the Insular belt consists mainly of two separate packages of rocks that were deposited or erupted outboard of ancestral North America at more southerly paleolatitudes, then transported northward to their present location, and younger rocks that intrude or overlap them. The two distinct fault bounded packages are called Alexander and Wrangellia terranes and are thought to have first amalgamated together and later accreted to North America. Intrusive rocks, some confined to, others stitching these terranes, provide timing constraints, as do the post-accretion sedimentary and volcanic assemblages that overlap terrane boundaries. The Denali and Duke River faults are such terrane boundaries and are the site of intense deformation and large scale (>300 km) dextral displacement.

Wrangellia forms an extensive belt of rocks that is rich in mineral occurrences (fig.3). Known mineralization is associated with volcanic rocks, mafic (iron-rich) and felsic (silica-rich) intrusive rocks and limestones as well as veins emplaced in reponse to deformation and/or plutonism. Metals found within the KWS include: gold, copper, nickel, cobalt, platinum group elements, molybdenum, tungsten. Placer gold, coal and industrial minerals such as gypsum, asbestos and wollastonite also occur within the KWS.



EXPLANATION

Figure 1 Morphogeological belts and regional strike-slip faults of the Canadian Cordillera.

from Gabrielse & Yorath, Eds. 1992

2. Previous Geological Work

Local native populations were the first to recognize and use the mineral resources of the area. Native copper nuggets from the Klet-san-dek (Copper) or Kletsan Creek were worked as tools and implements and used in trade.

The first documented geological report was done by two geologists accompanying Frederick Schwatka on exploration trips in 1891 and 1899 (Muller, 1967). Placer miners were attracted to the area around the turn of the century.

Mapping by the Geological Survey of Canada was started in 1904 and additional mapping projects have been ongoing intermittently ever since.

Three recent phases of mapping are still relevant. GSC Memoir 340 by J.E. Muller (1967) is outdated with respect to current geological thinking but contains interesting factual information about the area. This report includes a map at 1 inch to 4 miles scale covering map sheets 115F and G based on field work done in the 1950's before elaboration and the common acceptance of Plate Tectonics Theory. A mapping project ongoing throughout the 70's known as Operation St Elias resulted in the publication by Campbell and Dodds (1982) of a series of geological maps (O.F. 829, 830, 831) at a scale of 1: 125 000 that extend from the Yukon/BC border north to the White River. More detailed and accurate mapping at 1: 50 000 scale was done by Reed and Monger and the resulting map and accompanying report are published as O.F. 381 (1976). Recent mapping by Reed and Bremner in the Quill Creek area as well as north of the White River is still in preparation.

Numerous workers have documented the stratigraphy, structure, intrusive and volcanic activity, mineral occurrences and metallogeny of the area. This report attempts to present the state of current thinking in the context of land use planning. Time constraints did not permit the drafting of a new compilation map, nor the systematic consultation of assessment reports. The digital version of the Tectonic Assemblage map (Journeay and Williams, 1995) has been used as basis for this geoscientific compilation. This map is by its nature a simplification of a fairly recent state of understanding of the distribution of the different tectonic segments of the Cordillera. The actual distribution of rocks unit displays a much greater level of complexity, and in places, uncertainty, than is portrayed on this map.

Am	Amphitheater Fm.
Ax	Alexander Terrane
CPMC	Coast Plutonic Metamorphic Complex
Ds	Descon Assemblage
GN	Gravina-Nutzotin Belt
Kar	Karmutsen Assemblage
KsK	Kaskawulsh Fm.
KR	Kluane Ranges Plutonic Suite
KS	Kluane Schist
KU	Kluane Ultramafic Suite
Q	Quaternary
SE	St. Elias Plutonic Suite
Sk	Skolai Assemblage
WP	Wrangell Plutonic Suite
Wr	Wrangellia
WV	Wrangell Volcanics

scale: approximately 1: 600 000
or 1 km = 6km

Fig.5 map legend

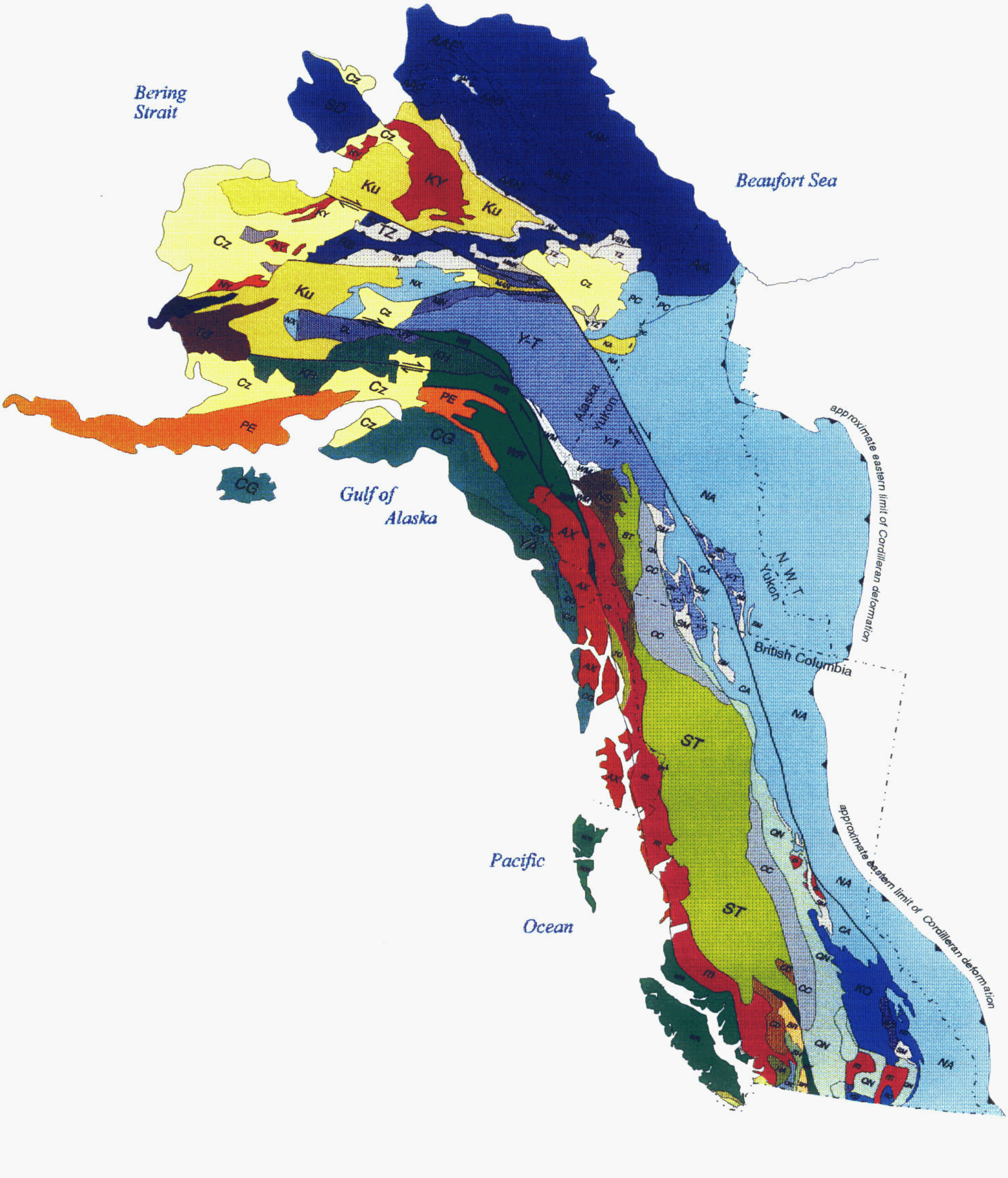

Bering Strait
Beaufort Sea
Gulf of Alaska
Pacific
Ocean
Cz
SD
KY
Ku
TZ
Y-T
PE
CG
AX
ST
NA
CA
CC
QN
KO
Alaska
Yukon
N.W.T.
Yukon
British Columbia
approximate eastern limit of Cordilleran deformation
approximate eastern limit of Cordilleran deformation

Fig. 2

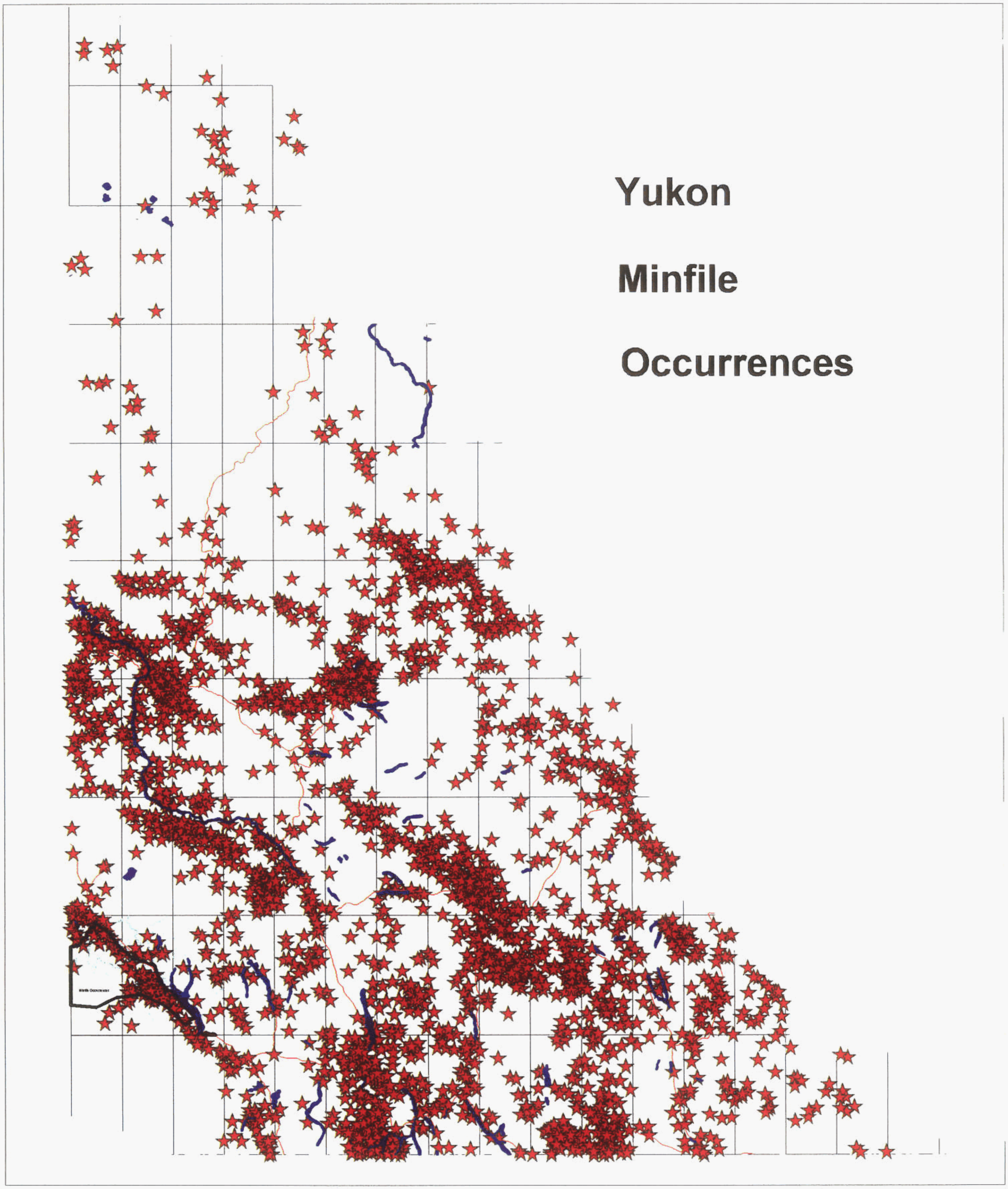


Fig. 3

3. TECTONIC SETTING

Tectonic assemblages and events are described from oldest to youngest, first by superterrane then individual terranes, then followed by the description of overlap assemblages, in the same chronological order.

The geology of the Kluane Wilderness Sanctuary (KWS) is a complex mosaic of distinctive lithological units juxtaposed by arrays of splaying and anastamosing faults. Due to structural complexity and poor fossil control, the stratigraphy within fault blocks is locally poorly defined and in places, correlations across fault blocks are tentative.

The KWS overlies two major superterranes or morphogeological belts that are bounded by major faults. The Denali Fault separates the Insular belt or superterrane to the southwest from the the Coast belt to the northeast.

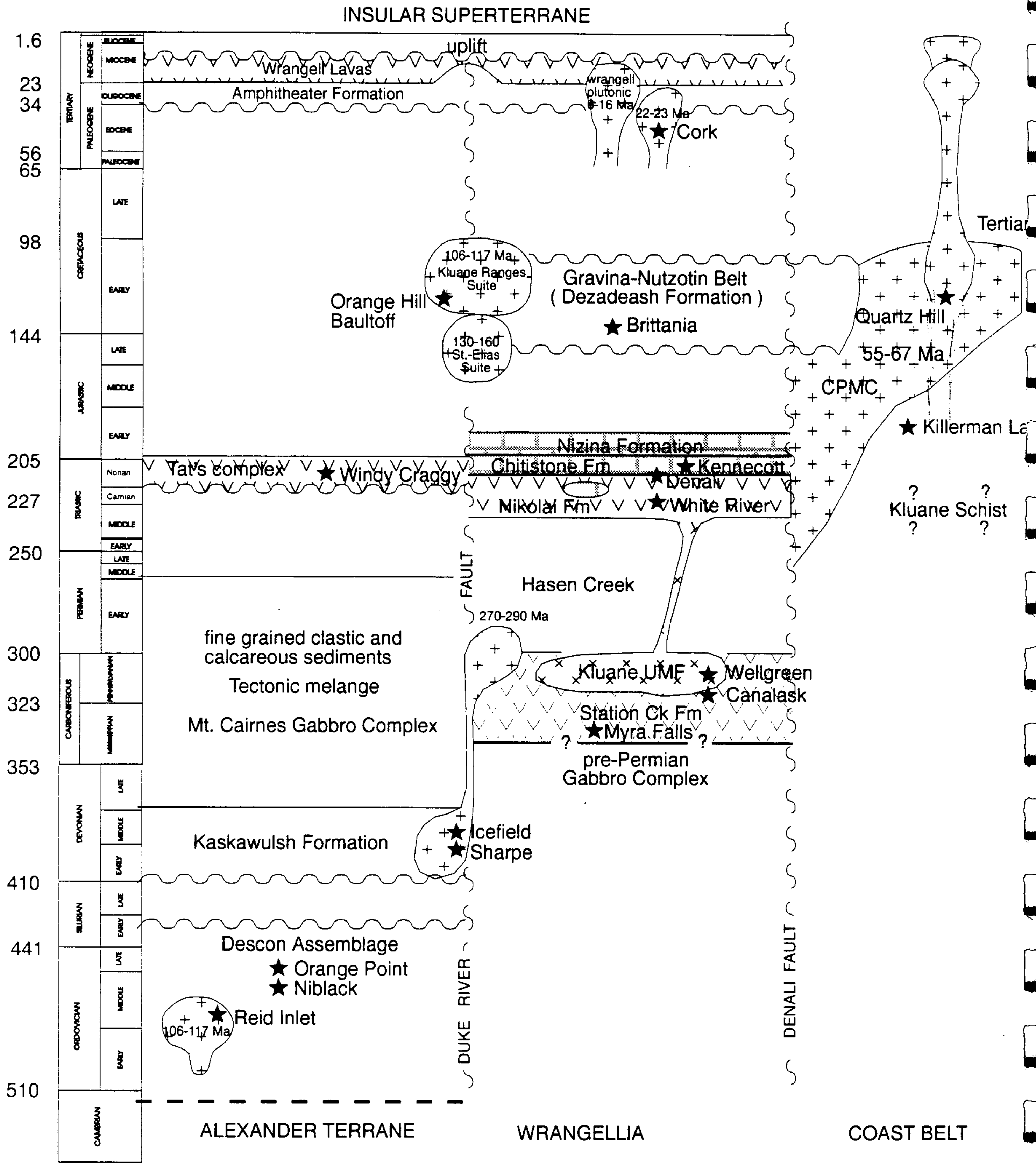
3.1. Insular Superterrane

Located southwest of the Denali fault, the Insular superterrane is a composite of six northwest trending fault-bounded terranes, which extend into contiguous Alaska and British Columbia. Two of these belts are represented in the KWS and are separated by the Duke River Fault. These are the Alexander Terrane, in the southwest corner of the KWS and Wrangellia (a.k.a. Taku-Skolai, W_2) in the northeast (fig. 6). The Alexander Terrane is bounded to the south, outside of the KWS, by the Hubbard fault. On a regional scale, structurally imbricated segments of Wrangellia also lie to the southwest of Alexander terrane. The terranes are further divided into tectonic assemblages (fig.7).

3.1.1 Wrangellia

Most of Wrangellia is underlain by generally well stratified upper Paleozoic and lower Mesozoic volcanic, sedimentary rocks and related plutonic rocks. The An altered pre-Permian gabbro complex defines the lowermost exposure of Wrangellia. It is overlain in depositional contact by the Pennsylvanian volcanogenic Station Creek Formation, which hosts numerous types of copper and/or gold deposits, and the lower Permian Hasen Creek formation. These two formations are correlated with both the Skolai assemblage of SE Alaska and with the Sicker Gp of southern B.C. The combined Station Ck/ HasenCk is herein referred to as the Slokai.

The upper part of the Station Creek Fm is intruded by Triassic Kluane Mafic-Ultramafic Intrusions. These consist of zoned ultramafic sills that host copper, nickel, cobalt and platinum group elements (PGE) deposits such as at the Wellgreen Mine which is located within the KWS. A sequence of mid Triassic argillite separates the Slokai from the overlying upper Triassic Nikolai greenstones and Chitistone limestones (aka Karmutsen Assemblage),



★ Mineral deposit shown in relation to host rock, not timing of mineralization

Fig. 4 Schematic Tectonostratigraphic Setting

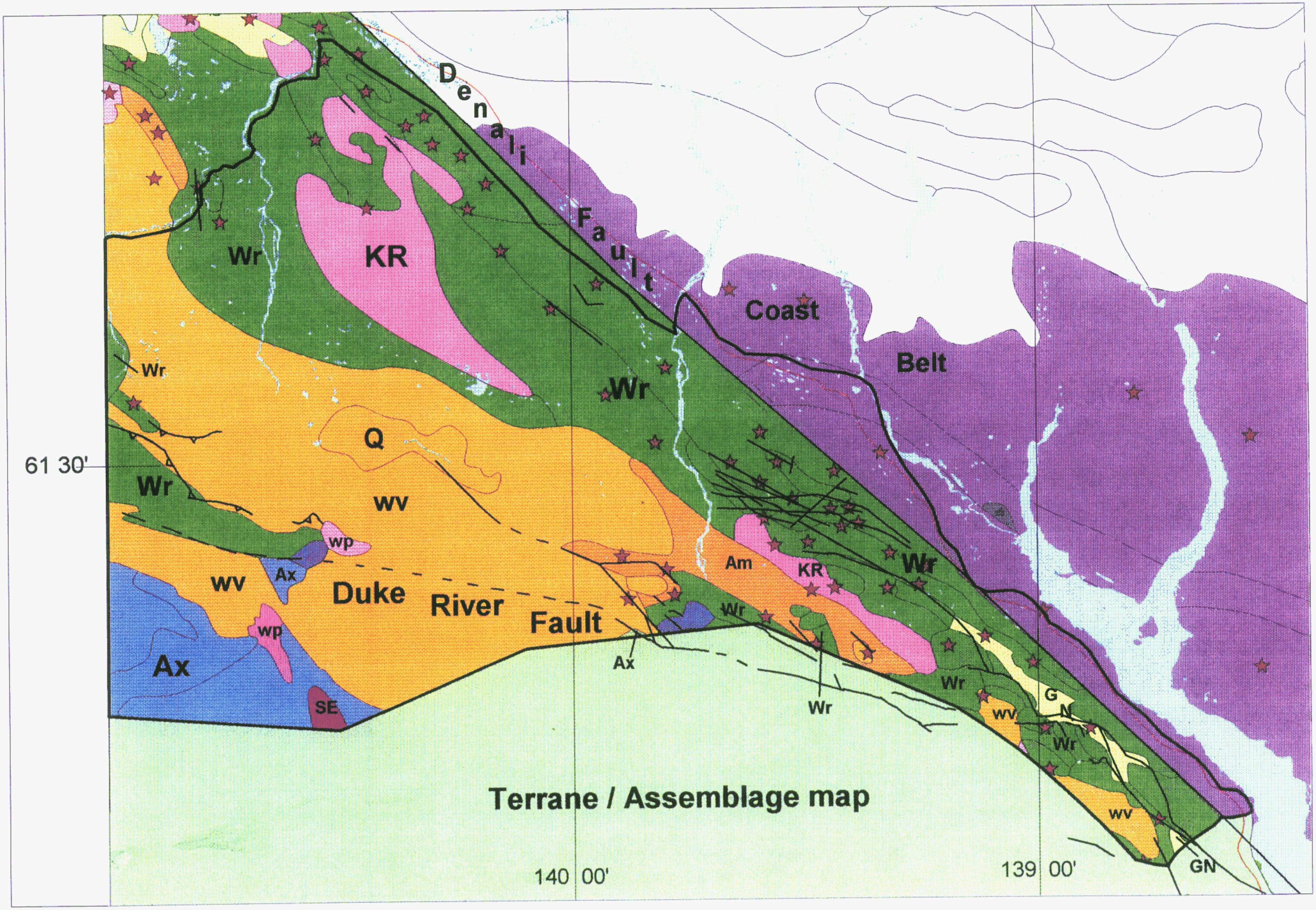

Denali Fault
Coast Belt
KR
Wr
Wr
Wr
Wr
Wr
Q
wv
wp
Ax
wv
Duke River Fault
wp
Ax
SE
Am
KR
Wr
Ax
Wr
Wr
G
N
wv
Wr
wv
GN
61 30'
140 00'
139 00'
Terrane / Assemblage map

Fig. 6

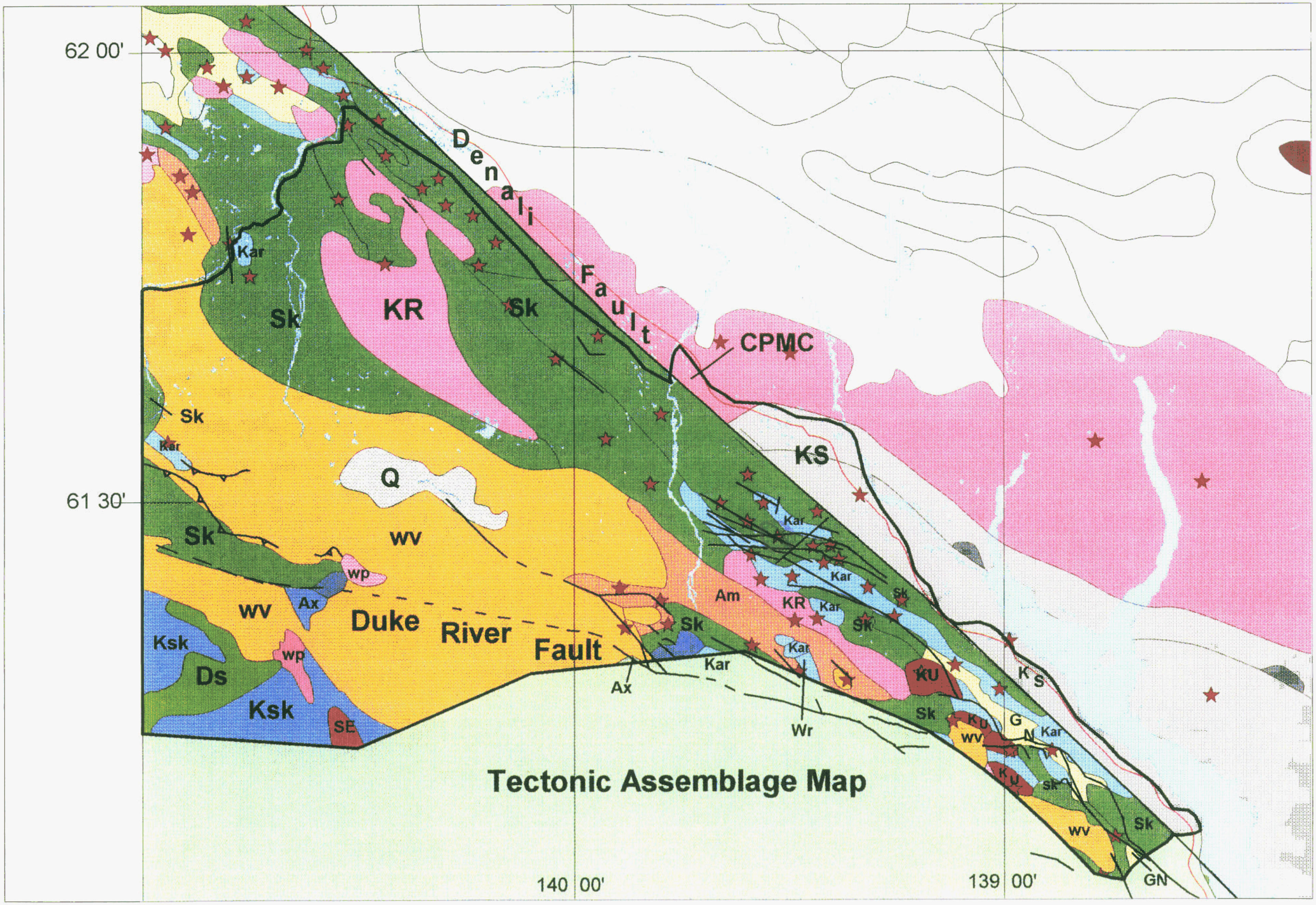

62 00'
61 30'
140 00'
139 00'
Denali Fault
Duke River Fault
Tectonic Assemblage Map
CPMC
KR
Sk
KS
Q
wv
wp
Ax
Ksk
Ds
SE
Kar
Am
KU
Wr
G
N
GN

Fig. 7

a distinctive rock package that is the most characteristic unit of Wrangellia stratigraphy. These mostly subaerial mafic volcanics and shallow water limestones host numerous copper deposits including the Kennicott and Denali mines in adjacent Alaska and the White River deposit contiguous to the KWS as well as numerous copper occurrences within the KWS. It is postulated that the Triassic ultramafic bodies intruding the Skolai Group are the feeders to the Nikolai basalts. The massive Chitistone limestone is succeeded by the Nizina Formation and the McCarthy formation that grades upwards into Jurassic argillite. The Triassic interval of Wrangellia documents the construction of a basaltic edifice to above sea-level and subsequent slow subsidence to deeper water basinal facies (DNAG, p. 316).

