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NAHANNI SYNDICATE PROPOSAL

by

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## INTRODUCTION

Within recent years it has become apparent that the Selwyn basin of eastern Yukon and adjacent parts of the Northwest Territories is one of the important lead-zinc metallogenetic provinces in the world. At least six major stratiform deposits with production potential have been found since 1951. Earliest discoveries of large lead-zinc deposits were made by conventional prospecting near Macmillan Pass (Tom group - Hudson Bay Mining & Smelting Ltd.) and near Ross River (Vangorda - Kerr Addison Mines Ltd.). The first application of airborne geophysics in the region was successful in finding the Swim Lakes ore body (Kerr Addison) near Vangorda in 1964. Further geophysical-geochemical exploration in the same area resulted in the discovery of the large Anvil Mine deposit by Dynasty Explorations Ltd. in 1965. The Anvil find spurred the most active staking rush in Yukon history and between 1965 and 1970 many companies were engaged in preliminary exploration in eastern Yukon. During this period the Fortin Lake deposit was found using geochemical methods by a project under my direction for Atlas Explorations Ltd. Since 1970 exploration activity has decreased and has been confined mainly to development of known properties and to moderate scale ventures by a few persistent companies. One of these companies is Canex Placer Ltd. which in the summer of 1972 made a geochemical discovery of the Nahanni property located northwest of Cantung. The Nahanni find may prove to be the most important yet made in the Yukon and the Selwyn basin has again become the site of intense exploration interest.

I have been engaged in lead-zinc exploration in eastern Yukon since 1966 with Kerr Addison, Atlas, Spartan Explorations Ltd. and as a consulting geologist. Over the years I have come to realize that all major lead-zinc deposits in the Selwyn basin occur in distinctly similar geologic environments and that they have several features in common; the area of the new Nahanni property is no exception. Most of these environments have received preliminary work which has resulted in the discovery of at least one major deposit. There is one, however, which has not yet been explored. It is for the purpose of conducting a thorough exploration project employing the best available techniques within this one remaining geologic environment highly favorable for lead-zinc deposits that the Nahanni Syndicate is being organized.

## GENERAL GEOLOGY OF THE SELWYN BASIN

The Selwyn basin is a division of the eastern tectonic belt of the Canadian Cordillera (Figure 1). The basin contains a thick stratigraphic succession of Proterozoic and Lower Paleozoic predominantly miogeosynclinal metasediments

which have been complexly deformed and intruded by granitic plutons (Fig. 2). Metasediments may be loosely divided into five stratigraphic sequences: Proterozoic, Lower Cambrian, Middle-Upper Cambrian, Ordovician-Silurian-Lower Devonian and Middle-Upper Devonian-Mississippian. Unconformities occur above Lower Cambrian, Middle Cambrian, Lower Ordovician and Lower Devonian strata.

Stratigraphy and plutonic rocks. Oldest rocks make up a thick sequence of phyllitic argillites of Late Proterozoic (Purcell) age lying along the eastern margin of the basin. During the Racklan orogeny, Purcell rocks were tightly folded around northeasterly axes and block faulted and tilted; northeasterly fractures in younger rocks throughout the region and cross folds near Macmillan Pass may reflect these older basement structures. Lying with angular unconformity above Purcell Phyllites is a great thickness of Late Proterozoic (Windermere) slates characterized by gritty feldspathic clastics and areas of medium to high grade metamorphics which are extensively exposed within broad northwesterly-trending structural arches, herein referred to as Proterozoic arches. The boundaries of the Selwyn downwarp became outlined in post-Windermere times with the rise of surrounding positive elements such as the Yukon and Pelly-Cassiar platforms southwest of the Tintina Trench and the Ogilvie and Redstone arches to the north and east; the basin remained a stable tectonic unit until Middle Devonian.

Thin Lower Cambrian limestones and slates have been erosionally removed from much of the eastern Yukon and are overlain by Middle-Upper Cambrian phyllites (variably graphitic, carbonate-bearing and chloritic) exposed along the northeast and southwest sides of the basin. Ordovician, Silurian and Lower Devonian strata make up an assemblage of fine clastics (commonly graphitic or graptolitic) and impure carbonates. An abrupt and persistent facies boundary existed throughout this interval along the eastern side of the basin; carbonates commonly reach maximum thickness east of the boundary and "shale-out" to the west (Fig. 3). Unconformities within this interval indicate westward tilting toward the axis of the downwarp and subsequent easterly bevelling so that younger strata overlies progressively older rocks as they are followed to the east.

The Selwyn basin became an unstable tectonic element in Middle Devonian times as black shales were spread over much of the Yukon and orogeny along the western side of the basin produced local unconformities within a eugeosynclinal assemblage of black cherts, chert pebble conglomerates, graywacke and basic volcanics which are accompanied by ultramafic intrusions near Tintina Trench.

Plutonic rocks of Middle Cretaceous age occur within three arcuate northwesterly-trending belts associated with Proterozoic arches. Intrusions range from diorite to granite with granodiorite predominant. Small stocks

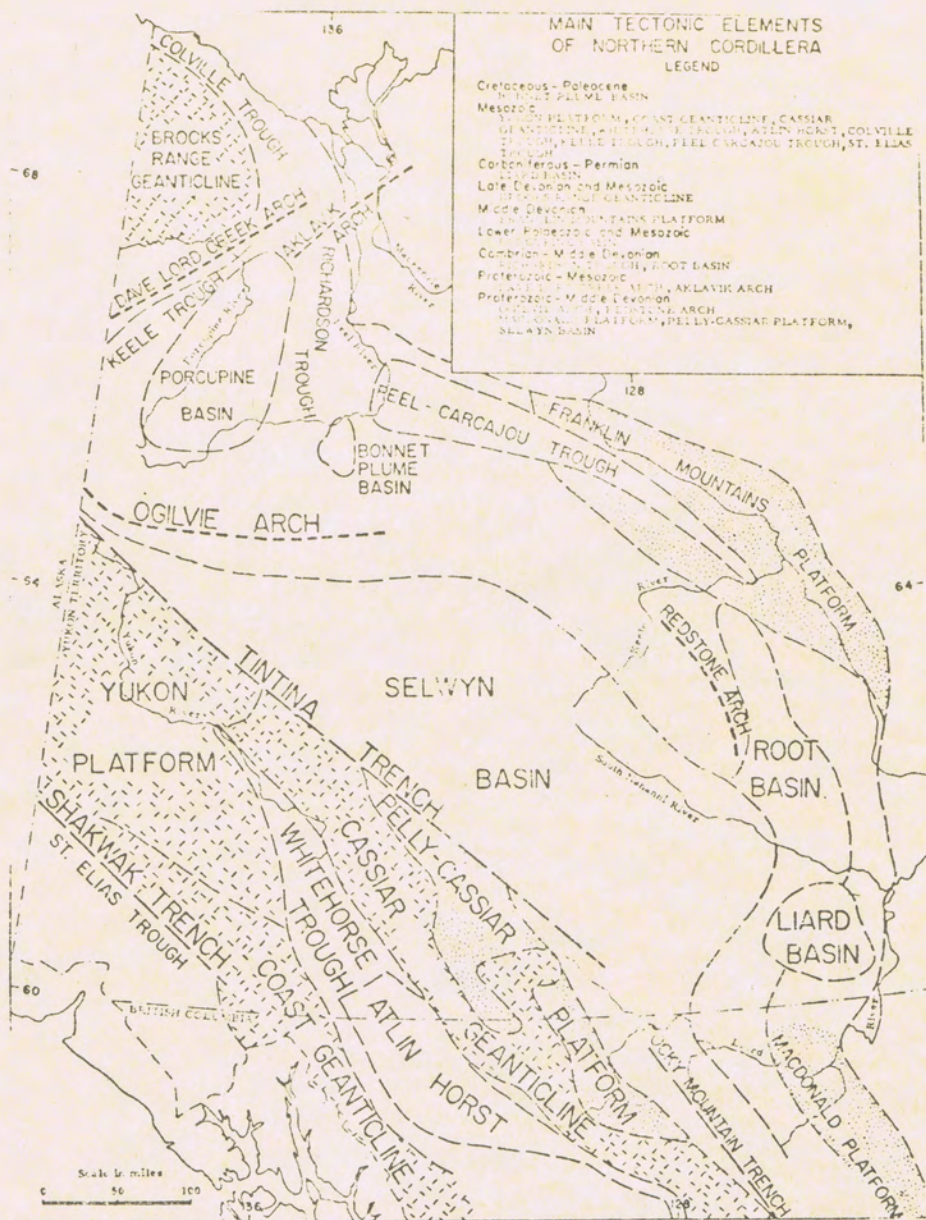


Figure 1. Main tectonic elements of northern Canadian Cordillera.

of quartz-feldspar porphyry, granite porphyry and syenite (commonly with associated minor porphyry copper or molybdenum mineralization) are numerous and locally intrude older plutonics.