3.1.2 Alexander Terrane

The Alexander Terrane (Ax) is characterized by Paleozoic to Mesozoic platform, island arc and rift-related rocks which have been metamorphosed to varying degrees. The lower part of the Alexander terrane outcrops within the KWS and consists of Ordovician to Silurian Descon Assemblage and mid-Devonian Kaskawulsh formation. The Descon assemblage consists of mudstone-greywacke turbidites interbedded with cherts and limestones juxtaposed laterally with basalts and volcaniclastics. The Kaskawulsh Fm consists of locally reefoid carbonates interbedded with turbidites and mafic to intermediate volcanic rocks. In western Ax (outside of the KWS), these rocks were intruded by the late Pennsylvanian to Permian Icefield Ranges Plutonic Suite. The section of younger stratified rocks of the Alexander terrane is not documented within the KWS. An upper Devonian to lower Permian package of mafic plutons, volcanic and sedimentary rocks is uncomformably overlain in part by the upper Triassic Tatshenshini volcanic complex that hosts the Windy Craggy copper-cobalt-gold deposit.

3.1.3 Overlap Assemblages

Younger rocks overlapping a (partly) amalgamated Insular superterrane include rocks of the Gravina-Nutzotin belt, the Amphitheater formation, and the Wrangell lavas and related plutons.

Upper Jurassic to lower Cretaceous marine sedimentary and volcanic rocks of the Gravina-Nutzotin belt (a.k.a. Gambier assemblage, Dezadeash Fm) are inferred to be deposited on top of both terranes (Ax and Wr) in the basin developed between the Insular and the Intermontane superterrane, and therefore constitute the earliest overlap assemblage. Rocks of the Gravina-Nutzotin belt outcrop mostly on the northeast side of the Denali fault but, within the KWS, occur on the southwest side of the fault. The marine flysch portion of this belt records deep-sea fan sedimentation derived from a westerly source. The volcanic portion of this belt records arc volcanism along the western edge of the Intermontane superterrane. This belt hosts VMS, skarn and porphyry deposits.

Wrangellia and the Alexander Terrane were therefore previously thought to have amalgamated together by upper Jurassic times, the age of the oldest rocks in the Gravina-Nutzotin belt. But some evidence points to earlier amalgamation since a mid-Pennsylvanian pluton of the Icefield Ranges Suite may intrude the base of the Alexander Terrane AND the Wrangellian Station Creek formation. If this interpretation is correct, this would mean that all rocks younger than mid-Pennsylvannian would be common to both terranes.

The Amphitheater formation consists of Tertiary (Oligocene) coal-bearing conglomerates, sandstones and shales that were deposited in fault-controlled basins, with sediments being mainly derived from the east.

The Wrangell lavas first erupted in Tertiary (Miocene) time and represent the continental expression of the Aleutian arc. The intrusive equivalent of these lavas are the Wrangell Plutonic Suite. Fluid lavas ranging in composition from calc-alkaline andesites to basaltic andesites flooded a vast area. Near the Alsek River, episodic volcanism of varying composition (basalts to rhyolites) and viscosity led to the construction and subsequent collapse of composite volcanoes. The source of the White River Ash has been traced to Mount Churchill, located less than 40 km from the Yukon-Alaska border, at the head of the Klutlan glacier. Radiometric dating indicate an average eruption age of 1260 Ma. Epithermal, porphyry and polymetallic vein deposits occur in the Aleutian equivalents of these rocks.

Significant amounts of uplift and erosion have taken place since the Miocene. The Amphitheater and Wrangell formations are thought to have been deposited on stable low lying topography and have been subsequently eroded as a result of the uplift of the Saint Elias Mountains. The rate and extent of this uplift is inferred to result from the change in direction of subduction of the Pacific plate.

3.2. Coast Belt

3.2.1 Kluane Schist

Metamorphic rocks of the Kluane Schist are of uncertain age but might be metamorphosed equivalents of the Dezadeash formation (Gravina-Nutzotin belt, see below). They consist of graphite-garnet-staurolite-bearing biotite schist and muscovite-chlorite schist and host the Killerman Lake gold deposit where vein hosted gold mineralization is thought to be related to metamorphic fluids emplaced in shears and faults.

3.2.2 Coast Plutonic-Metamorphic Complex

The Coast Plutonic-Metamorphic Complex records two episodes of plutonism. It consists mainly of the Cretaceous Ruby Range Suite consisting of granitoid rocks that were emplaced in response to subduction of the plate carrying the Insular beneath the Intermontane superterrane and thus forms a plutonic welt between the two superterrannes. Post-accretion Tertiary magmatism (Eocene) is documented in the more felsic Nisling Assemblage. Several skarn occurrences are related to rafts or pendants of older metamorphic host rocks preserved in the intrusive rock. Porphyry mineralization is usually related to the youger intrusive phase.

The Intermontane Superterrane, located east of the Coast Plutonic belt and outside the study area, is thought to have accreted to North America by Jurassic time. Timing of the accretion of the Insular superterrane with the Intermontane superterrane is unclear but is thought to have been complete by mid-Cretaceous time, and possibly as early as late Jurassic.

3.3. Post-accretionary Plutons

Fig. 8 portrays the relative distribution of the different magmatic suites.

3.3.1 Saint Elias Plutonic Suite

Late Jurassic to Early Cretaceous plutonism (160-130 Ma) gave rise to the Saint Elias Plutonic Suite that intrudes mainly Alexander terrane but also part of Wrangellia, and might be the deep-seated expression of the volcanic portion of the Gravina-Nutzotin belt. Molybdenum and tungsten mineralization has been reported in these rocks.

3.3.2 Kluane Ranges Plutonic Suite

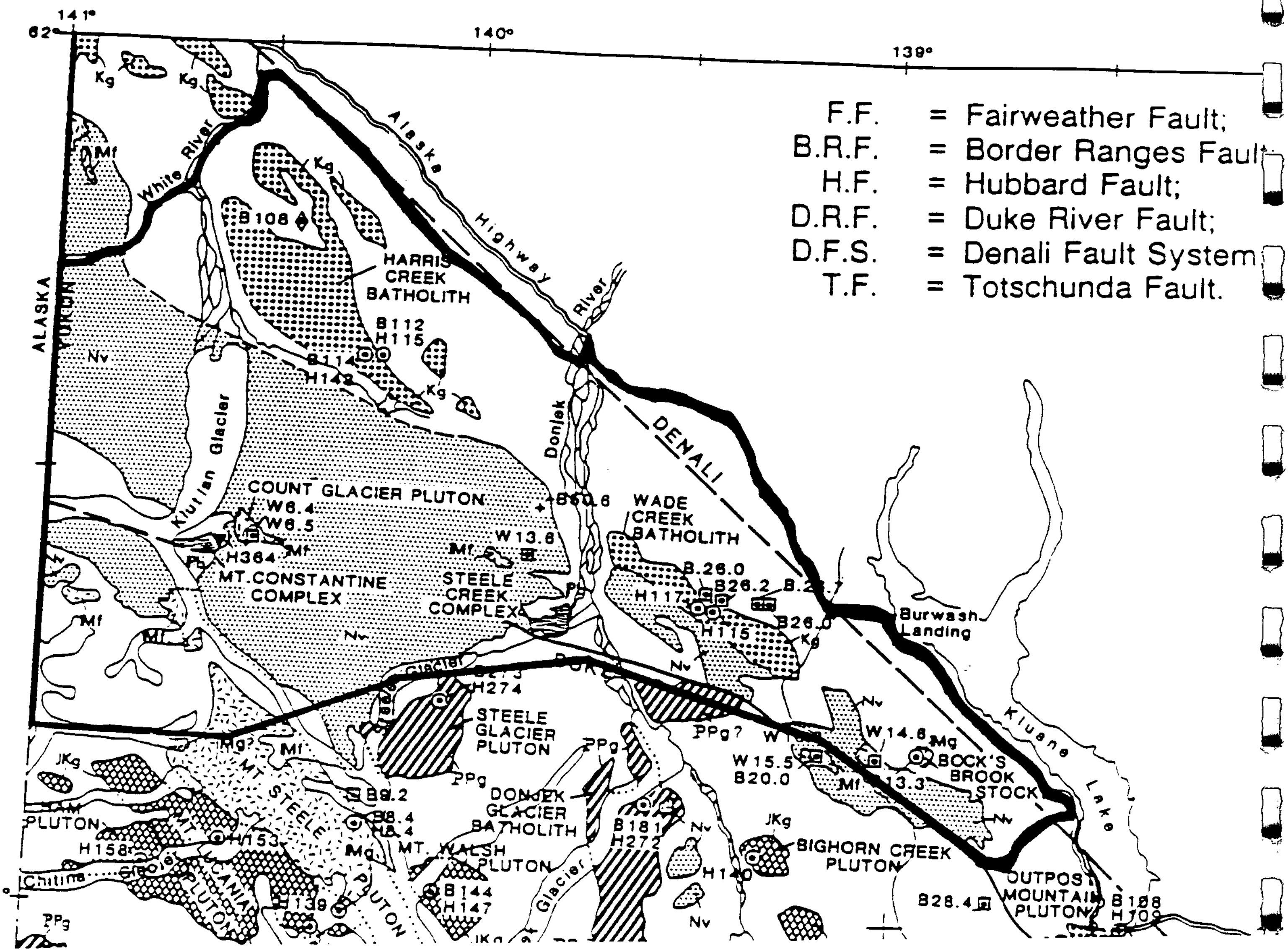
The Kluane Ranges Plutonic Suite was emplaced in late Early Cretaceous time and intrudes Alexander Terrane, Wrangellia and the cover of Gravina-Nutzotin rocks. It was possibly emplaced after the accretion of the Insular with the Intermontane superterrane. Porphyry mineralization is associated with this suite.

3.3.3 Wrangell Plutonic suite

The Wrangell Plutonic suite represents the magmatic equivalent to the Miocene Wrangell lavas.

3.3.4 Oligocene intrusions

An unnamed Oligocene plutonic suite, associated with porphyry and polymetallic vein deposits, also occurs in the area.



LEGEND

MID TO LATE MIOCENE (6–16 Ma)
WRANGELL PLUTONIC SUITE

Mf — ACID DYKES, SILLS AND SMALL PLUTONS.

Mg — GRANITE–GRANODIORITE; GABBRO–DIORITE.

NEOGENE
WRANGELL LAVA

Nv — SUBAERIAL CALC-ALKALINE VOLCANICS; LOCALLY UNDERLAIN BY OR ALL PALEOGENE CONTINENTAL SEDIMENTS.

OLIGOCENE (23–33 Ma)

Of — ACID DYKES, SILLS AND SMALL PLUTONS.

Og — TKOPE PLUTONIC SUITE: GRANITE, GRANODIORITE, GABBRO; RARER QUARTZ DIORITE, GRANOPHYRE.

Ogb — GRANITE–QUARTZ MONZONITE, GABBRO–DIORITE.

EOCENE (41–52 Ma)
SEWARD PLUTONIC SUITE

Eg — QUARTZ MONZONITE, GRANODIORITE, TONALITE, QUARTZ DIORITE.

LATE EARLY CRETACEOUS (~106–117 Ma)

Kg — KLUANE RANGES PLUTONIC SUITE: GRANODIORITE, QUARTZ DIORITE, DIORITE; RARE QUARTZ MONZONITE.

Kub — ALASKAN-TYPE MAFIC–ULTRAMAFIC COMPLEX.

LATE JURASSIC TO EARLIEST CRETACEOUS (130–160 Ma)
SAINT ELIAS PLUTONIC SUITE

JKg — GRANODIORITE, QUARTZ DIORITE; LESSER DIORITE, QUARTZ MONZONITE.

LATEST PENNSYLVANIAN TO EARLY PERMIAN (270–290 Ma)
ICEFIELD RANGES PLUTONIC SUITE

PPg — DIORITE–QUARTZ DIORITE AGMATITE AND SYENODIORITE COMPLEXES; RARER QUARTZ MONZONITE–GRANODIORITE.

(?) MID PALEOZOIC (~364 Ma)

Pb — GABBRO, DIORITE COMPLEX.

Figure 8 Distribution of episodes of plutonism and location of all available K-Ar age data (Table 1), Saint Elias Mountains, Yukon and British Columbia. The number indicates age in millions of years (Ma) and the prefixed letter indicates material sampled (B-biotite, H-hornblende, M-muscovite, W-whole-rock).

from Dodds and Campbell, 1988

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4. MINERAL OCCURRENCES - LOCAL AND REGIONAL EXAMPLES

The lithological units of the KWS are known to host several types of mineral deposits. The location of Minfile occurrences is shown in fig. 9. Rocks underlying the Wrangellia terrane have the highest number of mineral occurrences, mineral deposits and active claims within the KWS (fig. 10) Two deposits with published reserves are located within the KWS: **Canalask** (Minfile 115G 045) and **Wellgreen** (115G 024) which was mined in the '70s and still remains one of the most important mineral deposits of the Yukon.

Tables 1 and 2 summarize descriptions of the occurrences in and near the KWS. Table 3 cites regional examples of mineral deposits occurring in the same belt of rocks as the KWS elsewhere in the Cordillera. The discussion of mineral occurrences is divided by terrane, and further subdivided by formation and by mineral deposit type within each formation. Mineral occurences within the KWS are discussed first, then occurrences within the same belt of rocks within the Yukon but outside the boundaries of the KWS. Regional (B.C. and Alaska) examples are listed last for each deposit type/formation. Significant skarn occurrences are mentioned both in the section describing the sedimentary host rocks and in the one describing the intrusive host rocks to the mineralization. Epigenetic deposits are ones which host mineralisation that is younger than the enclosing rocks, such as vein or shear related deposits. In the study area, the age and origin of these deposits are not well understood nor well documented. Although described under the host terrane/assemblage heading, this type of mineralization postdates the host rocks. Porphyry-type deposits are described under the relative heading relating to the age of the host/pluton.

4.1 Wrangellia

4.1.1 Skolai Assemblage

The Station Creek and Hasen Creek formations form the Skolai assemblage that was defined in Alaska. The Station Creek hosts skarn, vein and fault or shear related as well as volcanogenic massive sulphide (VMS) mineralization. Skarns can be developed adjacent to mafic intrusions, such as discussed above, or in the contact zone of more felsic intrusions such as at the *Mexico* (115F 042) mineral occurrence. Vein and fault or shear related mineralization contains mainly gold and copper. The *Liberty* (115G 038) occurrence is underlain by silicified tuffs that are cut by quartz-carbonate veins that grade up to 13.7 g/T. The volcanic rocks of the *Rabbit* occurrence (115F 056) are cut by shear zone hosted quartz-pyrite-pyrrhotite-chalcopyrite-bornite veins that grade up to 1.02% Cu/ 9.4m. VMS potential is indicated by the propylitic alteration documented at the *Arby* (115G 095) occurrence. Massive sulphide mineralization occurs on the *Telluride* property (115B 008) as a lens of massive sulphide in andesite averaging 6.9% Zn, 1.8% Cu, 24g/T Ag and 0.2% Pb. Vein mineralization is also present at the margin of a mafic intrusion; quartz veins containing pyrite-pyrrhotite and chalcopyrite average of 1.4% Cu, 0.35% Ni and grade up to 1.2g/T Pt and 5.1g/T Pd .

Major skarn and VMS deposits are hosted in this part of the stratigraphy elsewhere in the Cordillera. Southern Wrangellia has a very high density of mineral occurrences, over 15 occurrences per square kilometer, the highest density in the Cordillera. The most common setting of significant VMS deposits is in the Sicker group, the southern equivalent of the Skolai assemblage, in or adjacent to ryolites. The *Myra Falls* and *Buttle Lake* deposits are located on northern Vancouver Island in the Sicker Group. The *Myra Falls* Kuroko-type VMS deposit is presently mined by Westmin and hosts reserves of 12.5MT grading 1.9% Cu, 0.5% Pb, 6.3% Zn, 2.1g/T Au and 45.6g/T Ag.

4.1.2 Kluane mafic-ultramafic intrusions

In addition to the deposit types listed above, rocks of the Skolai assemblage are host to ultramafic-hosted Cu-Ni-Platinum Group Elements (PGE) deposits. The Kluane mafic-ultramafic Belt (Hulbert, 1996) consists of a 130 km long belt of Triassic gabbro to peridotite sills (iron and magnesium rich magmas) that intrude the Pennsylvanian-Permian Skolai assemblage, generally at or near the transition between the Station Creek and the Hasen Creek Formations. Sulphides containing Cu-Ni-PGE settle gravitationally at the base of the sills and form high-grade massive sulphide lenses. Lower grade Cu-Ni ore but still high in PGE content occurs as dissiminations in the chilled gabbro phase of the ultramafite. Post-magmatic and hydrothermal mineralization, such as skarn, replacement and quartz-carbonate alteration zones enveloping the extremities of the ultramafic bodies, locally contain high Au and Pt +/- Ni,Cu. These deposits have a high magnetic signature and a very subtle geochemical response in soils. Standard stream sediment geochemistry does not seem to be an efficient tool to discriminate between background and anomalous metal concentration. These ultramafic intrusions are also host to asbestos occurrences and have additional potential for talc and chromite.

Numerous occurrences of the Kluane mafic-ultramafic intrusions outcrop within the KWS. The Quill Creek Ultramafic Complex is host to three major and one minor ore zones that are unusually rich in the rare PGE's (Os, Ir, Ru, Rh) (Hulbert, 1996). The ***Wellgreen*** deposit (115G 024) is located in the Quill Creek Ultramafic Complex, within a corridor of extensive deformation and shortening informally named the Quill Creek Fault Zone (T. Bremner, 1994). The steeply dipping stratigraphy exposes the base of the sill. Ore mineralization occurs in three zones and includes discontinuous massive sulphides lenses (1-18m thick) at the base of the intrusion, net-textured sulphides within the marginal gabbro phase and dissiminated sulphides in the overlying dunite. Ore mineralogy consists of pyrrhotite, chalcopyrite, pentlandite and magnetite. Miller (1991) found that the disseminated mineralization is preferentially enriched in copper, platinum, palladium and gold compared to the massive sulphides. Skarn mineralization is reported near the lower footwall contact. This deposit went into production in 1972-73 and total production was 33 853 tonnes of concentrate grading 7.4% Ni and 6.6% Cu. Current reserves are estimated at 49.9 million tonnes grading 0.36% Ni, 0.35% Cu, 0.51g/T Pt and 0.34g/T Pd which at today's metal prices defines an approximate in situ value of $2 **Billion US**, roughly $45 US/tonne.

The *Linda* property (115G 094), located east of the *Wellgreen* deposit, contains disseminated and massive Ni-Cu and PGE mineralization hosted in the gabbro phase of the ultramafic intrusive. Grades range up to 4.2% Ni, 0.68% Cu and 4.39 g/T Pd.

The *Canalask* deposit (115G 045) is located at the northern end of the KWS within the White River Ultramafic complex. Replacement Ni, Cu and PGE mineralization is hosted in the footwall tuff of the Station Creek Formation, 122m away from the base of ultramafic intrusion. The main sulphide zone measures 107 X 15m and contains reserves of 454 545 tonnes grading 1.5% Ni or 1.8 MT grading 0.86% Ni. Disseminated sulphides within the marginal gabbro phase contain Pt-Pd-Ni-Cu values.

At least twelve Minfile occurrences (see table 1, fig.12) with the same type of mineralization as discussed above are located along strike from the deposits listed or are hosted in other mafic-ultramafic bodies within the KWS. The *Onion* occurrence (115K 077), located just north of the KWS, contains high-grade Cu-Ni-Mo-Co-Au and PGE mineralization associated with a gabbro-peridotite body and quartz-carbonate alteration. Peridotite at the *Cats and Dogs* property (115F 041) grades uop to 0.31% Ni. The Tatamagouche Ultramafic Complex underlies the Burwash Uplands and appears to be very large and flat lying. It's base is not exposed therefore making it difficult to evaluate it's potential for massive magmatic mineralization.

The *Chilkat* and *Mansfield* mineralized occurrences represent the southern extension of this belt into northern B.C.

Near the Canwell Glacier in Alaska, a belt of mafic-ultramafic sills, dykes and small plutons off uncertain age intrude Wrangellia on the south side of the Denali fault and might be an offset equivalent of the Kluane belt (T. Buntzen, pers. comm.).

Mineralized mafic-ultramafic intrusions of the Kluane belt have been compared in their geology, chemistry and metallogeny to the world class *Norils'k-Talnakh* deposits of northwest Siberia which are also associated with elongate ultramafic belts. These deposits contain in excess of 20 million tonnes of Cu and Ni and

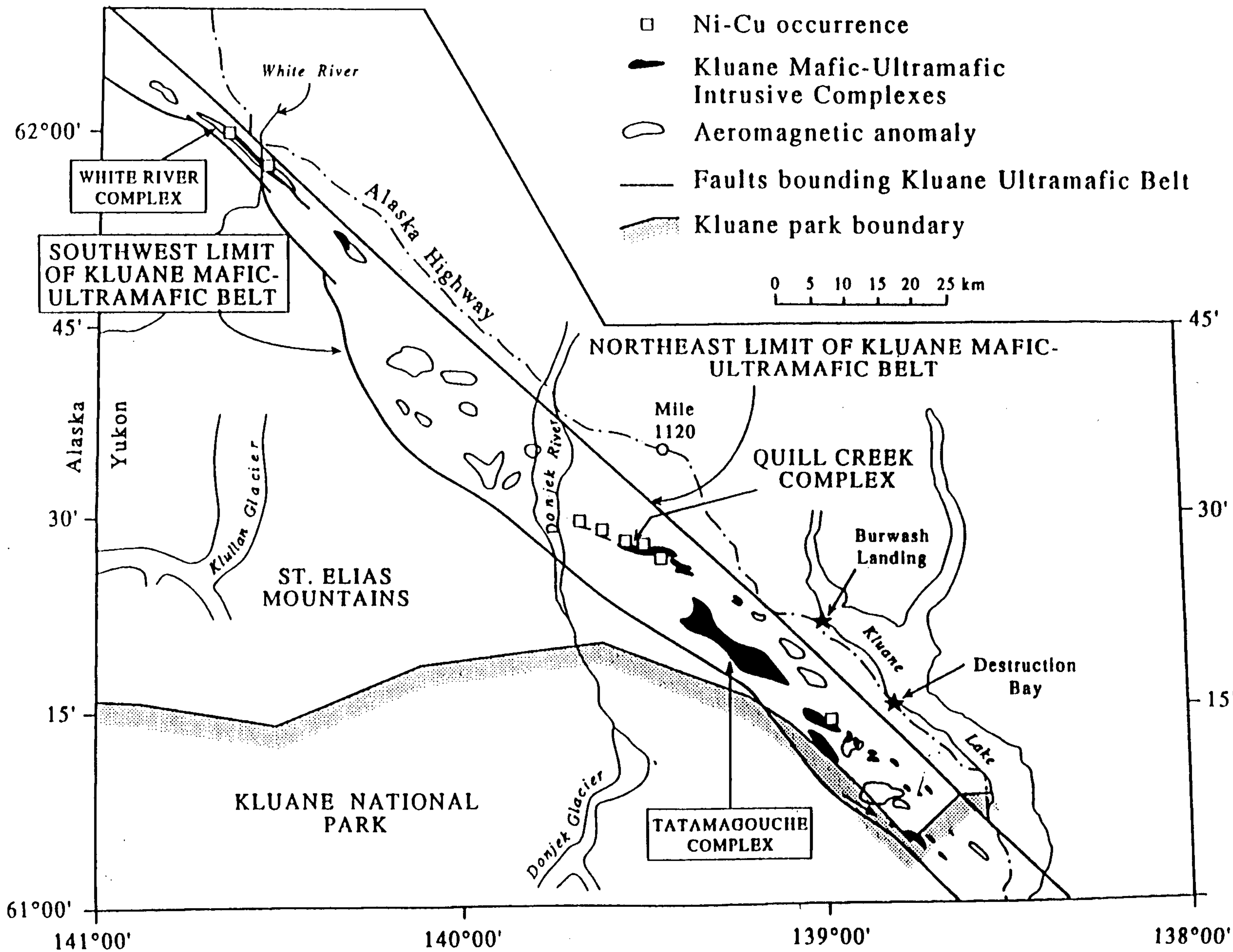


Figure 11 Map showing the distribution and size of known Triassic intrusions. and the outlines of other similar bodies inferred from

fig from Hulbert, 1996.

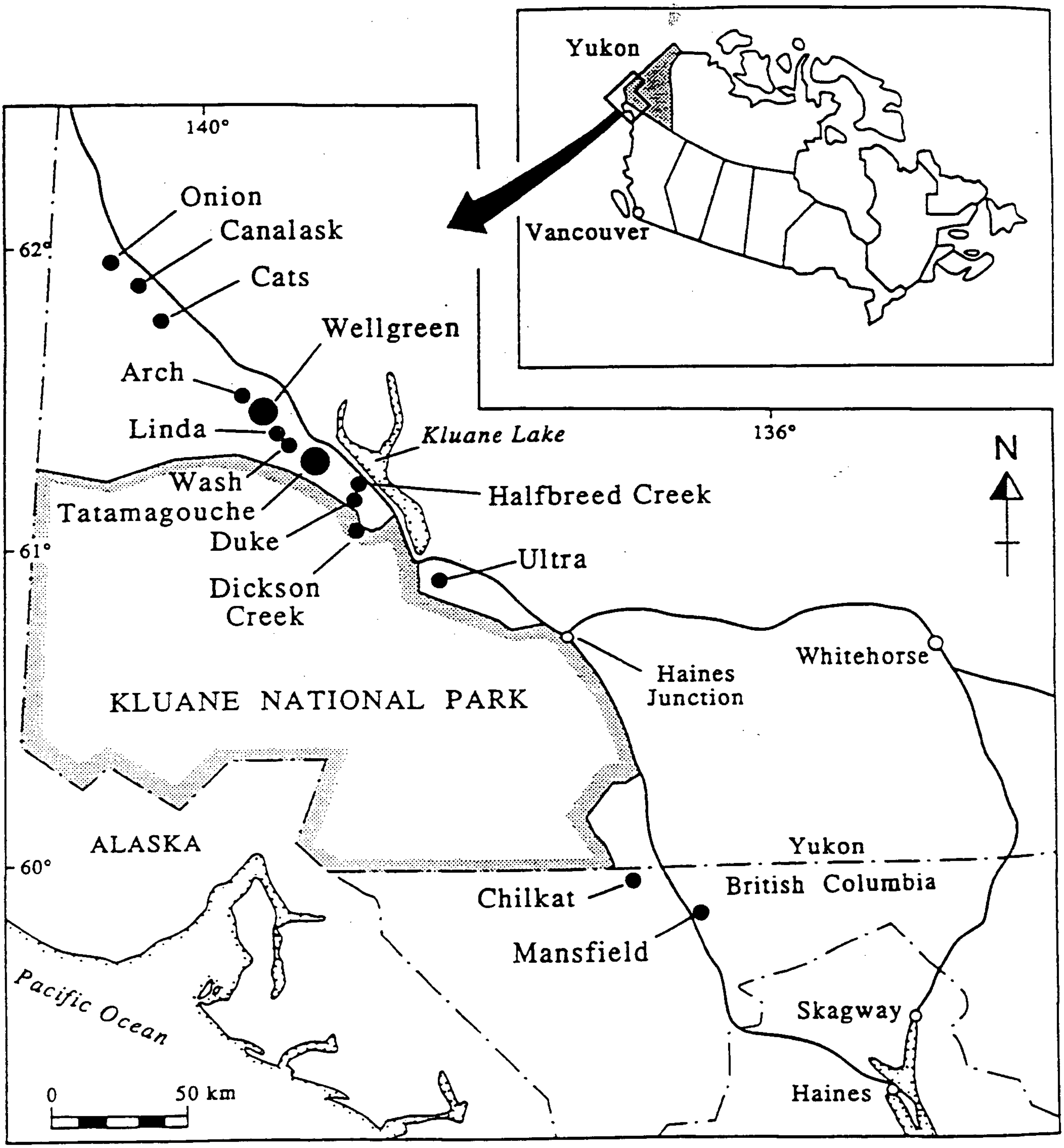


Figure 12 Map showing the location of some better known mineralized mafic-ultramafic properties in the Yukon and northern British Columbia, and most of those investigated during the course of this study. From Hulbert, 1996

hold the largest concentration of PGE's aside from the South African Bushveld Complex.

4.1.3 Karmutsen Assemblage and Nizina Limestone

The upper Triassic Nikolai Greenstone and the overlying Chitistone limestone (together forming the Karmutsen assemblage) host numerous copper occurrences as well as gold, silver, zinc, gypsum and wollastonite. The Nikolai basalts-andesites have a very high background copper content. It is believed that this copper is remobilized by metamorpic fluids and redeposited as native copper and copper oxides in amygdules (gas bubbles), veinlets and joint planes within the basalts. The *White River* deposit (115F 059) yielded the famous native copper slab that sits in front of the McBride Museum in downtown Whitehorse. Values of 2.14% Cu/ 20m and 3.53% Cu/ 9.1m were obtained from chalcocite, native copper, bornite, chalcopyrite, covellite, cuprite and native silver in vesicules, veinlets as well as disseminations within the basalts. Several other similar occurrences occur within the KWS such as the *Jaquot, Quill* and *Versluce* (115G 019, 020, 021). In addition to the hypogene replacement origin of the mineralization, faulting and shearing also contributed to copper enrichment. An average sample across a vein reached as high as 33% Cu.

Native placer copper is documented at the *Kletsan* occurrence (115F 061) where it was first recorded in 1892, as well as in Sheep Creek. Copper nuggets are derived from the Nikolai Greenstone. Gold mineralization in the Nikolai basalts is associated with alteration and/or faulting or shearing. Quartz-carbonate altered Nikolai basalt at the *Swede Johnson* occurrence (115G 027) grades up to 8.6g/T Au. Clay-altered volcanic rocks grades up to 1025 ppb Au at the *Burwash* occurrence (115G 017). The *Bock* occurrence (115G 084) overlies rocks that contain anomalous concentrations of Au and PGE.

Several occurrences of skarn mineralization containing Cu, Au, Zn, Ag and wollastonite within the Karmutsen Assemblage are documented within the KWS and adjacent to it. The *Lep* occurrence (115F 057) consists of massive pyrite, sphalerite and chalcopyrite at the diorite/ limestone contact. Adjacent to the KWS, the *Taylor* (115F 048), *Sanpete* (115F 049), *Monday* (115F 050) and *AZ* (115F 051) all host Cu-Au mineralization associated with magnetite +/- garnet-epidote skarns. The skarn assemblage at the *Monday* property also includes wollastonite that contains few impurities. Many economic skarn deposits occur within this section of Wrangellia, mainly iron skarns but also copper and gold skarns.

The *Johobo* property (115A 031), located south of the KWS was the site of small scale open pit mining during the 1960's. Massive sulphide mineralization occurs in a 30X30X3m lens best developed at the intersections of steep and shallow shears. Ore shipped consisted of 2345 tonnes grading 23% Cu and 68.6g/T Ag.

The Karmutsen assemblage and the overlying Nizina limestone are host to several gypsum occurrences. The _Metalline, Bock_ and _Gypsum_ occurrences (115G 001, 084, 085) are interpreted to be of evaporitic origin and those of the Maple and Bullion showings are probably remobilized by the faults that bound the deposits.

Skarn deposits rich in Fe and Cu in southern Wrangellia are commonly related to Jurassic plutonism and are hosted at the top of the Karmutsen assemblage. Past producers include: _Tasu_ and _Jedway_ on the Queen Charlotte Islands, _Argonaut, Coast Copper, Kennedy Lake, Merry Widow, Nimpkish_ and _Zeballos_ on Vancouver Island. The _Texada_ deposit on Texada Island produced 10 Million tonnes Fe, 35 900 tonnes Cu, 40 012 kg Ag and 3 313 kg Au from an iron skarn and produced 2 425 kg Au (2.4 tonnes) 16 368 kg Ag and 9 157 tonnes Cu from a gold skarn.

Southern Alaskan examples of mineralization hosted in the Nikolai/Karmutsen rocks include: Cu-Ag+/-Au skarn (_Rainy Creek, Midas, Zackly_), VMS Besshi-type (_Denali_, described below), replacement or basaltic Cu (_Kennecott_, described below, _Baker Creek, Westover, Nelson, Erickson_), polymetallic veins (_Kathleen-Margaret, Nikolai_) and porphyry Cu (_Baultoff_) deposits. The Fe-skarn at _Nabesna_ produced 1.66 million g Au and minor Cu while the one at _Rambler_ contains an estimated 18 000 tonnes at 34.3g/t Au. In southeastern Alaska, the _Apex, El Nido, Cobol_ deposits produced gold and silver in quartz veins cutting the Karmutsen assemblage.

At the _Denali_ copper mine, stratiform syngenetic copper mineralization is hosted at the contact between Triassic andesites and overlying argillaceous and limey sediments. Fine copper and iron sulphide laminaes are interbedded with graphitic argillite, shale, limestone at the contact with the andesites while mineralization in the volcanics themselves show replacement and exsolution textures.

The Kennecott or (Kennicott) copper district includes four separate deposits hosted in Chitistone limestone: the _Erie, Mother Lode, Bonanza_ and _Jumbo_ deposits. Mineralization consists of copper sulphides (mainly chalcocite) and carbonates thought to be derived from the underlying Nikolai greenstones and replacing the overlying folded and fractured limestone. The ore occurs as fissure veins, irregular massive replacements and stockwork in limestones (Bateman and McLaughlin, 1920). The four deposits produced 4,626,000 short tons that yielded 591,535 short tons of copper and 9,122,000 ounces of silver from 1911 to 1938 (T. Buntzen, pers. comm.) It is thought that a deposit of this type could also occur within the Nikolai volcanics themselves.

4.2 Alexander Terrane

4.2.1 Descon Assemblage and Kaskawulsh Fm.

The Descon Assemblage and the Kaskawulsh Formation, which form the exposed base of the Alexander Terrane, occur in the southwest corner of the KWS where ice coverage is extensive. No mineral occurrences are reported in the sedimentary rocks of Alexander Terrane within the KWS but they are locally mineralized when intruded by younger felsic plutons of the Icefield, St Elias and Kluane plutonic suite. The *St Elias* occurrence (115G 029) occurs just south of the KWS within the Kluane National Park and consists of molybdenite-bearing quartz veins in Paleozoic quartz-sericite schist. The *Mueller* and *Galloping* occurrences (115G 004, 031) consist of molybdenite showings related to the emplacement of leucogranite and granodiorite in the Alexander terrane.

In southeastern Alaska, numerous and varied mineral deposits are hosted by the same AX rocks that form the southwest corner of the KWS. The *Reid Inlet* deposit produced 250 000 g of Au hosted in steeply dipping quartz veins cutting the Descon Assemblage and an altered Cretaceous granodiorite. The *Glacier Creek* Kuroko-type VMS deposit contains 680,000 tonnes grading 3% combined Cu, Zn and 45% $BaSO_4$ .The *Orange Point* deposit, another Kuroko-type VMS contains values as high as 19% Zn and 5.2% Cu. Both deposits contain massive lenses and layers up to 25m wide and 170m long of Fe and base metal sulphides. Cretaceous and Tertiary granitic plutons intruding the same sequence of Alexander terrane as those deposits listed above host various types of economic deposits.

4.2.2 Devono-Mississipian gabbros.

At least two bodies of Devono-Mississippian gabbros of the Mt. Constantine complex are known to outcrop within the KWS, both near the trace of the Duke River fault. No mineralization has been reported.This rock type could potentially host disseminated or massive Cu-Ni-Au-PGE mineralization as well as occurrences of chromite and asbestos.

4.2.3 Triassic Rocks

The Triassic portion of Alexander terrane sits uncomformably over the lower part and is very rich in mineral occurrences. The most famous example is the ***Windy Craggy*** Cu, Co (Au, Ag, Zn) volcanogenic massive sulphide deposit (VMS) that contains reserves of **300 million tonnes of 1.5% Cu, 0.08% Co, and 1 to 3 g/T Au**. The host rocks to the deposit are informally named the "Tats Volcanic Complex". They are early Norian and and consist of a calc-alkaline to alkaline basaltic and andesitic pillows, flows, pyroclastics that are interbedded with marine sediments.

Although this part of the stratigraphy is not represented within the KWS, the potential for this type of mineralization should not be discounted as evolving ideas about the accretion history of the Insular superterrane and geochemical investigations point to possible relationships between the Tats volcanic complex and the Nikolai greenstones. If the Alexander terrane accreted with Wrangellia by Pennsylvanian times, this would imply that Triassic volcanism, whether Tats or Nikolai, erupted over a common landmass.

4.3 Overlap assemblages

4.3.1 Gravina-Nutzotin Belt

The mineral occurrences within the Gravina-Nutzotin belt in and near the KWS are mostly related to the cross-cutting younger felsic plugs and are discussed later. The B.C. extension of this belt hosts the *Brittania* deposit, after *Windy Craggy* the largest known VMS deposit in the Canadian Cordillera. Production from various ore bodies totalled about 48 million tonnes grading 2.8% Cu and 0.25% Zn. Several other occurrences in B.C. are also related to the volcanic component of this assemblage.

In southern Alaska, the Gravina-Nutzotin belt hosts porphyry and skarn deposits associated with Cretaceous plutons such as *Orange Hill*. The skarn assemblage consists of garnet- pyroxene and Fe, Cu and Zn sulphides. The porphyry section of this deposit is described under the Cretaceous plutons section. The whole deposit is estimated to contain 320 million tonnes grading 0.35% Cu.

In southeastern Alaska, the extensive Gravina-Nutzotin belt hosts numerous mineral deposits that are part of the Juneau gold belt. The *Treadwell* deposit consists of an extensive system of quartz and calcite replacement and veins with gold and Cu, Pb, Zn and Mo sulphides in fractured and altered granitic sills intruding slates and greenstones. About 101 million g Au was produced from 25 million tonnes of ore. Other similar deposits include the *Gold Standard* and *Goldstream* deposits.

A Besshi-type VMS deposit occurs at *Yakima*. Mineralization is hosted in quartz-calcite-sericite schist and consists of disseminated pyrite and minor sphalerite and galena.

4.3.2 Amphitheater Fm

The Amphitheater formation contains several coal occurrences. The Amphitheater (115G 012) occurrence hosts more than 12 seams that range from 0.3 to 4.9 m thick. Most occurrences consist of thin lignite to sub-bituminous coal seams, generally less than one meter thick. Studies show that the coal was deposited within a basin formed along the Duke River Fault.

This formation could possibly host paleoplacer occurrences (115G 092 *Biczok*-outside of KWS)) as well as uranium mineralization. Conditions for surficial or basal- type U deposit include favorable depositional environment associated with nearby felsic plutons and capping volcanic rocks.

4.3.3 Wrangell lavas

The Wrangell lavas and their intrusive counterpart, the Wrangell Plutonic Suite host two minfile occurrences within the KWS and two adjacent to it. Values up to 0.5% Cu are reported from the *Freibergs* occurrence (115G 089) as well as 4300 ppb Au in a panned silt sample. Anomalous copper and gold values were obtained from altered lavas at the *Canyon Mountain* occurrence (115G 087). Extensive argilic alteration and sulphide mineralization occur in the volcanic rocks particularly where plutonic or subvolcanic Tertiary felsic stocks have intruded the succession. These dykes have potential for epithermal gold and copper mineralization as do the potential occurrence of composite volcanic edifices, such as the one located near the Alsek River, where veining and hydrothermal alteration are reported.

In Alaska, similar age rocks in the Aleutian arc host epithermal gold, polymetallic vein and porphyry Cu and Mo deposits that are generally related to intermediate to felsic subvolcanic bodies. These occurrences are mentionned in the section pertaining to the Wrangell Plutonic suite.

4.4 Post-accretionary plutons

Polymetallic vein, porphyry Cu (-Mo), skarn and shear-related mineralization are associated with different periods of plutonic activity. Individual plutonic suites are discussed from the oldest to the youngest.

4.4.1 Pennsylvanian Permian Plutons- Icefield Ranges Plutonic suite

The Icefield Ranges Plutonic Suite intrudes mainly Alexander Terrane but in at least one instance (Barnard Glacier Pluton, in the Wrangell Mountains, AK, (Gardner et al, 1988) intrudes both Wrangellia and Alexander Terrane. This suite is therefore thought of as "stitching" the two terranes together.

The MINFILE (DIAND, 1993) reports one mineral occurrence hosted in this suite within the KWS. Data from Dodds and Campbell (1988) suggest instead a Cretaceous Kluane Range Plutonic suite host for the intrusive-hosted mineralization at the *Garlic* occurrence (115F 034). A gabbro body and carbonate and silica altered volcanic rocks are mineralized in magnetite, pyrrhotite and chalcopyrite while chalcopyrite and molybdenite are reported in a diorite.

North of the KWS, three mineral occurrences are related to the emplacement of this plutonic suite. The *California* (115K 080) occurrence hosts gold at surface (?) in a granite. A body of quartz porphyry cuts pyritized granodiorite at the *Wrangell* occurrence (115K 081). At the *Trudi* occurrence (115K 082) a pyrite-sericite altered monzonite cuts volcanic and sedimentary rocks. Anomalous Cu values are reported in soils, and up to 0.13% Cu in core.

At the *Sharpe* occurrence (115F 030), just south of the KWS and within the park, Mo, Cu, Au values are found in the silicified and pyritized intrusive contact zone. Values up to 4.8g/t Au are reported. Float mineralized in Cu-Mo was found down ice in a medial moraine (115 F 032).

4.4.2 Late Jurassic to Cretaceous plutons- St Elias Plutonic Suite

The northern tip of the Mt. Steele pluton extends into the KWS. The Tectonic Assemblage map considers this body to be of Jura-Cretaceous age, while Dodds and Campbell (1988) give it a Miocene age therefore classifying it with the Wrangell Plutonic suite.

Quartz monzonite float containing porphyry copper-molybdenite mineralization was found in a moraine on Steele Glacier (115G 032). The Mount Steele Pluton could be the source of this mineralization. If this suite is Jura-Cretaceous, it would therefore be the same age as the intrusion that hosts the *Island Copper* deposit in the Bonanza intrusions of southern B.C. If this pluton is in fact of Miocene age, it still has potential for porphyry copper mineralization as similar rocks in the Aleutian Arc host this type of deposit.The *Island Copper* porphyry deposit occurs in a Jurassic quartz-feldspar porphyry intruding pyroclastic andesites. The mine began production in 1971 with stated reserves of 257 million tonnes grading 0.52% Cu, and 0.17% Mo with significant precious metal content and high trace rhenium.

4.4.3 Late Early Cretacous- Kluane Ranges Plutonic Suite

South of the KWS, molybdenite and chalcopyrite occur as veins and disseminations in a quartz monzonite at the Icefield occurrence (115F 032).

Several plutons of this suite outcrop in the KWS including the Harris Ck and Wade Ck batholiths. The *Amp* (115G 014) and *Cork* (115G 015) are hosted in this suite according to the MINFILE and the Tectonic Assemblage Map but dating by Dodds and Campbell (1988) at the *Cork* occurrence shows the intrusive host to the mineralization to be an Oligocene body.

Although the MINFILE (DIAND, 1993) reports that the *Garlic* occurrence (115F 034) is hosted in Pennsylvanian-Permian intrusive rocks, data from Dodds and Campbell (1988) suggest instead a Cretaceous Kluane Range Plutonic Suite host for this intrusive-hosted mineralization. A gabbro body and carbonate and silica altered volcanic rocks are mineralized in magnetite, pyrrhotite and chalcopyrite while chalcopyrite and molybdenite are reported in a diorite. .

Numerous Alaskan deposits are hosted in or associated with Cretaceous felsic intrusions. These include porphyry Cu-Mo, skarns, polymetallic vein deposits as well as ultramafic-hosted Fe-Ti deposits.

The *Orange Hill* deposit consists of pyrite, chalcopyrite and minor molybdenite in potassic and sericitic quartz veins and as disseminations in Cretaceous quartz diorite and granodiorite that intrudes sediments of the Gravina-Nutzotin belt. Skarn mineralization is also associated with this intrusion. The whole deposit is estimated to contain 320 million tonnes grading 0.35% Cu. The *Baultoff* porphyry Cu (Mo) deposit contains 240 million tonnes of 0.2% Cu and 0.01% Mo hosted in Cretaceous quartz diorite to granite that also intrudes the Gravina-Nutzotin Belt.