Structural geology. Structural features in the Selwyn basin are complex and their trends outline a broad arc, convex to the northeast. The arc is bordered on the northeast by the more simple and continuous structures of the Mackenzie Mountains and is bounded on the southwest by the Tintina Trench. The Tintina Trench is a regional lineament reflected by a persistent topographic depression against which the arcuate structures of the Selwyn basin are truncated. The dominant structural features of the region are three northwesterly-trending Proterozoic arches; one arch lies northeast of the Tintina Trench and appears to be cut off by the trench north of Ross River, another lies along the axis of the Selwyn downwarp and another is located northeast of the Hess-South Nahanni lineament. Medium to high grade metamorphics are common within the arches and belts of granitic intrusions are associated with them. Occurring marginal to Proterozoic arches are several anticlinoria or uplifts of Lower Paleozoic rocks; some are cored by granitic plutons.

The region has a distinctive fracture system made up of northwesterly, northeasterly and north-south lineaments reflected by displacement of geologic features and by topographic trends. The northwesterly set includes the Tintina Trench and the Hess-South Nahanni lineament; the northeasterly set the Ross and Pelly lineaments and the north-south set the Fortin and O'Grady lineaments. The fracture system is similar to that related to the San Andreas Fault and may reflect the influence of right lateral wrench faulting along the Tintina Trench.

Folding is complex in the Selwyn basin and indicates multiple deformation and metamorphism of a heterogeneous stratigraphic succession interrupted by discordant granitic plutons. Recumbent folds overturned to the northeast are common and have been mapped northeast of the Tintina Trench, around Cantung and near Macmillan Pass. The most intense period of orogeny apparently occurred in Middle Cretaceous times and Laramide deformation was of minor importance.

#### STRATIFORM LEAD-ZINC DEPOSITS OF THE SELWYN BASIN

The Selwyn basin contains a variety of mineral deposits which may be broadly grouped into the following classes: stratiform lead-zinc, including massive to banded replacements and fracture fillings; skarns of tungsten, lead-zinc and complex metals; porphyry copper and molybdenum; veins of lead-zinc-silver.

SW

TINTINA TRENCH

SELVYN MTNS.

MACKENZIE MTNS

NAHANNI RIVER

REDSTONE ARCH

CANOL

RAM RIV

ALBIAN-APTIAN VOLCANICS  
REST UNCONFORMABLE ON  
P-C-P-M UNITS EVIDENCE  
FOR COLUMBIAN OROGENY

PELLY PLATFORM

P-C

FRANKLIN MTN

P-C

WINDERMERE  
EQUIV

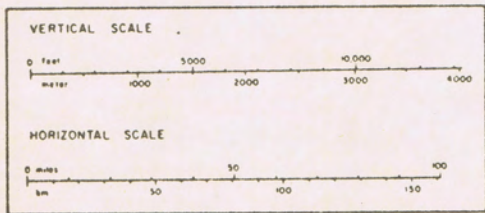


Figure 3. Stratigraphic diagram across Selwyn basin.

Tungsten skarns make up an important economic class and include the Cantung Mine and Mactung deposit (Amax Explorations Ltd.); ore bodies are in Lower and Middle-Upper Cambrian limestones. Lead-zinc skarns such as the Mt. Hundere property (Atlas Explorations) are generally small, mineralogically simple bodies in Cambrian limestones. Complex metal skarn deposits are of small size and occur throughout the Selwyn basin in limestone lenses of Proterozoic age. Porphyry copper and molybdenum showings are of small size and occur associated with stocks intruding Proterozoic metasediments or granitic intrusions. Production from the rich lead-zinc-silver vein deposits of the Keno Hill district (located northwest of the area of Fig. 2) since 1913 has made it one of the leading silver producing districts in the world. Veins cut Cretaceous quartzites and greenstones within a complexly deformed region of Proterozoic metamorphics. Other vein districts of significance have not been found within the Selwyn basin.