The *Margerie Glacier* Cu deposit consists of porphyry Cu and lesser polymetallic vein mineralization. Chalcopyrite, arsenopyrite, sphalerite, molybdenite and minor scheelite occur in quartz veins in shear zones , in massive sulphide bodies and as disseminations that occur in a propylitically altered Cretaceous? granite and adjacent hornfels. The deposit contains an estimated 145 million tonnes grading 0.02% Cu, 0.27g/t au, 4.5 g/t Ag, and 0.01% W and is classified as a combined porphyry Cu and subordinate polymetallic vein deposit.

The *Reid Inlet* deposit produced 250 000 g of Au hosted in steeply dipping quartz veins cutting the Descon Assemblage of the Alexander Terrane and an altered Cretaceous granodiorite.

Nabesna and Rambler Fe-Au skarn deposits occur at the contact of lower Cretaceous monzodiorite with Triassic limestone. The *Nabesna* deposit produced 1.66 million g Au. The *Rambler* is a small high-grade deposit containing an estimated 18 000 tonnes grading 34.3 g/t Au.

Ultramafic intrusions host Fe-Ti mineralization at the *Union Bay* and *Klukwan* deposits. The *Union Bay* intrudes the belt and contains an estimated 1 billion tonnes grading 18 to 20% Fe. The *Klukwan* Fe-Ti-V deposit, located in Paleozoic rocks of the Alexander Terrane, contains an estimated 11.8 billion tonnes grading 0.2% V_2O_5. 13% magnetite and up to 4.4% TiO_2 and consists of disseminated and tabular zones of titaniferous magnetite and minor chalcopyrite, hematite and iron sulphides.

4.4.4 Tertiary plutons

- includes -high level and subvolcanic bodies of the Wrangell plutonic suite
-Tertiary plutons cutting the CPMC

At least two separate felsic intrusions of the Wrangell Plutonic Suite occur within the KWS. These felsic plutonic and subvolcanic equivalents of the volcanic phase have high potential for epithermal gold and porphyry mineralization. The *Cork* occurrence (115 G015) hosts chalcopyrite and molybdenite in quartz veins and on dry fractures in a feldspar porphyry. It has been compared with the Alaskan Quartz Hill deposit described below.

South of the KWS, molybdenite and chalcopyrite occur as veins and disseminations in a quartz monzonite at the *Icefield* occurrence (115F 032).

Recent workers in the area noted several unmapped felsic Oligocene bodies within the KWS, including an extensive system of dykes that are thought to be feeders to the Wrangell lavas (Bremner, C. Bell, pers. comm.).

Alaskan examples of mineralization hosted in Tertiary intrusive rocks include epithermal, porphyry, polymetallic vein, felsic plutonic-hosted uranium as well as skarn deposits.

The *Quartz Hill* porphyry molybdenum deposit is hosted in an late Oligocene granite porphyry that intrudes the Coast Plutonic Metamorphic Complex. One of the worlds largest concentrations of molybdenite, this deposit occurs 70 km east of Ketchikan in a complex suite of 4 distinct intrusive phases. Molybdenite forms fracture coatings and occurs in veins with quartz in a random stockwork. Alteration is widespread but weak to moderate. Reserves of 1.7 billion tonnes grading 0.136% MoS_2 include a high-grade zone within the deposit that contains approximately 440 million tonnes grading 0.219% MoS_2.

The *Nunatak* is a Cu-Mo polymetallic vein deposit that consists of mineralized quartz veins in hornfels, skarn and a fault zone adjacent to a Tertiary granite porphyry stock intruding Alexander terrane. The closely spaced vein stockwork contains an estimated 2 million tonnes grading 0.067% Mo and 0.16% Cu. The *William Henry Bay* felsic plutonic uranium deposit consists of veinlets containing pyrite, chalcopyrite, galena, thorianite, and euxenite in a small Tertiary? granite pluton intruding Silurian(?) sedimentary and volcanic rocks. Samples contain as much as 0.2% U. This occurrence is similar to the mineralization hosted by the Tombstone Stock near Dawson, YT. An Fe skarn deposit occurs at *North Bradfield Canal* in marble and paragneiss intruded by a Tertiary granite of the CPMC. Drill core samples grade 50 to 65% Fe and 0.1 to 0.5% Cu.

The *Treadwell* deposit is part of the Juneau gold belt In southeastern Alaska. It consists of an extensive system of quartz and calcite replacement and veins with gold and Cu, Pb, Zn and Mo sulphides in fractured and altered granitic sills intruding slates and greenstones.The *Gold Standard* and *Goldstream* are similar deposits.

Tertiary intrusive bodies from the Aleutian arc host porphyry Cu-Mo, epithermal and polymetallic vein deposits deposits. The *Apollo-Sitka* epithermal vein gold deposit produced 3.33 million g Au from 435 000 tonnes of ore. The *Shumagin* deposit contains 540 000 tonnes grading 10g/t Au, 34g/t Ag. The *Pyramid* porphyry copper deposit contains 110 million tonnes grading 0.4% Cu and 0.05% Mo. Table 3 lists other occurrences in the area.

4.4.5 Plutons of uncertain age

A high-grade silver deposit was selectively mined at the *Kane* (115A 003) occurrence which is located in the southern KWS, near Dalton Post. Quartz lenses in the sheared edges of a post Permian feldspar porphyry contain galena, sphalerite, stibnite and tetrahedrite . Samples graded from 100 to 11 000 g/t Ag, 3-40% Pb and significant values in Zn and Sb.

At the *Souther* occurrence (115A 043) quartz-sulphide veins associated with hydrothermal alteration around a post-Tertiary? breccia pipe grade 7.6% Cu, 0.75% Pb, 0.3% Zn and 137.1g/T Ag.

The *Mueller* and *Galloping* occurrences (115G 004, 031) consist of molybdenite showings related to the emplacement of leucogranite and granodiorite in the Alexander terrane.

In Alaska, the *Rainbow Mountain* porphyry copper deposit consists of mineralized subvolcanic porphyry plutons, dykes and sills intruding Permian (?) metavolcanic and metasedimentary rocks (Skolai?).

4.5 Coast belt

Located on the east side of the Denali fault, the Coast belt portion of the KWS inludes at thin sliver of Kluane Schist and CPMC.

4.5.1 Kluane Schist

Two Minfile occurrences of minor importance that appear to be hosted in the Kluane Schist are located within the KWS. The *Cofer* occurrence (115G 105) consists of a mineralized shear zone that was found during excavation of a basement in Burwash Landing. Minor skarn and ultramafic-hosted gold and asbestos occurrences are hosted in the Kluane Schist and in rafts of Kluane schist within the CPMC.

The Kluane Schist hosts the Killerman Lake or Ruby Range occurrence where gold-bearing quartz veins are believed to have been formed during low-grade regional metamorphism and subsequent intrusion of Tertiary plutons. This is believed to be the same model as the *Alaska-Juneau* gold deposit where production between 1886 and 1944 was 108 000 kg Au, 59 million g Ag, and 21.8 million kg of Pb from 80.3 million tonnes of ore. Current reserves are estimated at 90.7 million tonnes grading 1.75g/T Au.

The Kluane Schist could host metamorphosed massive sulphide deposits. Base metal, gold and silver deposits in Yukon Tanana terrane as well as in in the Coast Belt of southeastern Alaska are examples of this type of mineralization.

4.5.2 Coast plutonic-metamorphic complex

Of all five geomorphological belts, the Coast Plutonic belts hosts the lowest number of significant deposits.

In the area of the KWS, as in most of the belt, skarn mineralization is mostly associated with metamorphic pendants of older rocks in dominantly Cretaceous granitoid. Porphyry-type mineralization is usually associated with post-accretionary Eocene intrusions and is discussed in that section of this chapter.

Metamorphosed massive sulphide deposits hosted in metamorphic pendants occur in Alaska. Fe skarn at North Bradfield canal occurs in marble and paragneiss intruded by Tertiary granite.

5. Regional Stream Sediment Geochemistry

Appendix 1 contains the figures depicting the sample location and the distribution of anomalous metal content in stream sediments.

Two main factors seem to control the distribution of anomalous metal content: the outline of Wrangellia and the location of the Denali Fault.

- **Au**: Two anomalous threshholds were depicted: 25 and 50 ppb. Anomalous gold values seem to cluster around the Denali, occur in the Slokai assemblage and at the contact or within the Kluane Ranges Plutonic Suite.

- **As**: shows a partial correlation with Au just E of the Donjek River, mostly within the Skolai and overlapping the trace of the Denali Fault.

- **Ba and Cd**: seem to correlate here. Barium-rich sediments are known to occur within the Permian. Cd is often associated with Zn mineralization.

- **Cu:** The high copper background of the Skolai and particularly the Nikolai within Wrangellia is readily apparent. The area around the Quill Creek Complex is highly anomalous as is the area staked by Inco in the southern-most part of the KWS. A section of Wrangellia between the White and the Donjek Rivers has anomalous copper values. To the north of the KWS, the Canalask area also shows anomalous copper content

- **F:** very mild F concentration in southern part of KWS.

- **Mn:** A slight Mn anomaly outlines the trace of the Denali fault

- **Ni:** Distributed throughout Wrangellia, mainly southeast of the Donjek River but also in the southwest part of the KWS near the trace of the Duke River fault.

- **Sb:** Very slight anomaly mainly centered on Slokai Assemblage.

- **V:** some slight anomalies centered on Skolai. V can be associated with base metal mineralization.

- **Zn:** generally high background in Zn, almost traces out the outline of Wrangellia

No analyses were made for PGE's which are an important target in this belt of rocks. One company in confidence informed us that the standard silt survey was not very useful for finding mineralized ultramafic bodies. Subtle metal ratios were more useful but the most important was analysing the silts for PGE's.

Of course the area overlain by glaciers could not be sampled. The data points adjacent or near the glaciers are not representative of the local upstream geology since the sediment that was sampled would have been transported by ice movement for an unknown distance.The significant geochemical features of the KWS are that Au, Ba, Cd, Cu, Ni, Zn anomalies outline the highly mineralized Wrangellia.

6. REGIONAL AEROMAGNETIC SURVEY

The most striking feature revealed by the regional aeromagnetic map (fig. 13) is that less than half of the area fo the KWS is actually covered by the survey.

The data that are present outline the general orientation of the tectono-stratigraphic units. The known occurrences of Kluane mafic-ultramafic intrusions and some related mineral occurrences line up with areas of high response. A belt of magnetic highs traces the outline of Wrangellia. The White River (Canalask) and Tatamagouche ultramafic complexes show up clearly. The Quill Creek complex, which hosts the Wellgreen mine and other significant occurrences is not covered by the survey. A strong anomaly west of the Donjek River at the edge of the area of aeromagnetic coverage suggests that a sizeable ultramafic body continues along strike from the Tatamagouche complex. Workers in this area conclude that only the large size ultramafic bodies are detected by this survey and that many smaller intrusions would only be detected by more detailed magnetic suveys (and geochemical).

The Kluane Ranges plutonic suite also appears to have a positive aeromagnetic signature. Again, fieldworkers have found out that many smaller intrusive bodies remain unmapped.

This survey would have to be completed in order to provide a full assessment. A completed survey would also increase the amout of control in the interpretation of the geology and would assist in defining more precise boundaries between units.

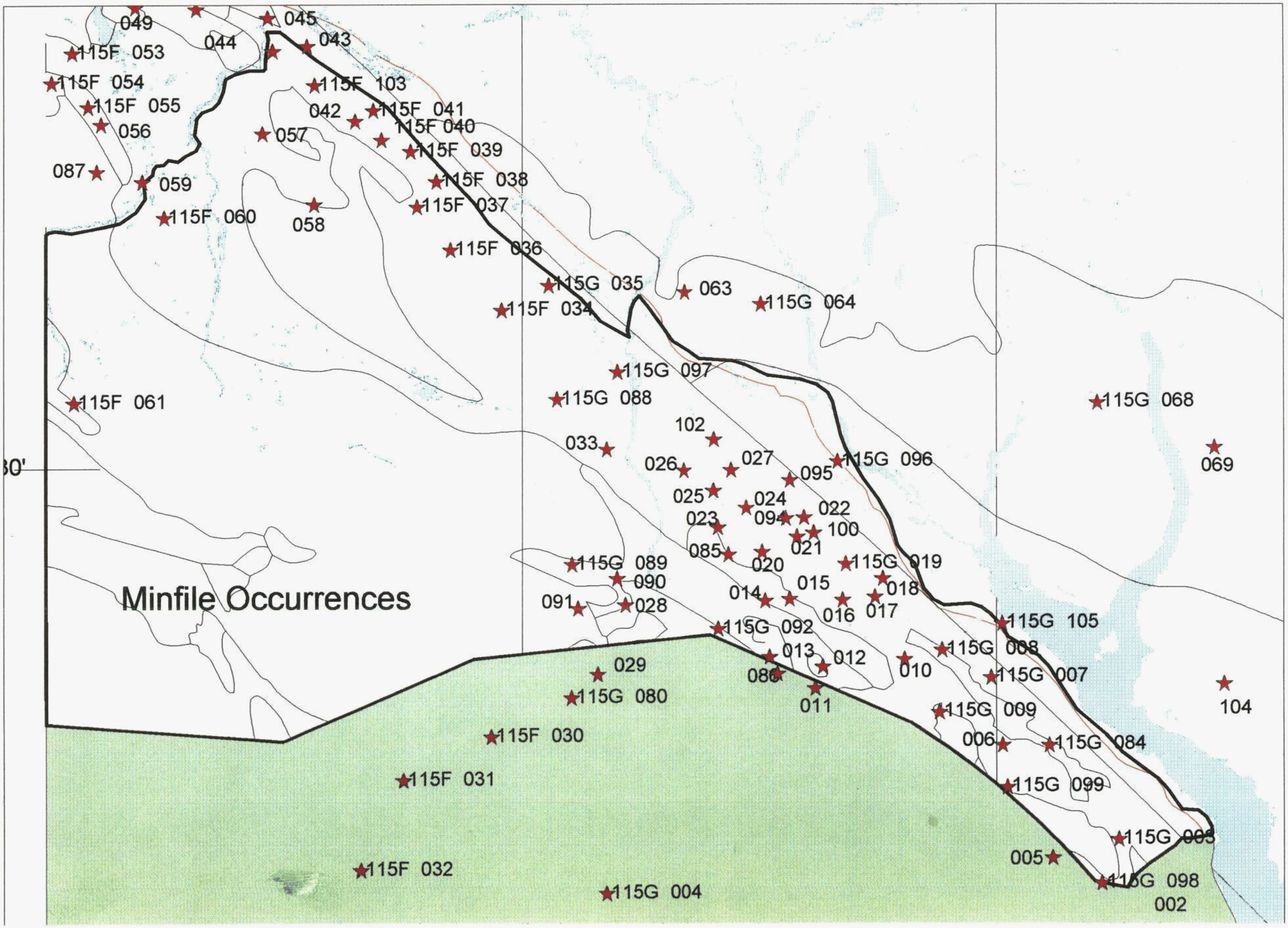
7. PLACER OCCURRENCES

The first placer claims to be staked within the Kluane ranges were on Sheep and Bullion Creeks (within the present Kluane National Park) in 1903. Burwash and Arch creeks (within the present KWS) were staked in 1904. Coarse nuggets of placer gold have been mined in a number of creeks including Squaw, Sheep, Bullion, Burwash, Quill, Arch, Reed and Swede Johnson Creeks. The placer deposits are preserved in narrow canyons underlying thick glacial deposits. These canyons, which acted as major sluice boxes, are oriented transversely to major Pleistocene glacial valleys and seem to be spatially associated with faulting , shearing and hydrothermal alteration (Muller 1967, Bremner 1994). Copper and platinum have been recovered in addition to gold which, in this area, exhibits variation in texture, structure and fineness.

Data on the specific production of the creeks of the area is sparse as it seems to be constantly under-reported. Cumulative maximum reported production since 1978 is 2 342 oz Au on Burwash Ck. A local bedrock source for the gold has been suggested for Burwash and Quill Ck.

Fig. 14 outlines the location of placer claims in good standing within the KWS.

In southern Alaska, two major placer districts overlie rocks of Wrangellia and of the Gravina-Nutzotin belt, south of the Denali fault; the same geological setting as in the KWS. The Chisana placer district produced 1.4 million g Au while the Chistochina district produced 4.4 million g Au with an average grade of $0.51 g/m^3$.


Minfile Occurrences
30'
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044
045
043
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115F 103
042
115F 041
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087
059
115F 038
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115F 060
058
115F 036
115G 035
063
115G 064
115F 034
115G 097
115G 088
115F 061
115G 068
102
033
027
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115G 096
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069
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100
021
085
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115G 019
115G 089
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028
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016
115G 092
115G 105
013
012
115G 008
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086
010
115G 007
115G 080
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115G 009
115F 030
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115G 003
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115F 032
115G 004
115G 098
002

Fig. 9

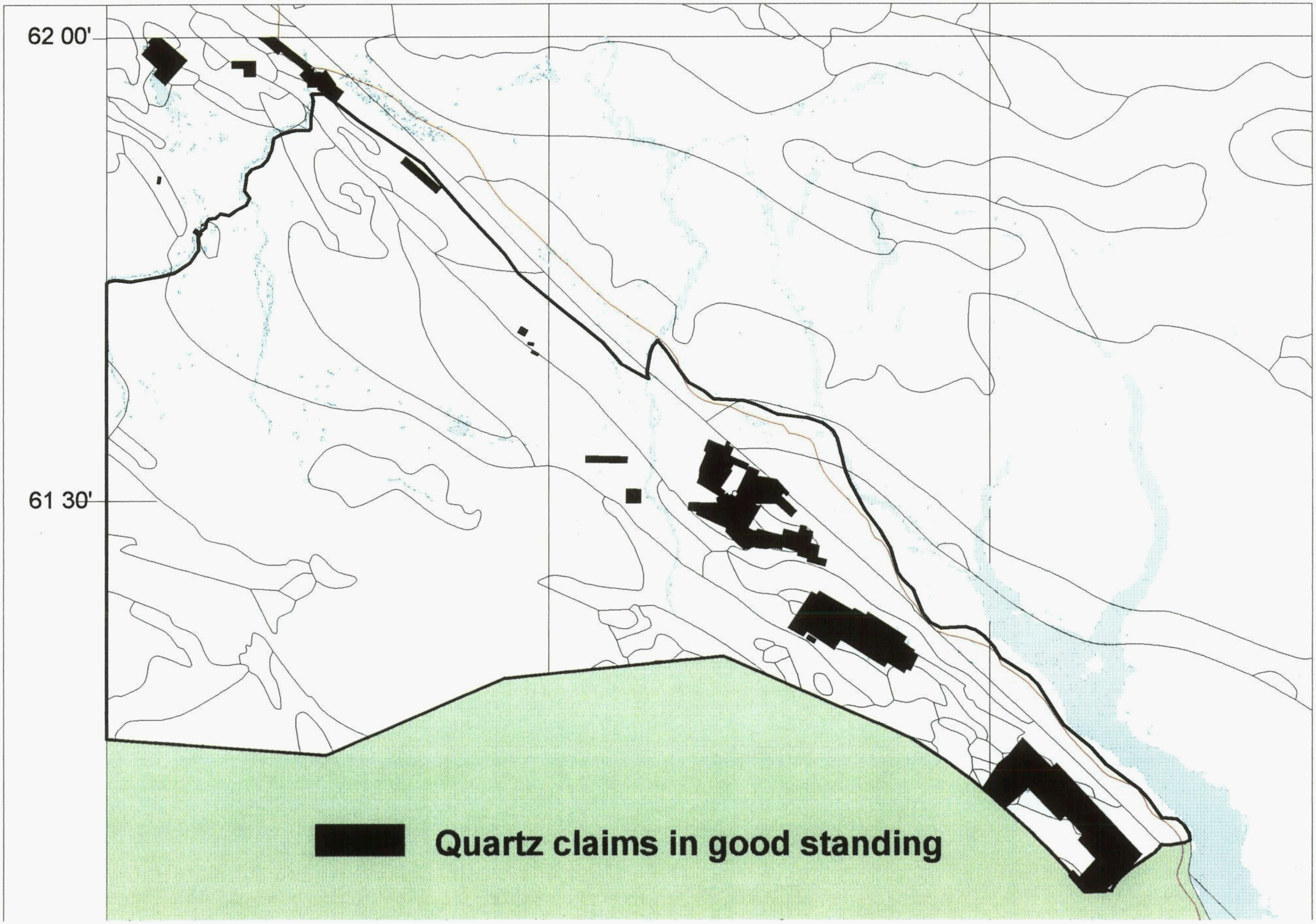


Fig. 10

Tectonic unit	Fm-litho	age	minfile	commodities	descriptions	reserves or grades
Kluane ranges	Gabbro intr Volcs, qtz monz, dior	Cretaceous	**115F 034 Garlic**	Mo, W	mt po cp in gabbro and carb+sil altered volcs, cp-mo in qtz monz	
Kluane ranges ?	Kluane R./ Amphitheatre Fm		**115G 014 Amp**		near Cork	
Wrangell Plut.	fspar porphyry intr Hasen Ck	Tertiary(Oligocene) intr Perm	**115G 015 Cork**	Cu, Mo	Vqtz py cp mo + on dry fract	0.2% Cu, 0.01% MoS2
Nisling ass?			**115G 105 Cofer**		mineralized shear zone (in Burwash landing)	
overlap	Amphitheatre	Tertiary	**115G 009 Windgap**	coal	several seams, sub-bitum A+C	
overlap	Amphitheatre	Tertiary	**115G 012 Amphitheatre**	coal	>12 seams , up to 5m, sub-bitum B+C	
Overlap	Amphitheatre	Tertiary	**115G 028 Cement**	Coal	thin seams	
Overlap	Wrangell intr./ Amphitheatre seds	Tertiary	**115G 089 Freibergs**	Cu	cp in siliceous rhyolite breccia	0.527% Cu, panned silt: 4300ppb Au
Overlap	Wrangell lavas/ felsic dykes	Tertiary	**115G 091 Elias**			
Wrang/ Overlap	Skolai/ Nikolai/ Chitistone/ Amph		**115G 092 Blczok**	Au	paleoplacer in Amphitheatre Fm?	
Wrang/Overlap	skolai/ Amphitheatre	pens-Perm/ Tertiary	**115G 090 Robertson**		fault zone	
Wrangellia	Perid. intr. Hasen Ck	lTriassic intr Permian	**115G 003 Congdon**	Ni-Cu-Au	cp-po in perid, ga-sph in Vcc	
Wrangellia	Perid. intr. Hasen Ck	lTriassic intr Permian	**115G 006 Destruction**	Ni-Cu-Co-Pt	sulph in gabbro and perid	
Wrangellia	Nikolai basalts	uTriassic	**115G 007 Halfbreed**			
Wrangellia	Nikolai basalts	uTriassic	**115G 008 Squirrel**			
Wrangellia	Perid. intr. Hasen Ck	lTriassic intr Permian	**115G 010 Duke**	asbestos, Ag, Au	low Au, Ag in Vcc py	
Wrangellia	peridotite	lTriassic?	**115G 013 Wade**	Cu Ag, Au		
Wrangellia	Perid. intr. Hasen Ck	lTriassic intr pens-Perm	**115G 016 Glen**	Ni, Cu	po, pn,cp at base of gabbro-perid, Cu-Ni 400X700m	
Wrangellia	Nikolai bas+ Skolai	uTriassic+pens-Perm	**115G 017 Burwash**	Au, Cu	up to 1025 ppb Au in clay alt volcanic rx	
Wrangellia			**115G 018 Nelms**			
Wrangellia	Nikolai basalt	uTriassic	**115G 019 Jacquot**	Cu, Au	bo, cp,cc in basalt, up to 33% Cu	
Wrangellia	Nikolai basalt	uTriassic	**115G 020 Vug**			
Wrangellia	Nikolai basalt	uTriassic	**115G 021 Quill**	Cu	cc in amygdules, diss native Cu, and Vqtz-carb cu,cc,mal in shear zone	0.92% Cu/3 m
Wrangellia	Nikolai basalt	uTriassic	**115G 022 Versluce**	Cu	cc, bo, cp patches +veinlets in sheared+alt bas near thrust	2.4% Cu/ 6m
Wrangellia	UMF sill intr skolai	lTriass intr pens perm	**115G 024 Wellgreen**	Co, Zn, Au	mass sulph (po, cp, pn,mt) at base of layered intr (1-18m)	**PAST PRODUCER :'49.9 MT @ 0.36% Ni,**
					high rare PGE content	**0.35% Cu, 0,51 g/T Pt, 0.34g/T Pd**
					diss sulph (net text+diss cp,po, pn) in marginal gabbro and oliv. pxenite	
					diss sulph pref enriched in Cu, Pt, Pd + Au wrt massive sulph	
					footwall skarn Pt/Ni+ Pd/Cu correlation	
Wrangellia	UMF sill intr skolai	lTriass intr pens perm	**115G 025 Airways**	Ni, Cu, PGE	mass cp+po at base of UMF sill, diss cp+ po in perid, Vsulph in cherty arg	2.51% Ni, 0.57% Cu, 1.8g/T Pt, 3.2g/T Pd, 0.07g/T Au
Wrangellia	UMF sill intr skolai	lTriass intr pens perm	**115G 026 Musketeer**	Cu	diss+ fract filling cp+ malachite	0.3% Cu in tuff
Wrangellia	Nikolai basalts/skolai/diorite	utriassic	**115G 027 Swede Johnson**	Au	up to 8.6g/T Au in qtz-carb alt Nikolai bas; cp,ba,py,po in skolai? volcs;	1.45% Ni in diorite float
Wrangellia	Umf intr. Skolai?	lTriass intr. pens-Perm?	**115G 033 Sexsmith**	Cu	on strike w lTriassic UMF	
Wrangellia	skolai volcs?	pens-Perm	**115G 035 Nox**		aeromag anomaly	
Wrangellia	skolai volcs?	pens-Perm	**115G 036 Hankins**			
Wrangellia	skolai/ Kluane Ranges intr	Pens-Perm seds/ Cret intr	**115G 037 Koidern**			
Wrangellia	silicified tuff Station Ck?	permian	**115G 038 Liberty**	Au, Cu, Pb	Vqtz carb cp ga py in silicified tuff	up to 13.7g/T Au
Wrangellia	skolai/ buried UMF sill?	pens-Perm seds (lTriass. sill?)	**115G 039 Quebec**		buried UMF sill?	
Wrangellia	skolai/ Kluane range intr	pens-Perm/ Cretaceous	**115F 040 Duensing**		contact zone	
Wrangellia	perid/skolai	lTriass intr/ pens-Perm	**115F 041 Cats and Dogs**	Cu, Ni	Cu-Ni perid float; diss+lam cp, po in volcanic flows and tuffs	0.31% Ni in perid, 1.2% Cu in pyroclastics
Wrangellia	skolai	pens-Permian	**115F 042 Mexico**	Cu,Fe	Skarn, cp in narrow stringers of massive magnetite	
Wrangellia	gabbro, volcs, qtzpebl cgl+chert		**115F 044 Sevensma**		tr po	
Wrangellia	perid intr. Station Ck	lTriass intr. pens-Perm	**115G 045 Canalask**	Ni, Cu, PGE	po, pn, sph, py, marc, cp diss+in lenses in tuffaceous volcs.	**454 545 tonnes@ 1.5% Ni**
					main sulph zone 122m from footwall contact of peridotite	
					also net texture po-cp in footwall contact of sill	
Wrangellia	limestone (Nikolai?)/ diorite	uTriassic/(Cret?)	**115F 057 Lep**	Cu, Zn, Ag	mass py,sph,cp in silicified limestone at contact w diorite	up to 17.2% Zn/ 2.6m, 1.07% Cu
Wrangellia			**115F 058 Down**			
Wrangellia	Nikolai basalt	uTriassic	**115F 059 White River**	Cu, Ag	cc, native cu,bn,cc, cp,py,cv,cupr, native Ag diss, in amygdules+veinlets	2.14% Cu/ 20m, 3.53% Cu/ 9.1m
					slabs of native Cu in joint planes	
Wrangellia	Station Ck volcanics	pens-Permian	**115F 060 Share**	Cu	15% diss mtw minor py-po, cp tr	0.15% Cu/0.3m
Wrangellia	Nikolai bas+ seds	uTriassic	**115F 061 Kletsan**	Cu	Placer native cu from Nikolai basalts	
Wrangellia	Nikolai basalt/ Nizina limestone	Triassic	**115G 084 Bock**	PGE/ gypsum	anomalous Au+PGE in Nikolai, evaporitic gypsum	
Wrangellia	Nikolai	Triassic	**115G 085 Maple**	gypsum	gypsum along fault contact between Cret dior+ Nikolai	
Wrangellia	Station Ck volcs (skolai)	pens-Perm	**115G 088 Lynx Ck**			
Wrangellia	peridotite-gabbro sills/ Nikolai	lTriassic/ uTriassic	**115G 094 Linda**	Ni, Cu, PGE	po, py, cp,pn as diss,fract fillings+ mass lenses, best w gabbro phases	in gabbro: up to 4.2% Ni, 0.68% Cu, 4.39g/T Pd
						in Nikolai bas: 9.42% Cu, 0.41 g/T Au
Wrangellia	Station Ck volcs (skolai)	pens-Perm	**115G 095 Arby**		propyllitic alteration	
Wrangellia	Station Ck volcs (skolai)	pens-Perm	**115G 096 Hudyuk**		tailing pond and former millsite of Wellgreen Mine	
Wrangellia	Station Ck volcs (skolai)	pens-Perm	**115G 097 Lonth**			
Wrangellia	UMF sills	lTriassic	**115G 098 Tony**			
Wrangellia	UMF sills/ Skolai	lTriassic/ pens-Permian	**115G 099 Kluane**	Ni, Cu, PGE	cp, po in gabbro:	2.04% Cu, 0.74% Ni, 420 ppb Pt, 1380 ppb Pd
Wrangellia	UMF sills/ Skolai	lTriassic/ pens-Permian	**115G 100 Wash**	Ni, Cu, PGE	po, cp, pn as diss+ fract fillings in peridotite sill (also gabbro+pxnite phase)	1.02% Ni, 0.46% Cu, 700 ppb Pt, 2160 ppb Pd
Wrangellia	Station Ck volcs cut by felsic dykes	pens-Permian / Tertiary	**115G 102 Tremblay**	Cu, Au	coarse angular placer Au, fault controlled sil+py alt, veining and boudinage	
Wrangellia	Ultramafic	TIriassic?	**115G 103 Harjay**		highly sheared limonitic UMF intrusion	

Table 1 Minfile Occurrences within Kluane Wildlife Sanctuary

Tectonic unit	Fm-litho	age	minfile	commodities	descriptions	reserves or grades
?	post diorite that is post Skolai?	? post permian	**115A 003 Kane**	Ag, Pb, Zn, Sb	qtz lenses w ga, sph, stb, tetr at sheared edges of fspar porph	open pit **past prod. 100-11 000g/T Ag, 3-40% Pb**
?		paleozoic	**115G 029 St Elias**	Mo	Mo in Vq in qtz sericite schist	
?		post-Tertiary?	**115A 043 Souther**	Cu, Pb, Zn, Ag, Mo	Vqtz-sulph associated with hydr. alt. around breccia pipe	7.6% Cu, 0.75% Pb, 0.3% Zn, 137.1g/T Ag
Alexander	leucogr.		**115G 004 Muller**	Mo	float	
Alexander	granodiorite intr. Kaskawulsh	Dev. seds	**115F 031 Galloping**	Mo	Mo in gossan along contact	
Icefield Ranges (AX)	Icefield Ranges plut.	penns-Perm	**115F 030 Sharpe**	Mo, Cu, Au	Mo, cp in silicified+pyritized at contact	4.8g/T Au
Icefield Ranges (AX)	Icefield Ranges plut.	penns-Perm	**115K 080 California**	Au	gold at surface (?) in granite	
Icefield Ranges (AX)	Icefield Ranges plut.	penns-Perm	**115K 081 Wrangell**		qtz pophyry cuts pyritized granodiorite	
Icefield Ranges (AX)	Icefield Ranges plut.	penns-Perm	**115K 082 Trudi**	Cu, Mo	py-ser altered monzonite cuts volc/sed	anomalous Cu in soils, 0.13% Cu in core
Nisling	UMF in Kluane Schist		**115G 104 Aubi**	Au	anom soils at contact with thrust-emplaced UMF	
Nisling Assemblage	marble		**115G 063 Eleven-Thirty**	W	Scheelite in diopside-epidote skarn	
Nisling Assemblage	marble		**115G 064 Kennedy**	W	Scheelite in diopside-epidote skarn	
Nisling Assemblage	pxnite-perid-gabbro		**115G 065 Tincup**	Asbestos		
Nisling Assemblage			**115G 068 Brooks**	Mo	skarn	
Overlap	Amphitheatre	Tertiary	**115G 002 Stove**	Coal		
Overlap	Amphitheatre	Tertiary	**115G 011 Hoge**	coal	3 seams up to 1.5m thick	
Overlap	Amphitheatre seds	Tertiary	**115F 054 Memoir**	coal	thin lignite seams	
Overlap	Amphitheatre seds	Tertiary	**115F 055 McLellan**	coal	thin lignite seams	
Overlap	Wrangell lavas	Tertiary	**115G 087 Canyon Mntn**	Cu, Au	anom Au+ Cu (cp) in weakly altered lava(prop, ser, sil+py alt)	
Wrangell Plutonic	Wrangell Plut. suite qtz monz	Miocene	**115F 032 Icefield**	Mo, Cu	diss+Vcp, py, *hem, mo in sil. qtz monz*	
Alexander ? ou Wr	limestone, clastics and felsic pluton	Devonian? seds + Cret. pluton	**115B 012 Kul**			
Wrangellia	Nikolai greenstone/ faults		**115A 031 Johobo**	Cu, Ag	3 mass sulph lenses cp, bo, py 3X30X30m , fault related	open pit **past prod.**
Wrangellia	Nikolai greenstone/ faults ?		**115A 030 Millhouse**	Cu, Ag	high grade float from Johobo, bn,cp, malachite	38% Cu, 140.6g/T Ag,
Wrangellia	peridotite	Triassic	**115B 006 Vulcan**	Ni		0.4-0.8% Ni
Wrangellia ?	?	?	**115B 008 Telluride**	Zn, Cu, Ag, Pb, Au	float of banded sulph from mass sulphide lens in andesite	aver. 6.9% Zn, 1.8% Cu, 24g/T Ag, 0.2% Pb
					also Vqtz-carb-py-po-cp at margin of mafic intr.	aver 1.4% Cu, 0.35% Ni, up to 1.2g/T Pt, 5.1g/T Pd
Wrangellia	Chitistone limestone	uTriassic	**115B 009 Bullion**	Gypsum	bound by Duke River fault	good commercial grade
Wrangellia	Nikolai greenstone	uTriassic	**115B 010 Sheep**	Cu	native cu float	
Wrangellia	limestone	?	**115B 013 Jennifer**	Ag, Au, Cu, Pb, Zn, Sb	Vqtz-cp-bn-tet-en-cc-hem in fract lmstn. up to 1.1m thick, vuggy	up to 1481g/T Ag, 35.14 g/T Au, 22.5% Cu,28 600 ppm Sb
						and > 5000ppb Hg **past prod?**
Wrangellia	Nizina	uTr	**115G 001 Metalline**	Gypsum	evaporitic, 180m thick, traced for 760m	
Wrangellia	perid intr. in Hasen ck arg+lmstn	lTr sill In perm seds	**115G 005 Dickson**	Ni-Cu-Pt-Co	po-cp-pn in sill, at contact and in host	
Wrangellia	perid intr. skolai	lTriass intr. penns-Perm	**115G 043 Pickhandle**	Cu, Ni, PGE	extension of peridotite *sill that hosts the Canalask deposit*	6.55% Cu, 0.56% Ni
Wrangellia	perid intr. skolai/ Cret diorite	lTriass intr. penns-Perm	**115G 047 Epic**	Cu, mo	py, cp, mo in cc stringers in shear zone, high Pt, Pd, Au in soils	
Wrangellia	dior/ Nikolai limestone	Cretaceous/Triassic	**115G 048 Taylor**	Au, Cu	Cu, Au+mt in epid-gnet-po skarn	up to 1350 ppb Au+5780 ppmCu in soils
						up to 23.3g/T Au+0.32% Cu/ 3m in rx
Wrangellia	Chitistone limestone/ granod	lTriassic/ Cretaceous	**115F 049 Sanpete**	Cu, Au	cp,py,po, mt in skarn	
Wrangellia	Nikolai limestone/ granodiorite	lTriassic/ Cretaceous	**115F 050 Monday**	Wollastonite	mt wo skarn- few impurities	
Wrangellia	Nikolai basalt+limestone	lTriassic	**115F 051 AZ**	Cu, Au	Cu-Au in limestone+ga-ep-mt skarn and in Nikolai greenstone	up to 8g/T Au, 171.4g/T Ag, 10.1% Cu
Wrangellia	Nikolai basalt		**115F 053 Rail**		aeromag anomaly	
Wrangellia	Station Ck volcs (skolai)	Pennsylvanian	**115F 056 Rabbit**	Cu, Ag	E showing: Vq py po cp bn in shear zone	1.02% Cu/ 9.4m
					W showing:Vpy cp	W: 0.85% Cu/ 1.1m
Wrangellia	Nizina limestone	Triassic	**115G 086 Gypsum**	Gypsum		
Wrangellia	perid intr. skolai/ Cret diorite	lTriass intr. pens-Perm	**115K 077 Onion**	Cu, Ni, Au, PGE	sulph in gabbro-peridotite and associated. qtz-carb alteration	2.66% Ni, 1.08% Cu, 1120 ppb Pt, 1610 Pd
					cp, mo in diorite	
Wrangellia ?			**115K 078 Chair**	Zn, Pb, Cu, Ag, Au	Vqtz-mal-az-py-cp-tetr associated w porph dyke and fault	
					also Vqtz-ba-sph-cp-py-ga	>2% Zn, 0.88% Pb, 1400 ppm Cu/0.25m. up to 500 ppb Au
Wrangellia ?	chl/serp volc/ near pyritic granite	?	**115K 079 Nutzotin**	Cu, Ag	ox Cu-mt in epidote skarn	grab: 10.3% Cu, 17.1g/T Ag. Best chip: 0.6% Cu/12m
Wrangellia	andesite	?	**115K 083 Rip**	Cu, Au	minor Au-Cu in Vqtz=cp-py cut by shears	
Wrangellia	?	permian or triassic?	**115K 095 Nutz**	Cu	cp in shear zones	
Wrangellia	Station Ck?	Pennsylvanian-Permian	**115K 096 Gruber**			

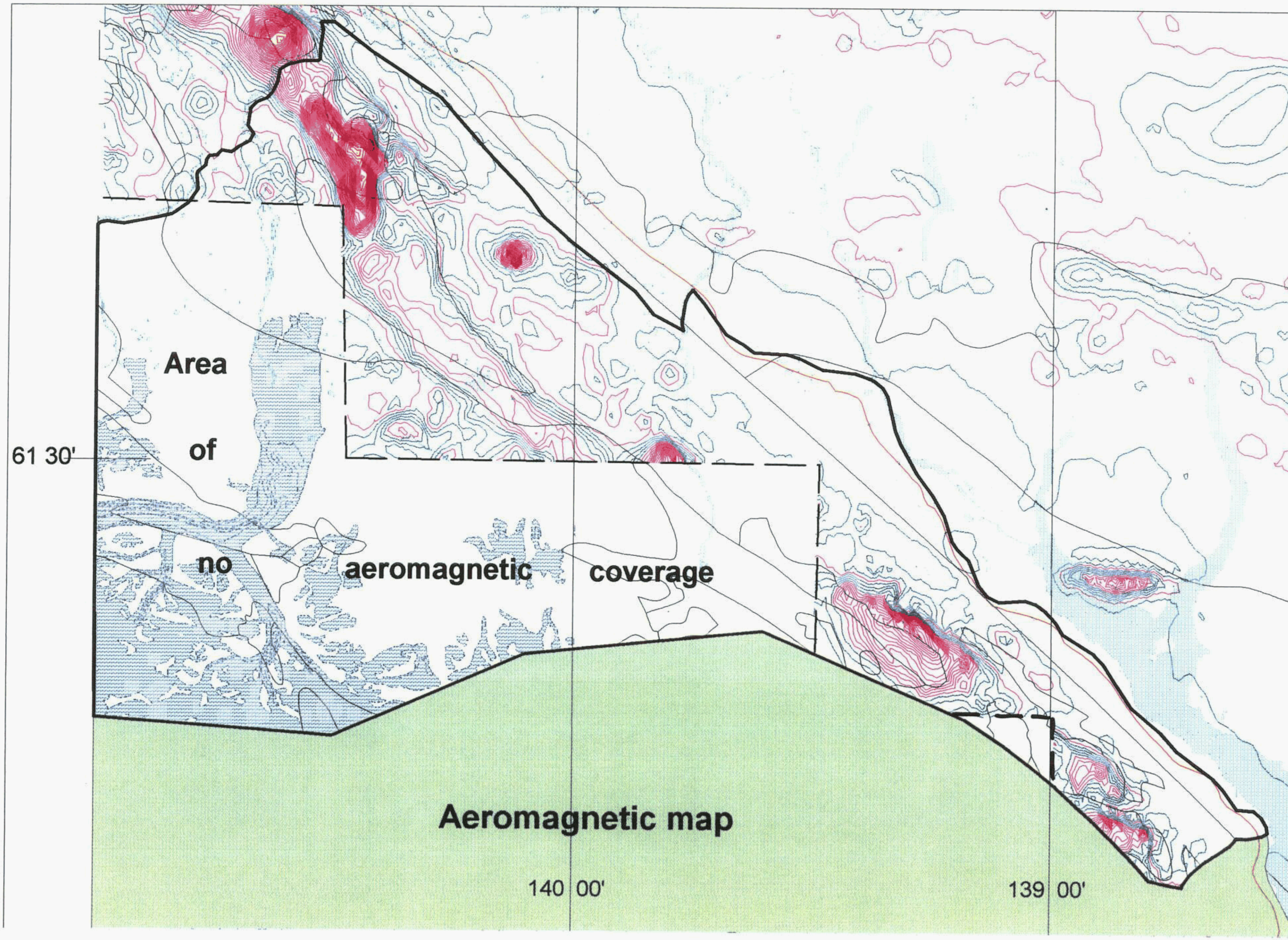
Table 2 Mineral Occurrences adjacent to Kluane Wildlife Sanctuary

Tectonic unit	Fm-litho	age	deposit name	commodities	descriptions	reserves or grades
BRITISH COLUMBIA						
Wrangellia	Sicker Group	Permian	**Myra Falls**	Cu, Pb, Zn, Au, Ag	Kuroko VMS	12.5 million tonnes grading 1.9% Cu, 0.5% Pb, 6.3% Zn, 2.1 g/t. Au, 45.6 g/t. Ag
Wrangellia	Sicker Group	Permian	**Buttle Lake**		Kuroko VMS	
Wrangellia	UMF	Triassic	**Chilkat**	Cu, Ni		
Wrangellia	UMF	Triassic	**Mansfield**	Cu, Ni		
Wrangellia	Dior. porph intr. Karmutsen lst.	?/Triassic	**Tasu**	Fe (Cu, Au, Ag)	Fe skarn	**Past Producer** 5.5 Mt. Fe, 56,084 t. Cu, 47,030 kg Ag, 1,302 kg Au Reserves: 5.46 Mt. 45% Fe, 0.3% Cu (1976)
Wrangellia	Diorite intr. Karmutsen lst.	?/Triassic	**Jedway**	Fe (Cu, Au, Ag)	Fe skarn	**Past Producer** 3.94 Mt. Fe
Wrangellia	Granodior. intr. Karmutsen lst.	eJur intr. lTr	**Argonaut-Iron Hill**	Fe (Cu, Au, Ag)	Fe skarn	**Past Producer** 2.03 Mt. Fe
Wrangellia	Diorite intr. Karmutsen lst.	eJur intr. lTr	**Coast Cu-Old Sport**	Fe (Cu, Au, Ag)	Fe skarn	**Past Producer** 508,023 t. Fe, 27,488 t. Cu, 11,731 kg Ag, 3869 kg Au Reserves: 816,480 t. 0.33% Fe
Wrangellia	Dior- Gabbro intr. Karmutsen lst.	eJur intr. lTr	**Coast Copper**	Cu (Fe, Au, Ag, Mo)	Cu skarn	**Past Producer** 42,300 t. Cu, 3,840 kg Au, 10,976 kg Ag
Wrangellia	Granodior. intr. Karmutsen lst.	eJur intr. lTr	**Kennedy Lake**	Fe (Cu, Au, Ag)	Fe skarn	**Past Producer** 3.0 Mt. Fe
Wrangellia	Dior- Gabbro intr. Karmutsen lst.	eJur intr. lTr	**Merry Widow**	Fe (Cu, Au, Ag)	Fe skarn	**Past Producer** 1.68 Mt. Fe
Wrangellia	Diorite intr. Karmutsen lst.	eJur intr. lTr	**Nimpkish**	Fe (Cu, Au, Ag)	Fe skarn	**Past Producer** 890,704 t. Fe
Wrangellia	Diorite intr. Karmutsen lst.	eJur intr. lTr	**Zeballos**	Fe (Cu, Au, Ag)	Fe skarn	**Past Producer** 227,066 t. Fe
Wrangellia	Granodior-gabbro intr. Karmutsen lst.	eJur intr. lTr	**Texada**	Fe (Cu, Au, Ag)	Fe skarn	**Past Producer** 10 Mt. Fe (est.), 35,900 t. Cu, 40,012 kg Ag 3,313 kg Au
Wrangellia	Granodior-gabbro intr. Karmutsen lst.	eJur intr. lTr	**Texada**	Au (Ag, Cu)	Au skarn	**Past Producer** 2,425 kg Au, 16,368 kg Ag, 9,157 t. Cu Reserves: 152,000 t., 1.5% Cu, 7.2 g/t. Au
Alexander Terrane	qtz. diorite intr. Paleozoic lst., sltst	eCret intr. Paleozoic	**Banks Island**	Au (Ag, Cu)	Au skarn	90,700 t., 17.4 g/t. Au
Alexander Terrane	Tats Volcanic Complex	eNorian	**Windy Craggy**	Cu, Co (Au, Ag, Zn)	VMS	300 Mt. of 1.5% Cu, 0.08% Co, and 1 to 3 g/t Au
Gravina-Nutzotin		Jura-Cretaceous	**Brittania**	Cu, Zn	VMS	48 Mt. grading 2.8% Cu, 0.25% Zn
	Bonanza Intrusives	Jura-Cretaceous	**Island Copper**		Porphyry Cu-Mo	257 Mt. grading 0.52% Cu, 0.17% Mo
ALASKA						
Gravina-Nutzotin (?)			**Jualin**	Au, Ag, Pb	Au quartz vein	Produced 1.5 million g Au
Gravina-Nutzotin			**Kensington**	Au, Ag, Pb	Au quartz vein	Produced 11,000 t. grading about 5.8 g/t Au
Gravina-Nutzotin			**Yakima**	Au, Pb, Zn	Besshi massive sulfide	Production not recorded
Gravina-Nutzotin			**Treadwell**	Au, Ag, Pb	Au quartz vein	Produced about 90 million g Au from 25 Mt. ore
Intr/Gravina-Nutzotin	Ultramafic Intr.	Cret/Jur	**Union Bay**	Fe, Ti, Cr, PGE		1,000 Mt. grading 18 to 20% Fe, minor PGE
Intr/Gravina-Nutzotin	Zoned mafic-ultramafic	Cret intr. JK	**Klukwan**	Fe, Ti, V, Ni		12 billion tonnes grading 0.2% V205, 13% magnetite, 1.5 to 4.4% TiO2
Intr/Gravina-Nutzotin		Cret. intr. J/K	**Baultoff, Horsefeld and Carl Creek**	Cu,Mo	Porphyry Cu	240 Mt. grading 0.2% Cu, <0.01% Mo, trace Au
Intr(?) Intr/Gravina-Nutzotin	qtz. diorite intr. seds	Cret. intr. J/K	**Orange Hill and Bond Creek**	Cu, Mo	Porphyry Cu-Mo and Cu-Au skarn	320 Mt. grading 0.35% Cu (Orange Hill) 500 Mt. grading 0.30% Cu (Bond Creek)
Intr/Coast Belt	Granite porphyry	Oligocene intr. Cret.	**Quartz Hill**	Mo	Porphyry Mo	As much as 1,700 Mt. grading 0.136% Mo
Alexander Terrane	Volcanics	lTriassic	**Greens Creek**	Z, Pb, Cu, Ag, Au	Kuroko massive sulfide	3.6 Mt. grading 8% Zn, 2.7% Pb, 0.4% Cu, 360 g/t. Ag, 3.4 g/t. Au
Alexander Terrane		Paleozoic	**Niblack**	Cu, Au, Ag	Kuroko massive sulfide	Produced 636,000 kg Cu, 34,200 g Au, 466,500 g Ag
Alexander Terrane	Paleozoic		**Glacier Creek**	Ag, Au, Ba, Cu, Pb	Kuroko VMS	680,000 t. grading 45% BaSO4, as much as 3% combined Cu, Zn
Alexander Terrane			**Orange Point**	Zn, Cu, Ag, Au	Kuroko VMS	Samples with as much as 19% Zn , 5.2% Cu, 3.5 g/t. Au, 70 g/t. Ag
Intr/Alexander	granodiorite intr. Descon Ass.		**Reid Inlet**	Au, Pb	Au quartz vein	Produced 220,000 to 250,000 g Au
Intr/Alexander	Felsic Pluton	Tertiary	**William Henry Bay**	U, Th, REE	Felsic plutonic U	Samples with as much as 0.2% U
Intr/Alexander	Cret intr. Paleozoic		**Margerie Glacier**	Cu, Ag, Au	Porphyry Cu and polymetallic vein	145 Mt. grading 0.02% Cu, 0.27% g/t Au, 4.5 g/t. Ag
	Intr. Descon	Tertiary intr. Ord.-Sil.	**Nunatak**	Ag, Au, Cu, Mo	Polymetallic vein, porphyry Cu-Mo	2.0 Mt. grading 0.067% Mo, 0.16% Cu
	Granite intr. marble	Tertiary	**North Bradfield River**	Fe, Cu	Fe skarn	Drill core grading 50 to 65% Fe, 0.1 to 0.5% Cu
			Funter Bay	Cu, Ni, Co	Gabbroic Ni-Cu	Up to 540 thousand tonnes grading as much as 1% Cu, Ni each
Wrangellia	Karmutsen	Triassic	**Apex, El Nido**	Au, Ag, Cu, Pb, W	Au quartz vein	Produced 622,000 g Au, 93,300 g Ag
Wrangellia	Karmutsen	Triassic	**Cobol**	Au, Cu, Pb, Zn	Au quartz vein	Produced 3,100 g Au