Stratiform lead-zinc deposits are the most important economic class in the Yukon. The Anvil district includes three deposits totalling more than 80 million tons of ore averaging greater than 9% combined Pb-Zn and 1oz/ton Ag. The Anvil Mine went into production in late 1969 and is currently operating at 6,600 tons per day. The Kerr Addison deposits at Vangorda and Swim Lakes are of smaller size but have a production potential similar to Anvil.

The Tom group deposit contains greater than 10 million tons of ore in two zones grading about 16% combined Pb-Zn and 3oz/ton Ag. Since 1953, Hudson Bay Mining & Smelting has completed more than 40,000 feet of surface and underground drilling as well as exploratory tunnelling. The Fortin Lake property is a low grade zinc deposit with large tonnage potential. Mineralization occurs within a 90-foot thick host unit which is reflected by a strong geochemical anomaly over three miles long. Results of a two-year diamond drilling program financed by Mitsui Mining & Smelting have not been announced. The Nahanni property contains showings in three areas located along a 25-mile belt. Grades apparently range up to 30% combined Pb-Zn within a host unit which is from 50-150 feet thick. The tonnage potential for high grade ore is obviously great.

Characteristics of deposits. The major stratiform lead-zinc deposits of the Selwyn basin make up a distinct group with regard to their mineralogical, textural, alteration and host rock characteristics (Table I). All are simple in primary sulfide mineralogy containing varying amounts of pyrite (or pyrrhotite), sphalerite, galena and chalcopyrite (or tetrahedrite). Gangue minerals include quartz, carbonates, barite or gypsum. Textures range from massive to banded replacements with fracture fillings in breccia, shear zones or cleavage. Phyllite host rocks in the Anvil district are altered to silica and sericite and carbonate host rocks at the Tom group and Fortin Lake are

altered to silica, barite and dolomite. Host rocks range from carbonate-bearing argillites or phyllites to impure argillaceous carbonate rocks; all host rocks contain significant amounts of graphite or organic material. It is interesting that although host rocks are similar lithologically, they differ in age (a fact which tends to discredit a recent emphasis in exploration which has been placed on stratigraphic correlations): Anvil deposits are in Middle-Upper Cambrian rocks, Nahanni in Lower Ordovician, Fortin Lake in Silurian-Lower Devonian and Tom in Middle-Upper Devonian.

Geologic setting of deposits. In addition to the above similarities, the stratiform lead-zinc deposits share several features in common with regard to their local and regional geologic settings. The following is a discussion of these features.

1. The deposits lie within northwesterly-trending anticlinoria or uplifts which are located parallel and marginal to Proterozoic arches. The anticlinoria bring underlying Lower Paleozoic strata to the surface in the midst of overlying Middle-Upper Devonian strata. Most anticlinoria are associated with granitic intrusions which in some cases make up the core of the structure. The Anvil district lies on the southwest limb of an anticlinorium which nearly parallels the Tintina Trench and has the Anvil batholith as a core. The trench cuts across the neighboring Proterozoic arch which broadens to the southeast. The Tom ore body lies within a region of strong cross folding and granitic intrusion which has produced a group of complex uplifts rather than a simple anticlinorium. It is believed that having lacked the interference of a northeasterly structural grain, tectonic development of the region would have resulted in a broad northwesterly-trending uplift. The Fortin Lake deposit is within the southwest limb near the nose of a plunging anticlinorium which is cored by the Fortin batholith. The Nahanni property is located along the southwest limb of a large narrow anticline projecting northwesterly from a Proterozoic arch. Granitic rocks have not been recognized in the area but it has received only preliminary mapping by the Geological Survey. It is interesting to note that the Mt. Hundere lead-zinc skarn deposit is located in an anticlinoria similar to those mentioned above.
2. The deposits are located near the intersection of pronounced lineaments believed to reflect regional fractures. The Anvil deposits are northeast of the Tintina Trench and are associated with northeasterly linears which terminate against the Anvil batholith. The Tom property is near the intersection of the Hess-South Nahanni lineament and the Ross lineament. Fortin Lake is near the intersection of the Pelly and Fortin lineaments. The Nahanni lineament, as well as another prominent northeasterly linear, passes through the Nahanni property (Fig. 4). There