table 3. Mineral Occurrences- Regional Examples

Tectonic unit	Fm-litho	age	deposit name	commodities	descriptions	reserves or grades
Wrangellia			**Baker Peak**	Cu	Basaltic Cu(?)	Samples with as much as 2.0 to 7.5 % Cu, minor Au, Ag
Wrangellia	Karmutsen	Triassic	**Denali**	Cu, Ag	Besshi massive sulfide(?)	Massive sulfide layers with abundant Cu, and as much as 13 g/t. Ag
Wrangellia	Intr/Karmutsen		**Zackly**	Au, Cu, Ag	Cu-Au skarn	1.25 Mt. grading 2.6 % Cu and >6 g/t. Au
Wrangellia	Karmutsen	Triassic	**Kathleen-Margaret**	Cu, Ag, Au	Cu-Ag quartz vein	Samples with as much as 13% Cu, 3.2 g/t. Au, 300 g/t. Ag
Wrangellia			**Rainy Creek**	Cu, Ag, Au	Cu-Au skarn	Samples with as much as 5.6% Cu, 300 g/t. Ag, 1.2 g/t. Au
Wrangellia			**Nabesna Glacier**	Cu, Zn, Au	Polymetallic vein	No data
Wrangellia	Intr/Karmutsen	Triassic	**Midas**	Au, Cu, Ag	Cu-Au skarn	Samples with as much as 8 g/t. Au, 10 g/t. Ag, and 20% Cu
Wrangellia			**Nugget Creek**	Cu, Ag	Cu-Ag quartz vein	Samples with as much as >200 g/t. Ag, >2% Cu
Wrangellia	Karmutsen	Triassic	**Kennecott District**	Cu, Ag	Basaltic Cu	Produced 544 million kg Cu and 280 million g Ag from 4.3 Mt. ore
Wrangellia	Karmutsen	Triassic	**Nikolai**	Cu, Ag	Cu-Ag quartz vein	Sample with as much as 1% Cu
Wrangellia	Karmutsen	Triassic	**Westover**	Cu, Ag	Basaltic Cu	Samples with > 2% Cu, 50 g/t. Ag, 0.2% As
Wrangellia	Karmutsen	Triassic	**Nelson**	Cu, Ag	Basaltic Cu	Samples with > 2% Cu, 50 g/t. Ag, 0.3% As
Wrangellia	Karmutsen	Triassic	**Erikson**	Cu, Ag	Basaltic Cu	Samples with >2% Cu, 70 g/t. Ag
Intr/Wrangellia	Intr. Skolai	Penns.-Perm.	**Rainbow Mountain**	Cu, Ag	Porphyry Cu	Samples with as much as 10% Cu, 44 g/t. Ag, trace Au
Intr/Wrangellia	Intr.		**Slate Creek**	Cu, Ag, Au, Zn	Porphyry Cu(?)	Samples with as much as 2% Cu, 70 g/t. Ag, 2 g/t. Au
Intr/Wrangellia	Intr.		**Chistochina**	Pb, Cu, Ag, Au	Porphyry Cu and polymetallic vein	Samples with as much as 20% Pb, 1.4 % Cu, 21 g/t. Ag, 1.4 g/t. Au
Intr/ Wrangellia	monzodiorite/ Karmutsen limestone	Cret/Triassic	**Nabesna, Rambler**	Au	Fe skarn	Produced 1.66 million g Au and minor Cu (Nabesna)
						Estimated 18,000 t. grading 34.3 g/t. Au (Ramble)
Intr/Wrangellia			**London and Cape**	Cu, Mo, Ag	Porphyry Cu-Mo	Samples with as much as 10% Cu, 0.007% Mo, 1.5 g/t. Ag
Aleutian Arc			**Sedanka**	Zn, Pb, Cu	Polymetallic vein	Average grade of 6.8% Zn, 0.45% Cu, 0.29% Pb, 48 g/t. Ag
Aleutian Arc			**Canoe Bay**	Au, Ag, Hg, As, Pb	Epithermal vein	No data
Aleutian Arc			**Aquila**	Au, Ag	Epithermal vein	Samples with as much as 7.8% g/t. Au, 27 g/t. Ag
Aleutian Arc			**Apollo-Sitka**	Au, Ag, Pb, Zn, Cu	Epithermal vein	Produced 3.33 million g Au from 435,000 t. ore
Aleutian Arc			**Shumagin**	Au, Ag	Epithermal vein	540,000 t. grading 10 g/t. Au, 34 g/t. Ag
Aleutian Arc			**Pyramid**	Cu, Au	Porphyry Cu	110 Mt. grading 0.4% Cu, 0.05% Mo, trace Au
Aleutian Arc			**San Diego Bay**	Ag, Au, Cu, Pb	Epithermal vein	No data
Aleutian Arc			**Kawisgag**	Cu, Mo, Au	Porphyry Cu or polymetallic vein	Samples with 0.2 to 1.0% Cu, as much as 0.02% Mo, 0.23 to
Aleutian Arc						0.4 g/t. Au
Aleutian Arc			**Warner Bay**	Cu, Mo, Pb, Zn	Polymetallic vein	Average grade of 0.3% Cu, as much as 0.7% Cu
Aleutian Arc			**Cathedral Creek,**	Cu, As, Zn, Pb	Polymetallic vein	No data
Aleutian Arc			**and Braided Creek**			
Aleutian Arc			**Mallard Duck Bay**	Cu, Mo	Porpyry Cu-Mo or epithermal	No data
Aleutian Arc					vein(?)	
Aleutian Arc			**Bee Creek**	Cu, Au	Porphyry Cu	4.5 to 9.1 Mt. grading 0.25% Cu, 0.01% Mo
Aleutian Arc			**Rex**	Cu, Au	Porphyry Cu	No data
Aleutian Arc			**Mike**	Mo, Au, Ag, Pb, Zn	Porphyry Mo	Samples with >20 g/t. Mo
Aleutian Arc			**Kilokak Creek**	Pb, Zn	Polymetallic vein(?)	No data
Aleutian Arc			**Kuy**	Au, Ag, Cu	Epithermal vein	No data
Aleutian Arc			**Fog Lake**	Au, Cu, Ag	Epithermal vein	Samples with as much as 37 g/t. Au, 5 g/t. Ag, >0.5% Cu
INTERNATIONAL						
			Norils'k	Cu, Ni, PGE		g.t. 20 Mt. Cu, Ni

table 3. Mineral Occurrences- Regional Examples



61 30'
Area
of
no
aeromagnetic
coverage
Aeromagnetic map
140 00'
139 00'

Fig. 13

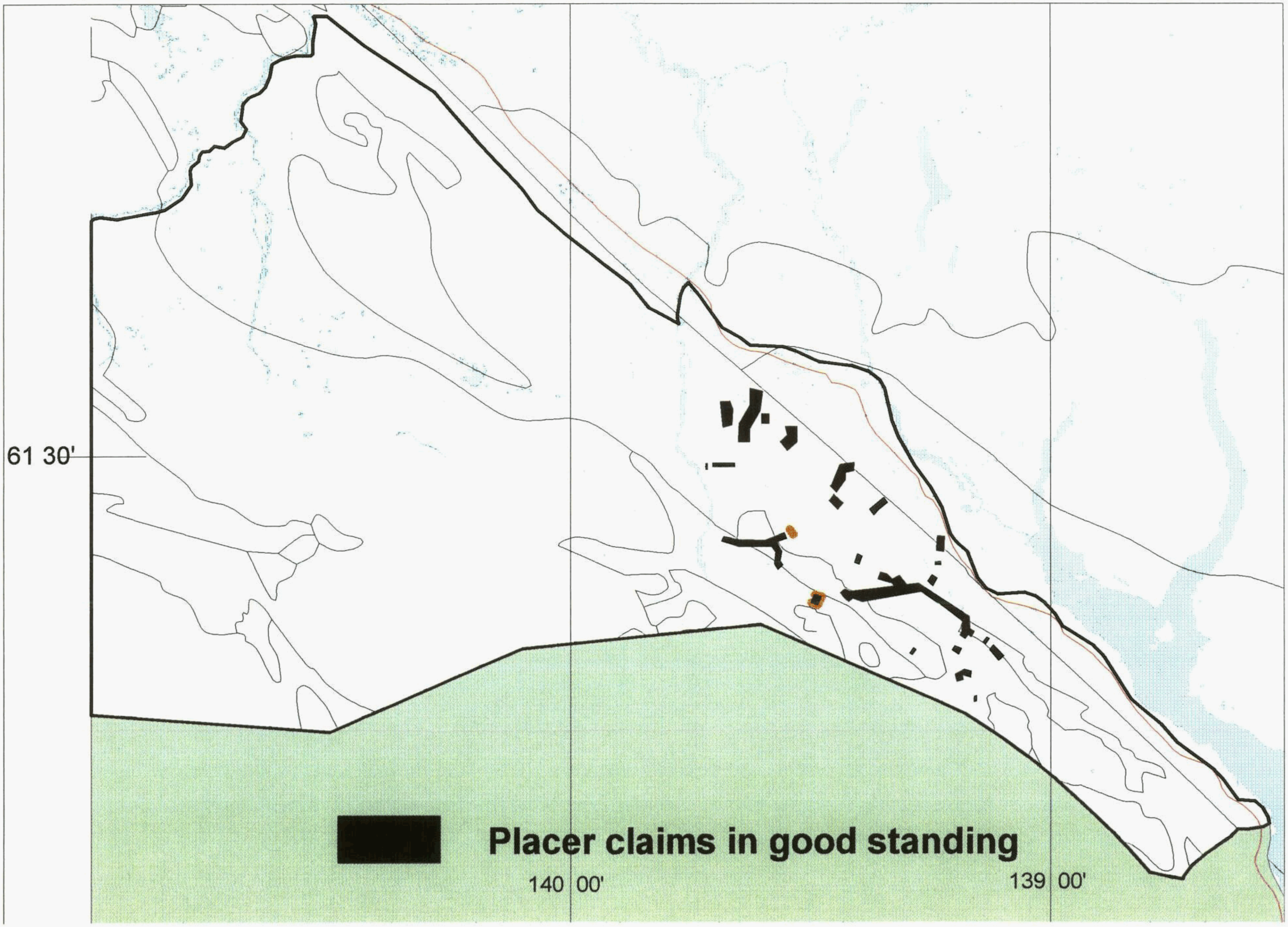


Fig. 14

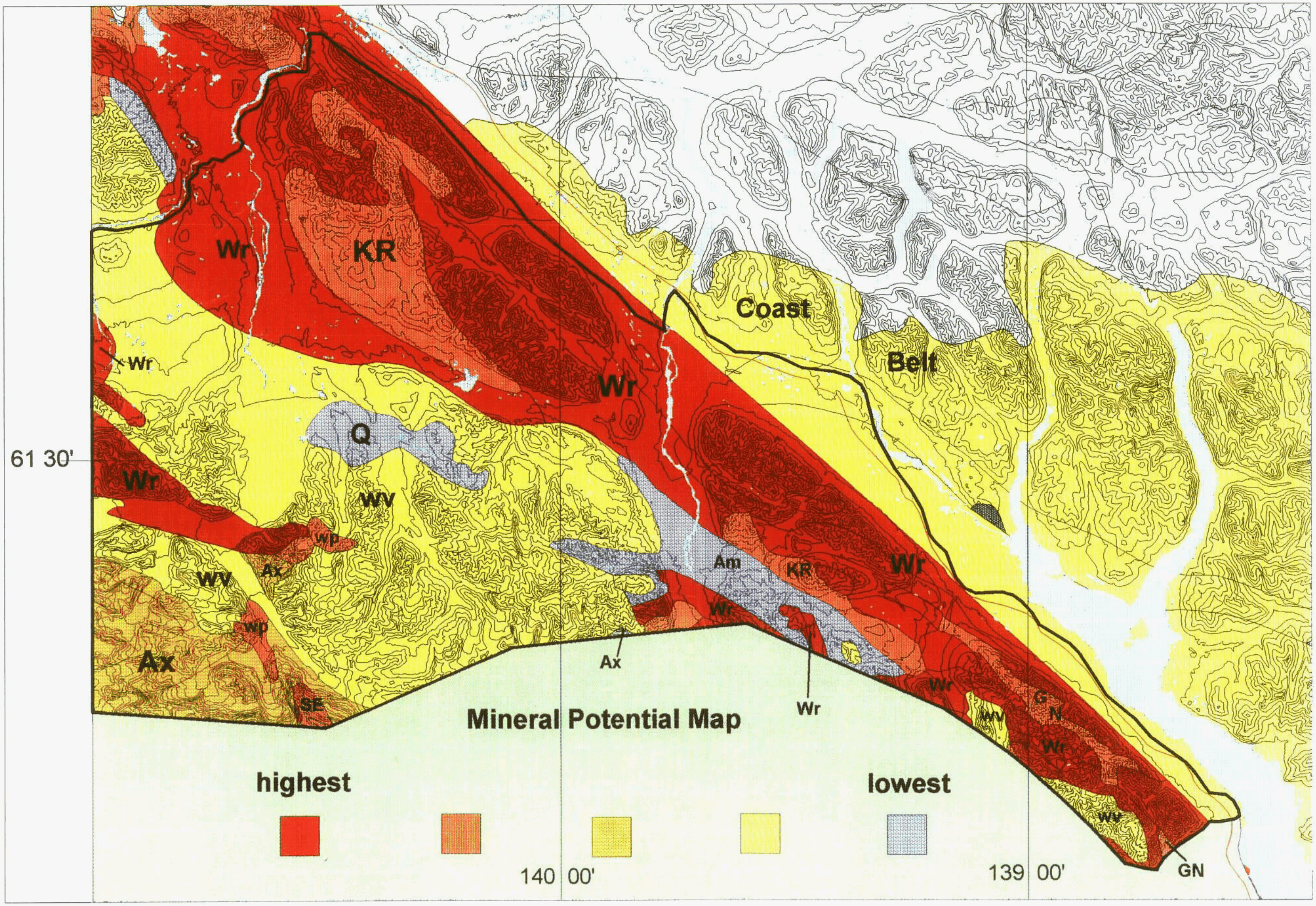

Mineral Potential Map
highest
lowest
61 30'
140 00'
139 00'
Wr
KR
Coast
Belt
Q
WV
wp
Ax
SE
Am
G
N
GN

Fig. 15

8. MINERAL POTENTIAL SUMMARY

A mineral potential map (fig. 15) shows the different rock units and their mineral potential rating. All rock units could potentially host shear-related mineralization, especially those bordering the major faults (Denali, Duke River, Quill Creek). In fact this type of target, generally overlooked in the past, is becoming increasingly important in light of the new understandings of the structural complexities of the area.

8.1- Wrangellia

Of all the units underlying the KWS, those of the Wrangellia terrane have the highest potential of hosting economic mineral deposits. Distribution of Yukon mineral occurrences clearly outlines Wrangellia as an occurrence-rich belt (fig. 3,7).This belt hosts numerous past and present producers in the Yukon, B.C. and Alaska. The KWS includes two deposits with proven reserves.

- The Skolai Assemblage is host to Kuroko-type VMS (Myra Falls), skarn, vein and shear-related deposits as well as replacement Ni-Cu-PGE mineralization (Canalask).

- The late Triassic Kluane Ultramafic Belt intrudes the Skolai near a major stratigraphic transition. It hosts magmatic Ni-Cu-PGE(-Au) mineralization at the Wellgreen Mine and in several other occurrences in the KWS (Linda, Onion). This mineralization is unusually rich in the rare PGE's and has been described as an analog to the Norils'k deposits which contain some of the world's richest Ni-Cu-PGE ore.

- The Karmutsen Assemblage contains numerous copper deposits occurring as Besshi-type VMS (Denali), Cu-Fe-Au skarns (Texada, Rainy Creek, Nabesna) and replacement or basaltic Cu (Kennecott district, White River) deposits hosted in copper-rich Nikolai volcanics and the overlying Chitistone limestones.These rocks also host polymetallic vein deposits (Kathleen-Margaret) as well as gypsum and wollastonite occurrences.

- the Nizina Limestone contains gypsum occurrences and could host skarn mineralization.

Every segment of Wrangellian stratigraphy has potential for economic mineralization. Wellgreen, a past producer within the KWS, is presently being evaluated for possible production. Inco Ltd is investigating mineralized ultramafic intrusion near Congdon Ck and is reporting (confidentially) elevated PGE-Au values. The eastern part of the belt is overlain by a significant number of active quartz claims. The segment of Wrangellia that lies between the White and

Donjek rivers rates as highly as the rest of the belt does but less is known about it since no recent mapping covers that area. Muller (1967) reports occurrences of migmatites, augen gneiss and marbles. The deformation and metamorphism of these rocks could be caused by structural and intrusive activity, or the package could represent a yet undocumented "basement" to Wrangellia. This basement could possibly be of lower mineral potential than the known "supracrustal" succession.

In the case of the Wellgreen example, mineralization is concentrated preferentially at the base of the sills. It is important to have good structural control in these rocks as the base of these sills could easily be faulted off by the complex and intense faulting and folding that deformed the succession. Limestone previously thought to be Pennsylvanian have been found to be Triassic in age, therefore extending the distribution of the Chitistone limestone in the area. This limestone is host to several copper deposits in Alaska, the most famous of which is the Kennecott district.

8.2- Post-accretionary Plutons and Gravina-Nutzotin belt

Post-accretionary plutons and rocks of the Gravina-Nutzotin belt rate second highest in their potential to host economic deposits. The intrusive suites host several mineral occurrences within the KWS and both tectonic units contain significant deposits at a regional scale.

- Felsic intrusive rocks are associated with porphyry-style, dominantly Fe- but also Cu, Au-skarn, polymetallic vein, uranium and shear-related mineralization.
- Workers in the field report more intrusions than presently documented on geological maps.
- Every plutonic suite (except the Devonian gabbros) represented in the KWS is associated with known mineralization.
- There is a certain level of uncertainty, both locally and regionally, about the age of granitoid intrusions hosting several mineral occurrences.
- Most mineralization seems associated with the Cretaceous and Tertiary suites with some mineralization within the Pennsylvanian-Permian suite.
- Local significant deposits include the Cork, Kane and Souther occurrences. Regionally significant deposits include the Island Copper porphyry deposit in southern B.C., the Alaskan Quartz Hill deposit, one of the world's largest molybdenum deposit as well as the Margerie Glacier, Orange Hill, Baultoff, Reid Inlet, Nabesna and Rambler deposits, all of which host significant reserves.
- Cretaceous ultramafic rocks are also mineralized (in Fe-Ti, etc).
- The Gravina-Nutzotin belts hosts VMS, vein-related and skarn deposits of regional significance: Brittania (B.C.), Orange Hill as well as Treadwell in Alaska.

8.3- Alexander Terrane

Third in ranking is the Alexander Terrane. This unit, although not known in the area around the KWS for its mineral occurrences, is highly mineralized in southeastern Alaska. Mineral deposit types include Besshi and Kuroko-type VMS, skarn, polymetallic veins as well as UMF-hosted and porphyry deposits.

- Important mineral deposits set in Alexander Terrane are Orange Point, Glacier Ck, Klukwan, and Windy Craggy, one of the largest VMS deposits in Canada.

- The section of the Alexander Terrane that lies within the KWS is not well known due to extensive ice cover and it's relatively more remote location.

8.4- Wrangell Lavas and Coast Belt

The Wrangell lavas and the Coast Belt rank fifth as they contain fewer mineral occurrences than the units described above, both locally and regionally.

- Wrangell lavas within the KWS are mapped as flood basalts.This rock type usually has relatively low mineral potential. However, it appears that a felsic subvolcanic component to this suite is present and remains to be thoroughly documented. This felsic component has high potential for epithermal, porphyry and polymetallic vein deposits, as is evident in the deposits hosted in the rocks of the Aleutian Arc.
- The Coast Belt represents a very thin wedge of the KWS. Some mineral occurrences are associated with these rocks, but quite few relative to the density of occurrences found in the units discussed above. Porphyry and skarn deposits hosted in the CPMC are usually related to younger Tertiary plutons, while mineralization within the Kluane Schist usually consists of minor skarn. One significant deposit occurs in that belt: the Killerman Lake gold vein deposit.

8.5- Amphitheater formation and Quaternary cover

These two formation have the least amount of known mineralization.