TABLE I  
CHARACTERISTICS OF MAJOR STRATIFORM PB-ZN DEPOSITS IN SELWYN BASIN

<u>Deposits</u>	<u>Mineralogy</u>	<u>Textures</u>	<u>Alteration</u>	<u>Host Rocks</u>
Anvil Mine Vangorda Swim Lakes	primary sulfides: pyrite, pyrrhotite, sphalerite, galena minor metallics: chalcopyrite, tetra- hedrite, bournanite, arsenopyrite secondary minerals: marcasite, anglesite, goethite, gypsum gangue minerals: quartz, sericite	grade from massive sulfide replacements with faint banding parallel to folia- tion to fine laminated replacements of bedding	irregular envelope of bleached or silicified-ser- icitized phyllites and locally dis- seminated sul- fides from 100-200 feet from ore zones.	Middle-Upper Cambrian quartz-chlorite phyllite, locally graphitic or calcareous; minor chloritic tuff (the three deposits occur at different stratigraphic levels)
Tom Group	primary sulfides: pyrite, sphalerite, galena, tetrahedrite, chalcopyrite (minor) secondary minerals: cerrusite, smith- sonite gangue minerals: quartz, barite, dolomite, calcite	one zone consist of strongly banded ore with replacement laminae of dark color alternating with light colored gangue another zone consists mainly of fracture fillings in sheared zone parallel to stratification	barite and quartz alteration with minor dolomite	Middle-Upper Devonian graphitic limestone and argillite in sequence of cherts, cherty argillites, and chert pebble conglom- erates
Fortin Lake	primary sulfides: pyrite, sphalerite, galena, chalcopyrite (minor) secondary minerals: smithsonite, marca- site gangue minerals: quartz, calcite, gyp- sum, siderite, barite	fracture fillings in breccia and veinlets; disseminated replace- ments; fine laminated replacements of bedding	silicification and pyritization of carbonate rock; minor barite	Silurian-Lower Devonian graphitic dolomite and argillite

TABLE I (Cont'd)  
 CHARACTERISTICS OF MAJOR STRATIFORM PB-ZN DEPOSITS IN SELWYN BASIN

<u>Deposits</u>	<u>Mineralogy</u>	<u>Textures</u>	<u>Alteration</u>	<u>Host Rocks</u>
Nahanni	primary sulfides: sphalerite, galena, pyrite secondary minerals: smithsonite, cerussite gangue minerals: carbonates, quartz, gypsum	fracture fillings in slaty cleavage and fine laminated replacements of bedding.	not known	Lower Ordovician graphitic argillite

are numerous additional lineaments in the eastern Yukon but those mentioned above are among the longest and most obvious.

3. The deposits are located close to facies boundaries which existed during the period of deposition of strata which now act as host rocks for mineralization. Figures 5-10 show the shift of facies boundaries through Lower Paleozoic times. In general, carbonate shelf sediments on the northeast and southwest sides of the downwarp pass into miogeosynclinal shales. The Anvil district is along a boundary shown for Middle Cambrian (Anvil host rocks are Middle-Upper Cambrian) which persisted through most of the Lower Paleozoic. The Tom deposit is located near a boundary which existed through the entire lower Paleozoic including the Middle Devonian, which is the age of Tom host rocks. The Fortin Lake mineralization is in Silurian-Lower Devonian beds; from Upper Ordovician to Devonian the area was located between two facies boundaries although not particularly close to either one. Nahanni host rocks are Lower Ordovician; boundaries pass close to the property for Upper Cambrian through Lower Silurian times.

Cross-sections constructed from drill logs of the Anvil deposits indicate the strong local effect of facies boundaries. Ore bodies are within phyllites northeast of a zone along which phyllites grade into graphitic phyllites. Mapping near the Tom property also suggests that mineralization occurs where host carbonates grade into graphitic carbonates.

4. All deposits except Nahanni are known to occur close to granitic intrusions some of which are small stocks and dykes of granitic porphyry.

Origin of deposits. Although the origin of the Yukon lead-zinc deposits has been debated for several years, I believe that their similarities allow them to be classified as members of a stratiform group which has been recognized throughout the world and on which research during the last decade has pointed to a fairly simple genetic model. Applying the results of this research, it is reasonable to suggest a common process of origin for the stratiform lead-zinc deposits of the Selwyn basin which may be used as an aid in developing concepts for exploration; the following stages are included in a proposed genetic theory.

1. Creation of sulfide-deficient, saline, Na-Ca-Cl brines by selective solution of salts from sediments by connate, metamorphic or magmatic waters circulating at temperatures higher than 100°C within the Lower Paleozoic sediment pile of the basin while it was undergoing orogeny and metamorphism in Cretaceous times.



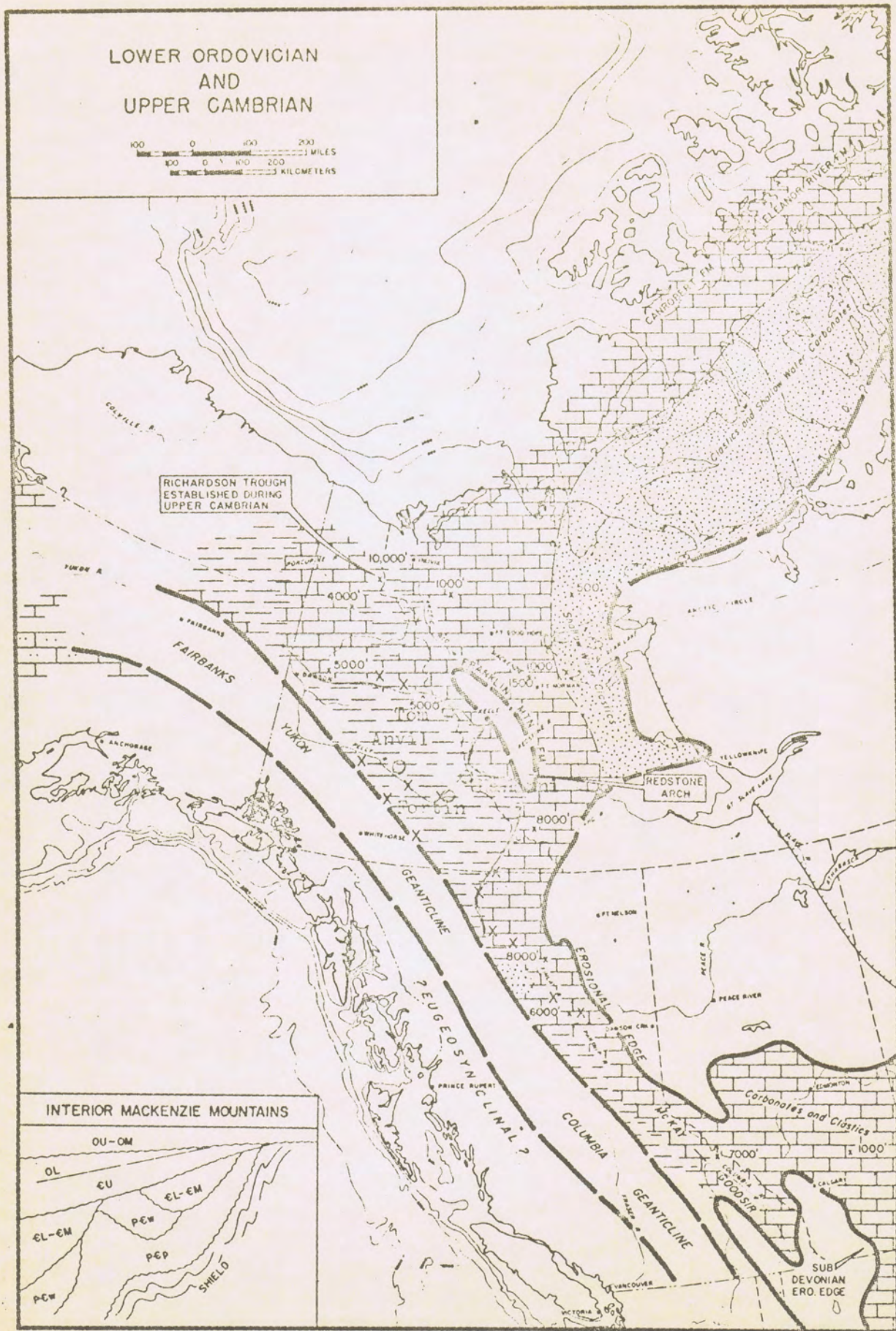


Fig. 6. Interpretative paleogeographic map of western Canada - Upper Cambrian and Lower Ordovician