- The Amphitheatre Fm contains coal occurrences. Thicknesses rarely excede 1m and are usually 0.3m. Not enough coal has been found in this formation to warrant a significant mineral potential rating.

- The Quaternary cover refers to the massive glacial deposit located around the Wolverine Plateau area. No metal enrichment is known to occur in that region. As for the creeks themselves, not much is known about the placer enrichment of the area. Accurate production figures are not available. It must be noted that this Quaternary cover is a veneer of glacial sediments laid over older rocks. The thickness of this veneer might still permit access to the underlying rocks.

9. Conclusions

The mineral potential of the Northern Kluane Wildlife Sanctuary (KWS) is rated as HIGH.

1- Within the KWS, rocks underlying the Wrangellia Terrane rate the highest as they include two mineral deposits with proven reserves, one past producer, favorable stratigraphy for a variety of mineral deposits with production history and proven reserves elsewhere in the Cordillera as well as over 45 mineral occurrences within the boundaries of the KWS. Ultramafic hosted Ni-Cu-PGE, Fe, Cu, Au skarn, replacement or basaltic copper, VMS and polymetallic vein deposits are hosted in this belt of extremely high mineral potential that includes the Wellgreen (within the KWS), Kennecott and Denali mines (in Alaska). Anomalous gold values in silts remain as yet unexplained.

2- On a local as well as regional scale, stitching Pennsylvanian and post-accretionnary Cretaceous and Tertiary plutons are also of high potential for a variety of mineral deposit types including porphyry copper, epithermal gold and silver, skarns and polymetallic veins. Sedimentary and volcanic rocks of the Gravina-Nutzotin belt are host to VMS, skarn, and vein hosted gold and polymetallic occurrences such as the Brittania mine in B.C. and the Orange Hill, Treadwell and Yakima deposits in Alaska. A more careful investigation of the mineral occurrences would help determine the exact plutonic suite which is host to the mineralization.

3- The lower part of the Alexander Terrane, which is exposed within the KWS, contains few local documented mineral occurences but, at a regional scale, contains numerous important and varied mineral deposits. Examples include the Reid Inlet auriferous vein deposit, the Glacier Creek and Orange Point VMS deposits as well as several intrusive-hosted deposits. The Triassic succession of Alexander Terrane, which hosts the world-class Windy Craggy Cu-Co-Au deposit,is not known to outcrop within the KWS although similar Triassic rocks of the Karmutsen Assemblage do. The "Alexandrian" portion of the KWS occupiesthe most remote and ice covered corner of the study area. This would explain the paucity of information on the area but also lessens it's exploration appeal.

4- The mineral potential of the Wrangell lavas and related plutons is not well understood. More mapping is needed in order to define the extent of the reported but undocumented felsic end member of this suite. These rocks appear to be of relatively lower mineral potential within the KWS although they host significant mineral deposits and mines in Alaska. A sliver of Coast Plutonic Metamorphic Complex and Kluane Schist occurs within the KWS. Most of the significant deposits occurring in these rocks are generally related to younger plutons intruding them. One exception is the Killerman Lake occurrence which is hosted in the metamorphic rocks of the Kluane Schist.

5- The Amphitheater assemblage and the Quaternary cover are the lowest rating units.

Careful examination of the occurrence descriptions indicate many instances of structurally-controlled mineralization as hosted in veins, faults and shear zones, often related to small granitic intrusions. This is a type of target that has not been actively pursued and that has potential for high grade mineralization.

The geology of the area is very complex. Structural imbrication of similar looking units make the deciphering of the geology a very challenging task.Geological map coverage is is very poor for the area between the White and Donjek Rivers and needs to be upgraded in order to determine the extent of high potential rocks in that part of Wrangellia. Field checking of the Wrangell lavas is also needed in order to establish their potential for economic mineralization. Aeromagnetic coverage is incomplete for the area, and is non-existent for the area surrounding the Klutlan glacier and the Wellgreen mine.

10. Proposed Workplan

A workplan is proposed to complete the geological coverage, at least within a poorly documented section of Wrangellia. Four steps are proposed to increase our knowledge and understanding of the area to permit informed decision making.

1. Aeromagnetic coverage must be completed if any high potential areas are considered for withdrawal.

2. Additionnal mapping and investigation of mineral occurrences must be done between the White and Donjek Rivers, northeast of Harris and Wolverine Creeks, if that area is considered for withdrawal. Peter Read from Geotex

helicopter support, logistics and report writing would cost approximately $30 000

3. Re-analyses of the stream sediment samples for PGE would provide an essential tool for finding additional mineralized ultramafic sills such as the ones that host the Cu, Ni, PGE mineralization at Wellgreen.

4. The Wrangell lavas must be explored for potential felsic volcanic or sub-volcanic component that would carry high potential for epithermal and possibly VMS mineralization, if they are considered to be withdrawn.

ACKNOWLEDGEMENTS

Many thanks to Cameron Bell,Trevor Bremner, Tom Buntzen, Craig Hart, Steve Johnston, Mitch Mihalynuk, Robert Stroshein and Charlie Roots for their help received from discussions on the geology of the area. Diane Brent helped with Map Info, Will van Randen gave great support for printing, drafting and overall stress management consulting services, Geoff Mulligan helped with typing and final edits and Don Murphy and Rod Hill with text editing. Finally, I want to thank my computer.

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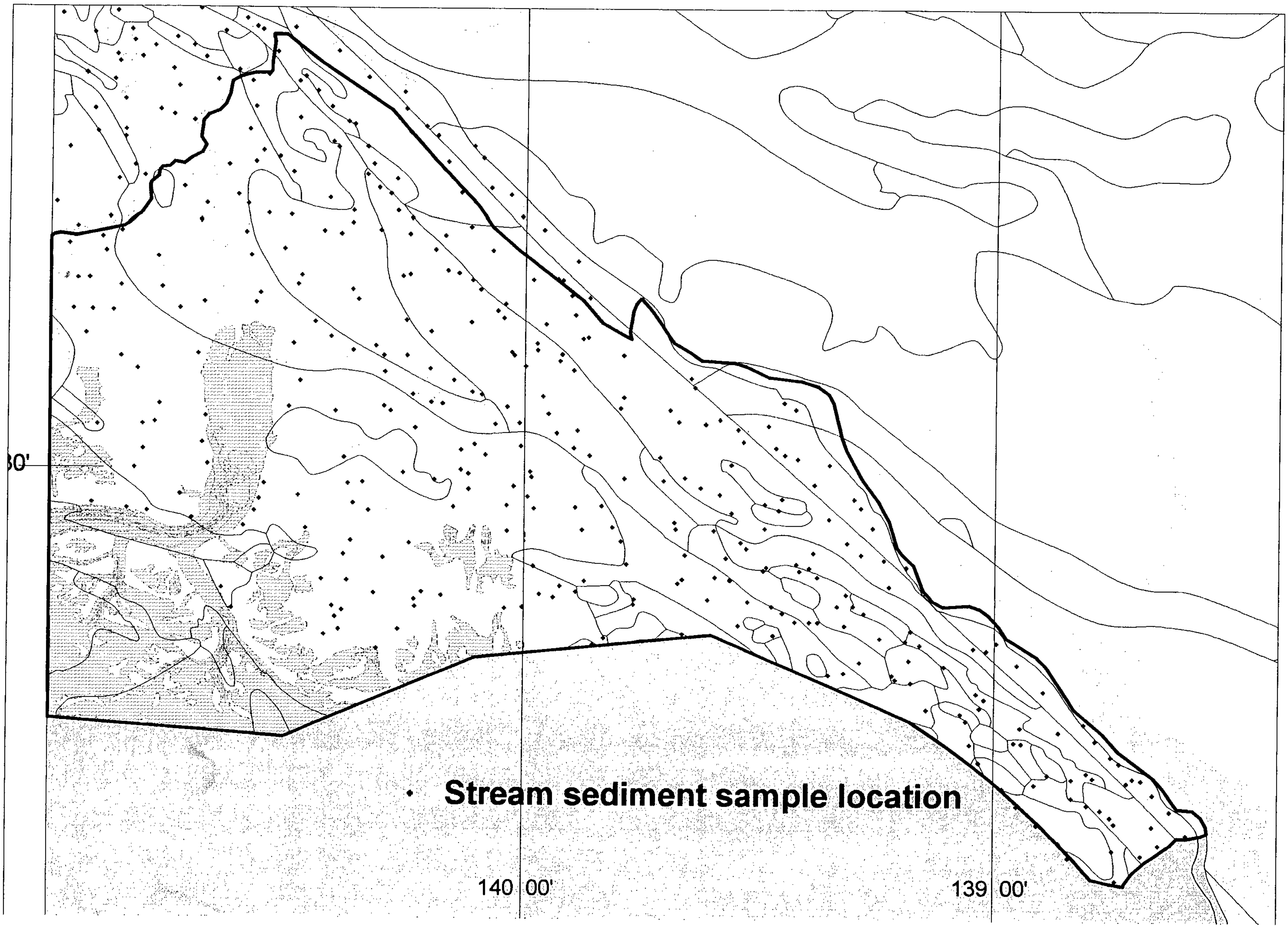
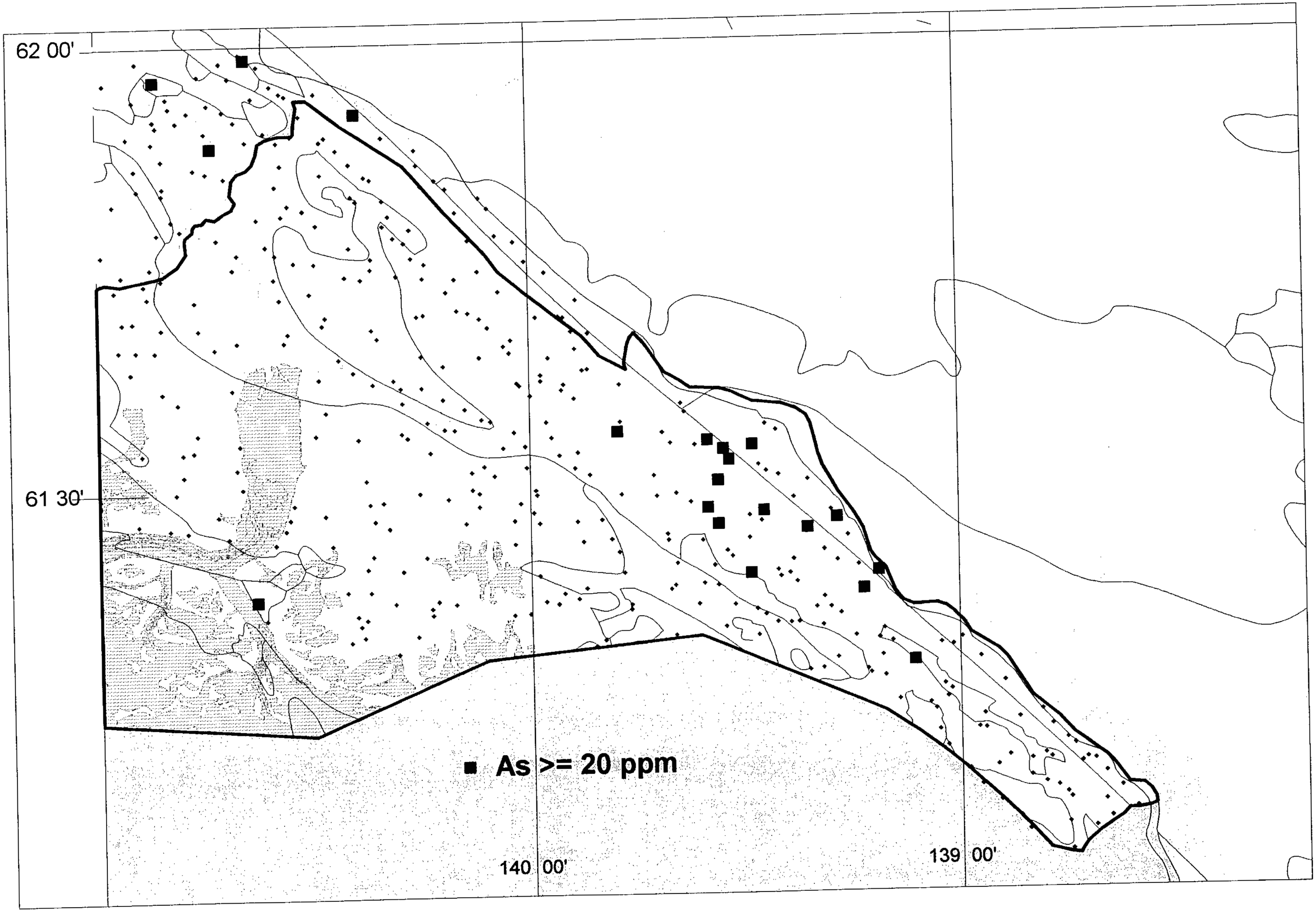
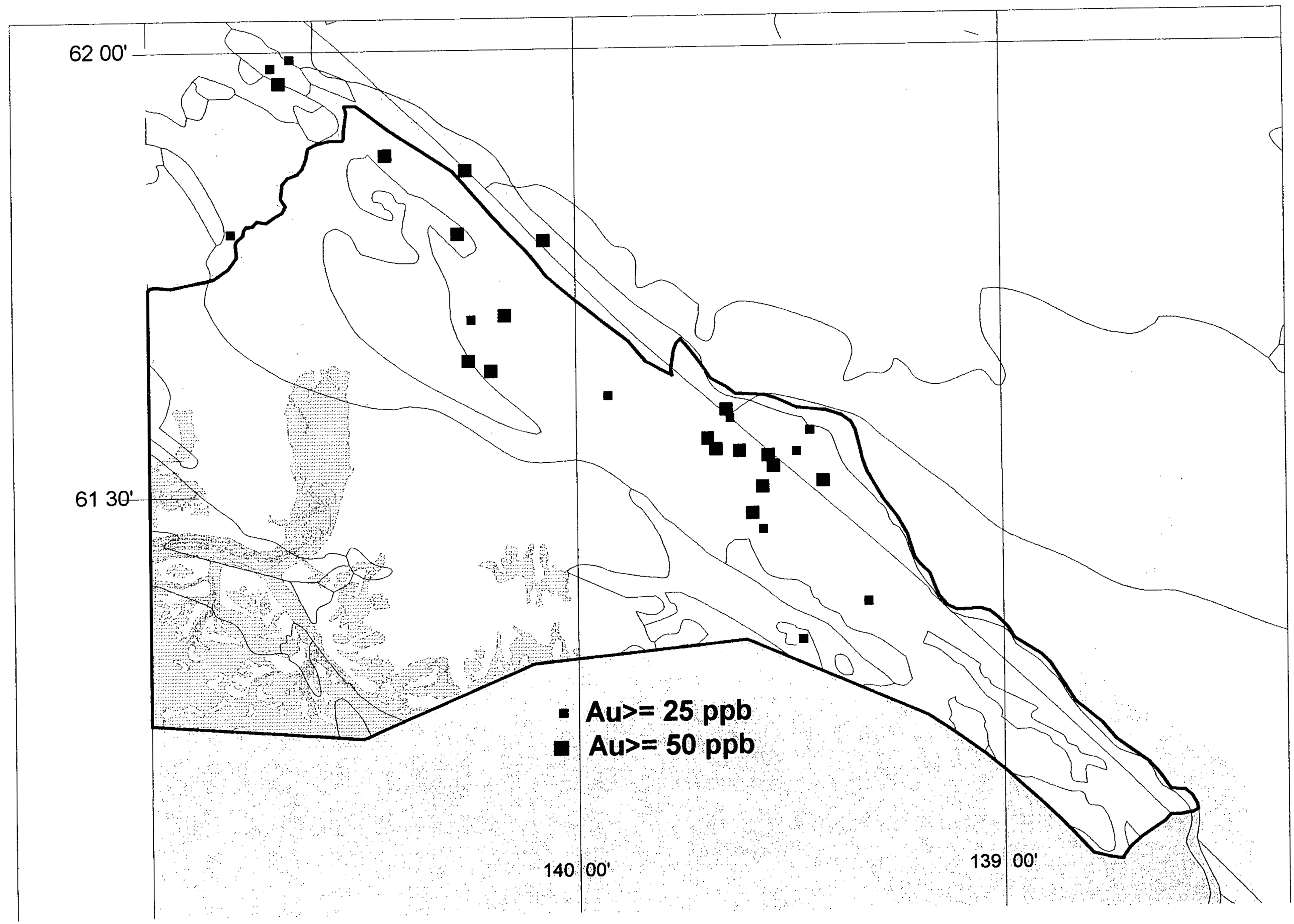
Appendix 1

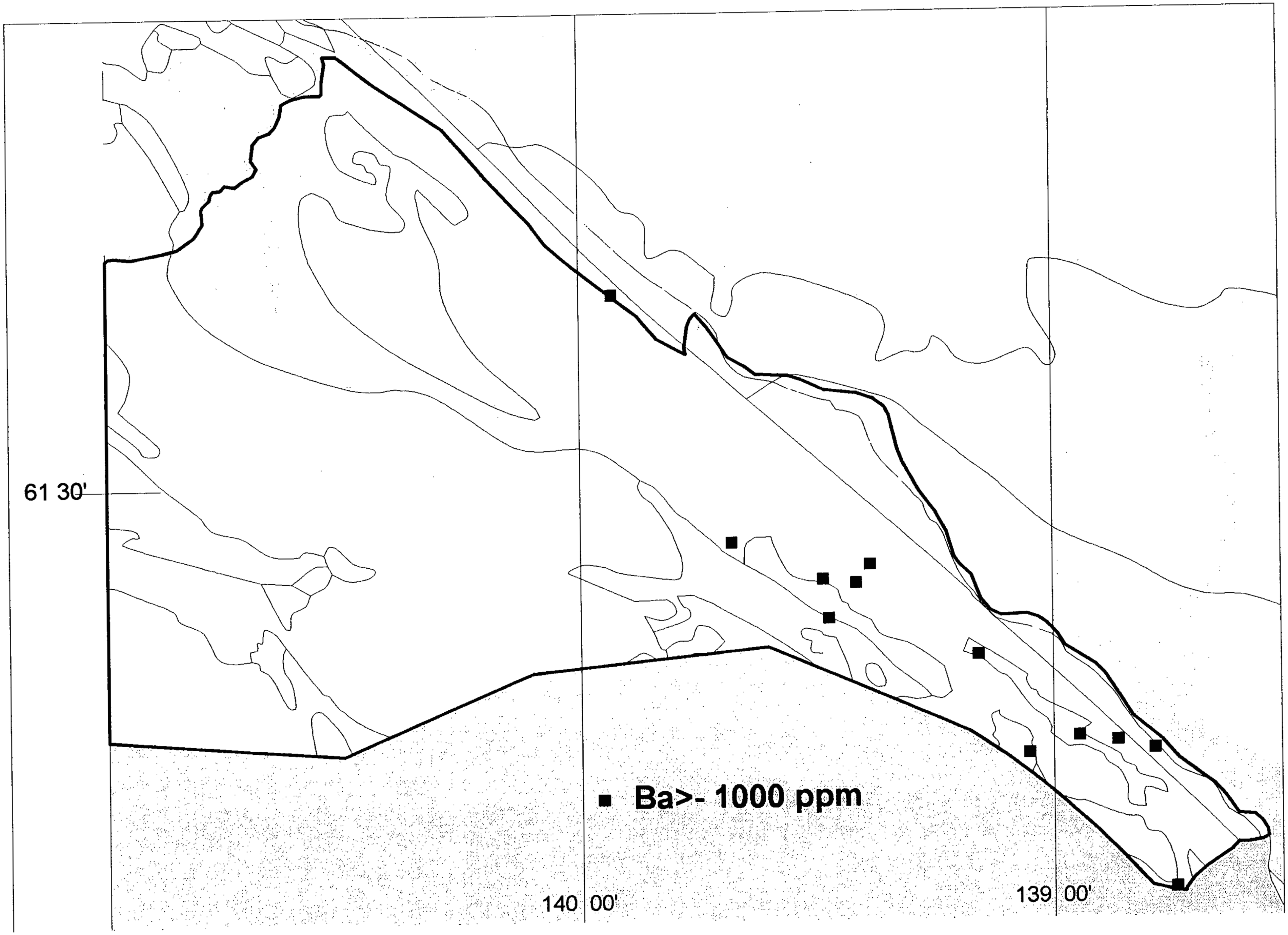
Stream Sediment Geochemistry

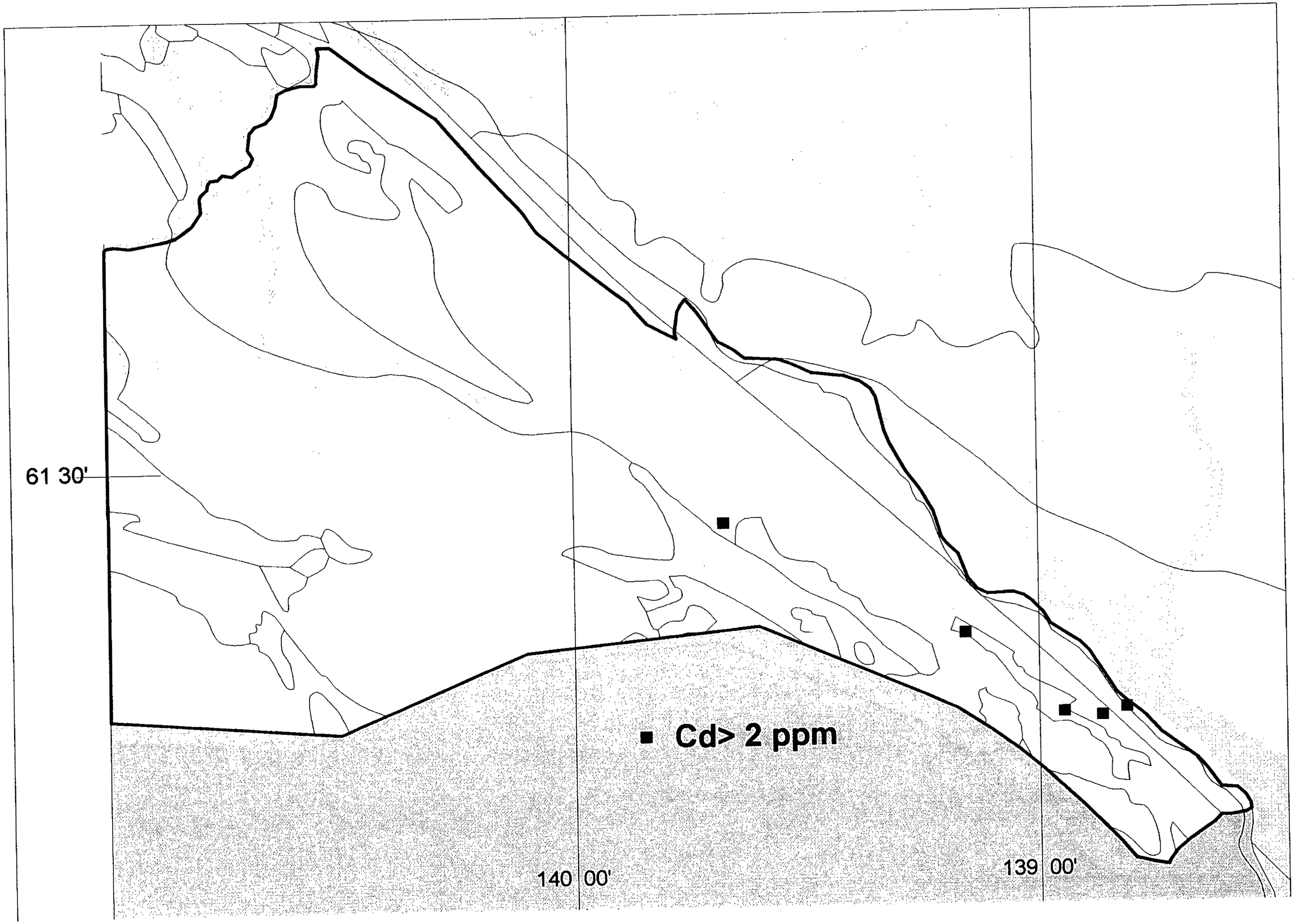


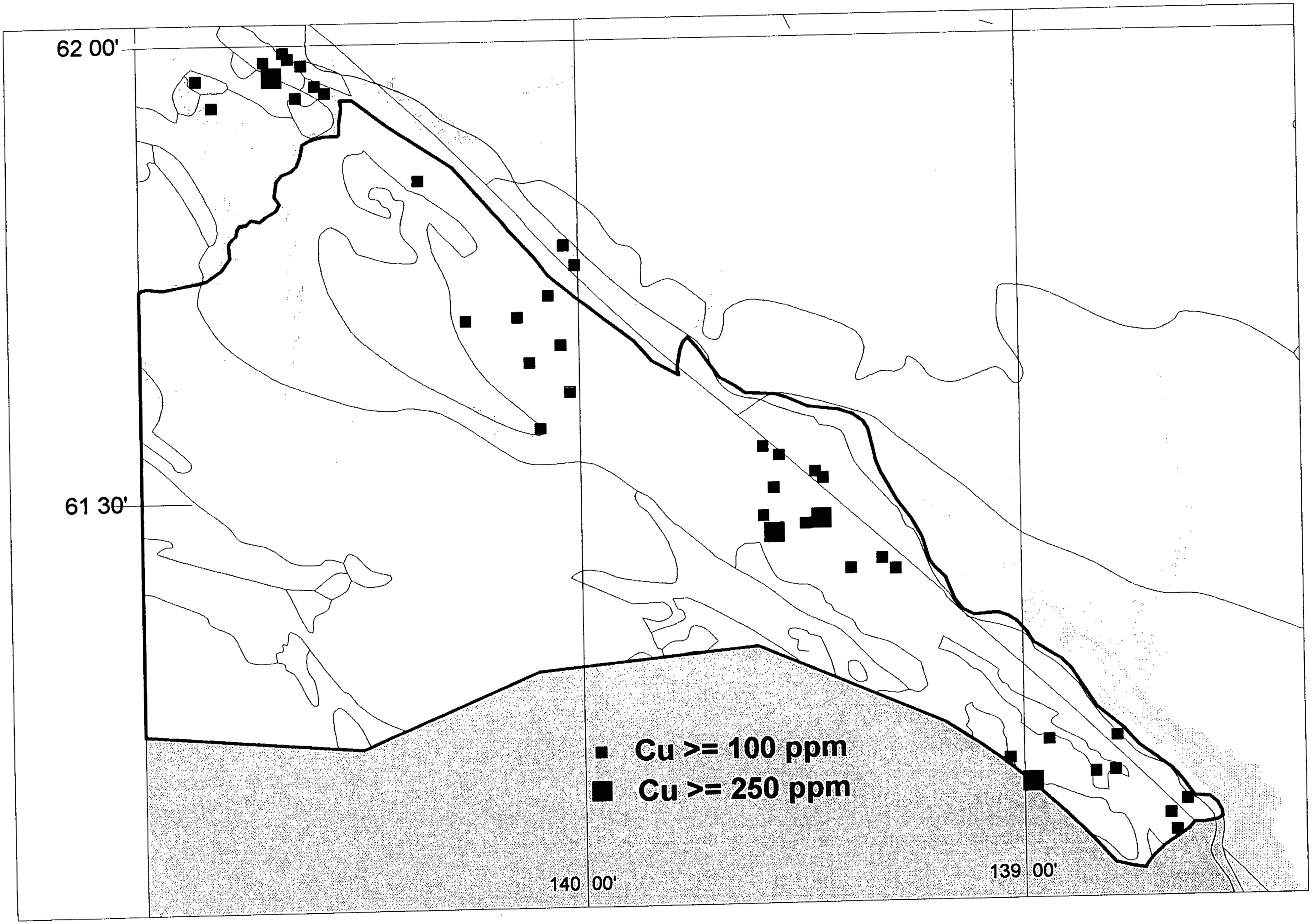
30'
Stream sediment sample location
140 00'
139 00'

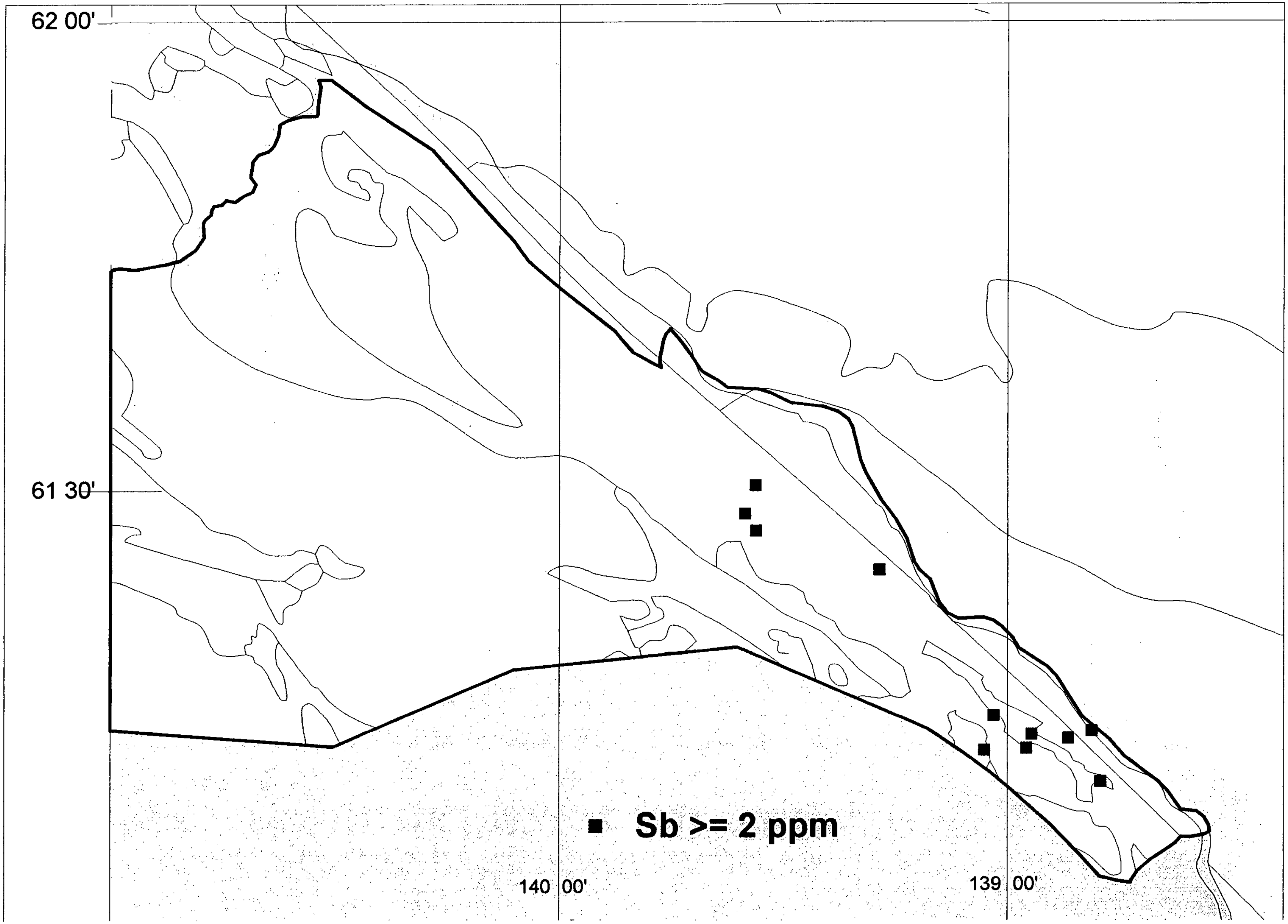

62 00'
61 30'
As >= 20 ppm
140 00'
139 00'


62 00'
61 30'
140 00'
139 00'
Au>= 25 ppb
Au>= 50 ppb

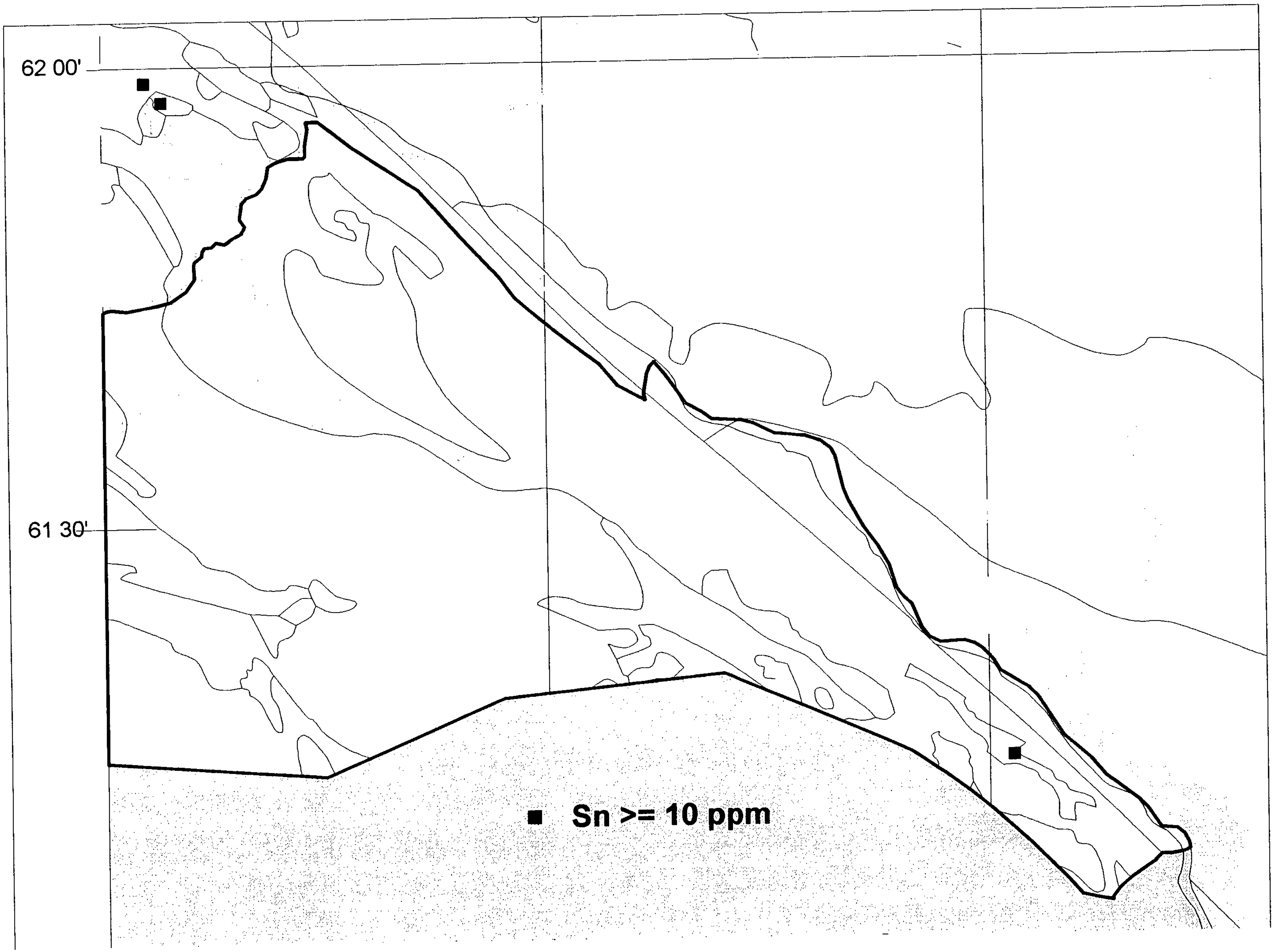

61 30'
140 00'
139 00'
Ba>- 1000 ppm

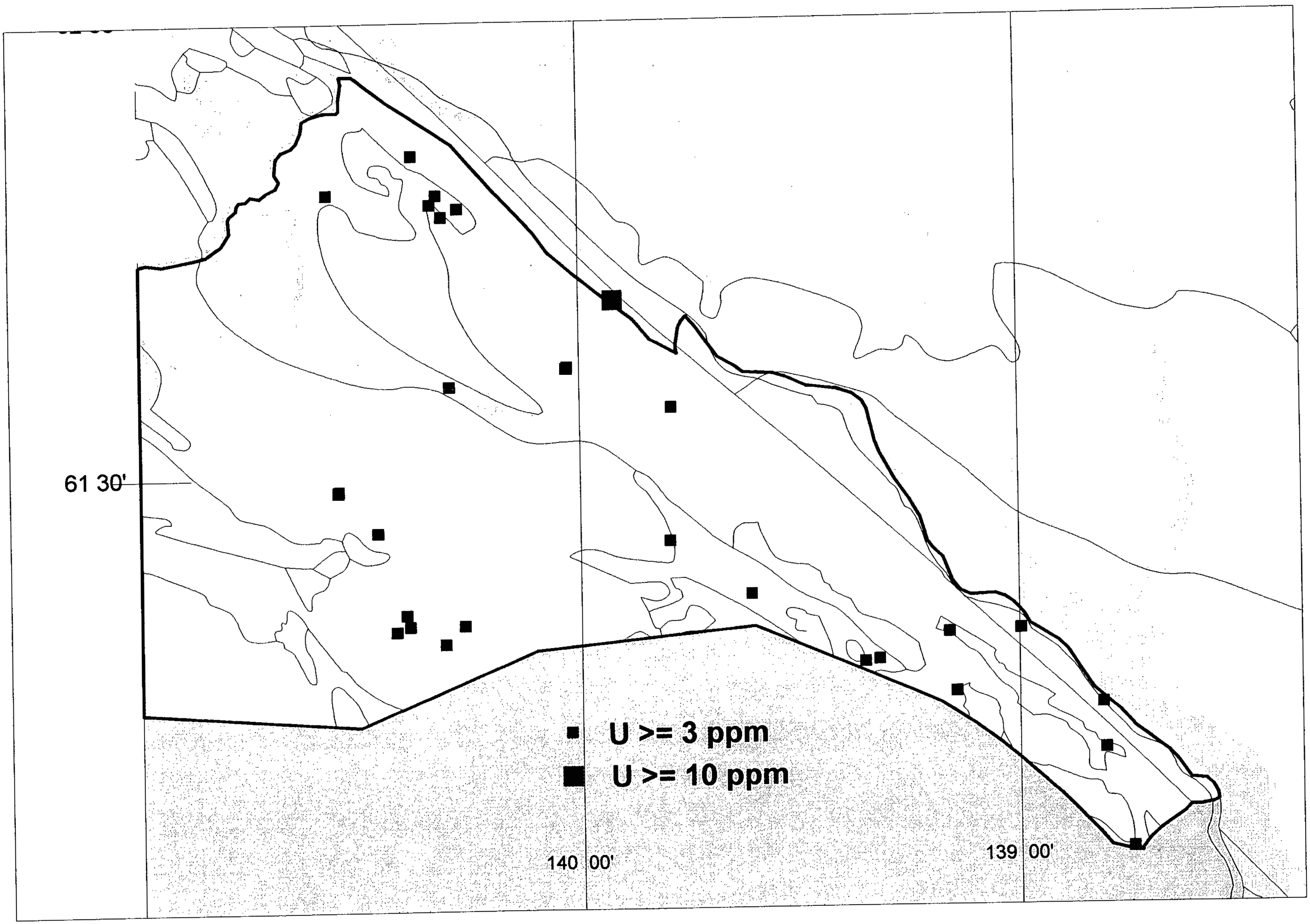

61 30'
■ Cd> 2 ppm
140 00'
139 00'


62 00'
61 30'
140 00'
139 00'
Cu >= 100 ppm
Cu >= 250 ppm

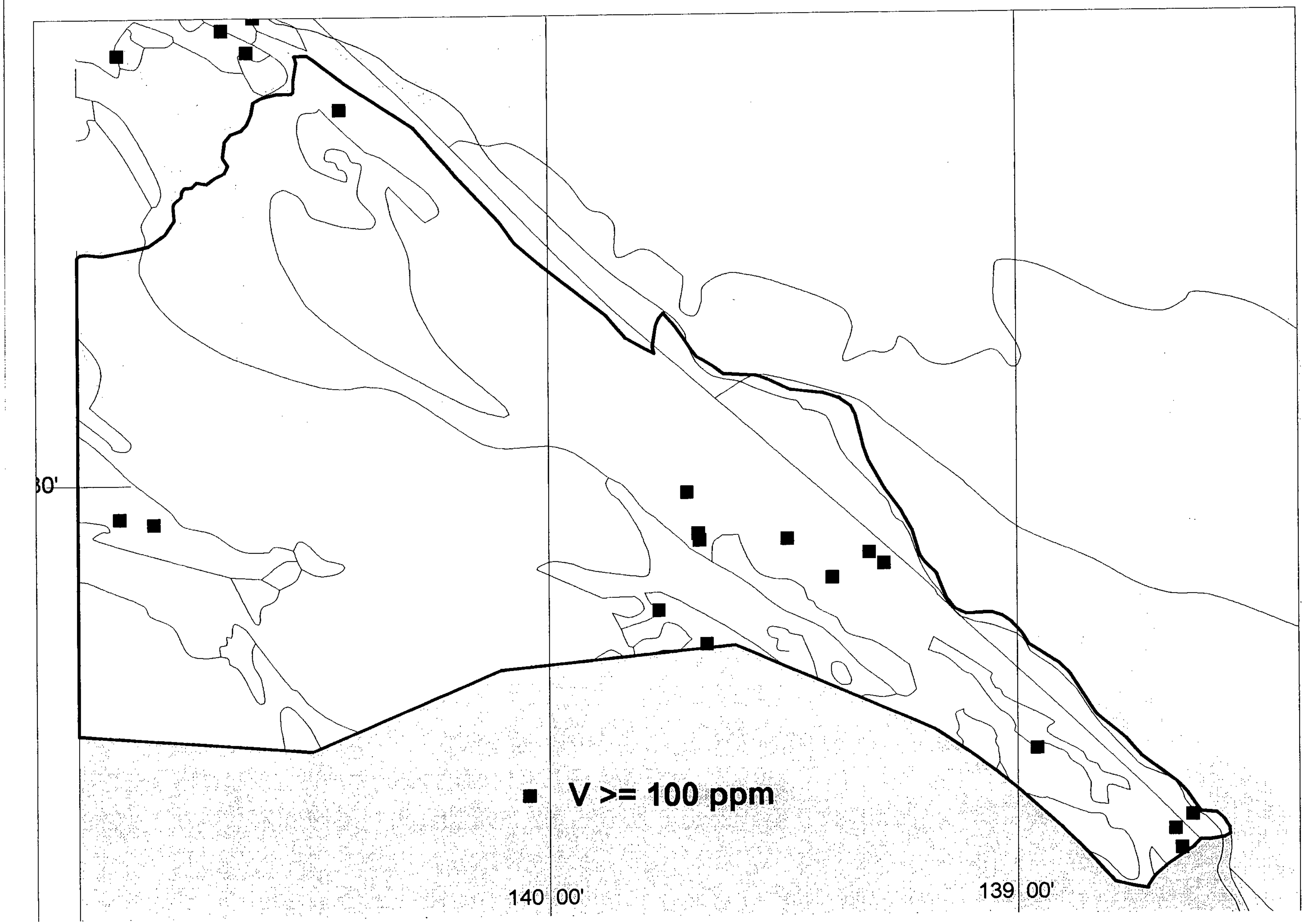


62 00'
61 30'
Sb >= 2 ppm
140 00'
139 00'

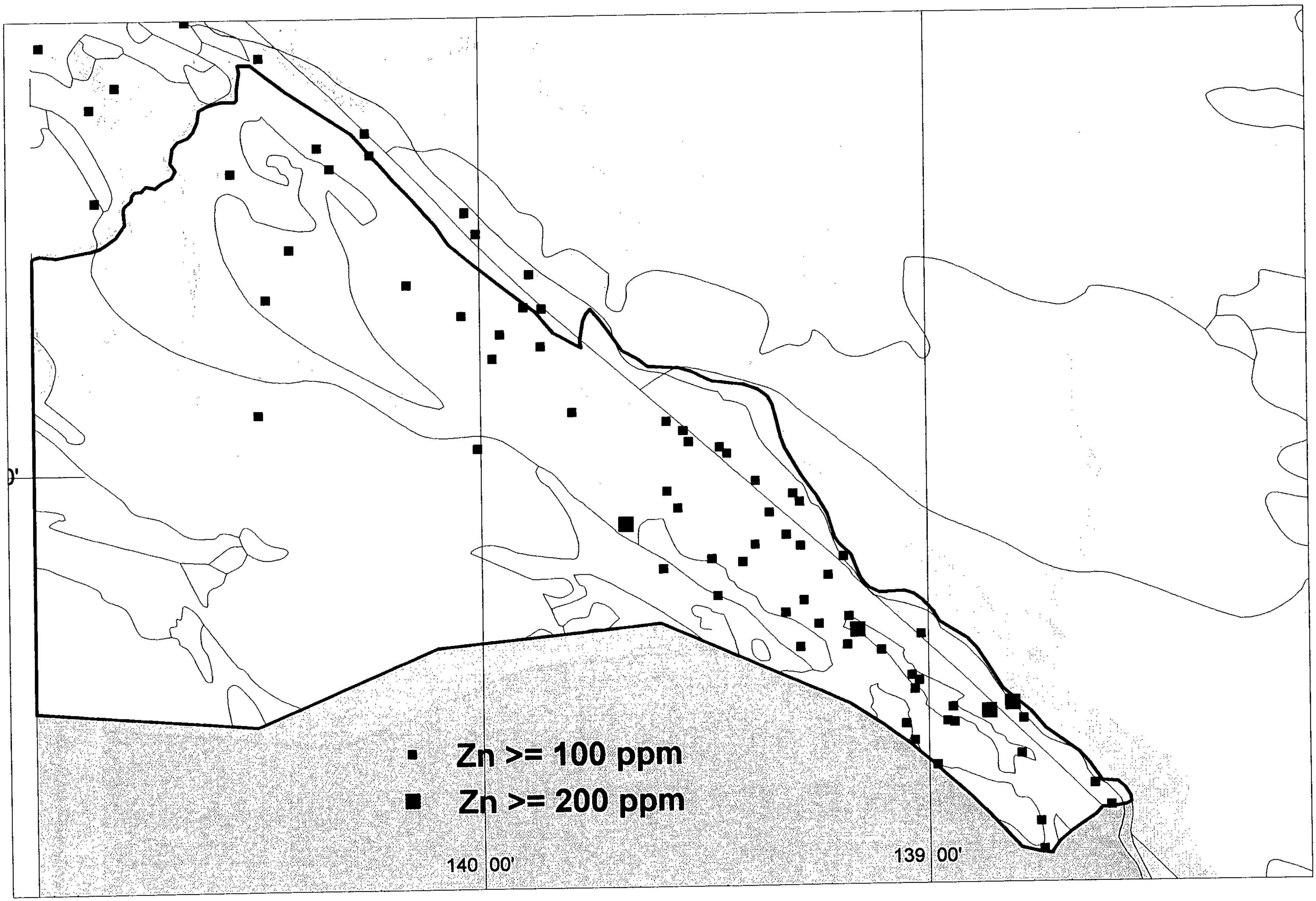

62 00'
61 30'
Sn >= 10 ppm



61 30'
U >= 3 ppm
U >= 10 ppm
140 00'
139 00'



30'
V >= 100 ppm
140 00'
139 00'



0'
Zn >= 100 ppm
Zn >= 200 ppm
140 00'
139 00'