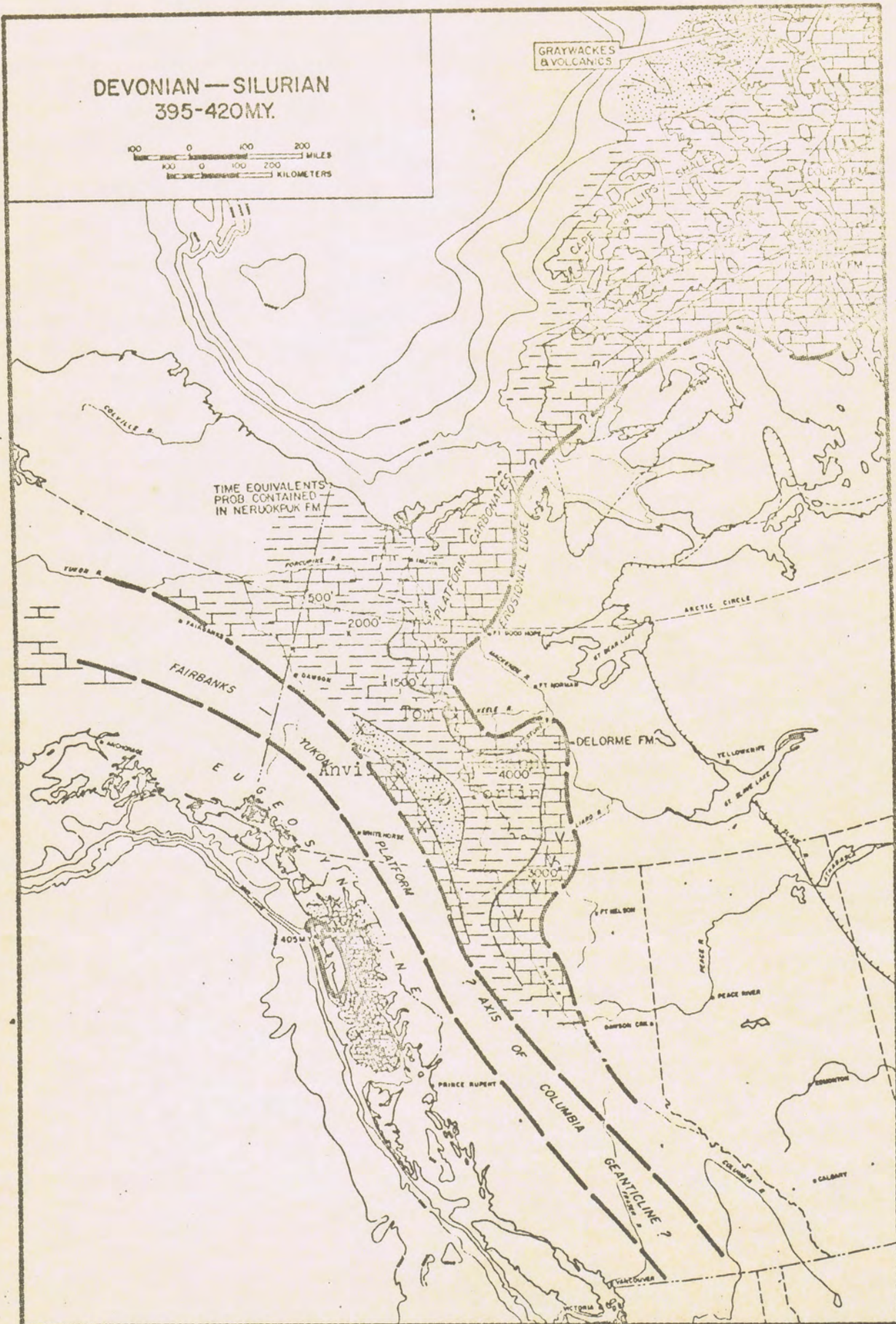


Fig. 8. Interpretative paleogeographic map of western Canada - Silurian and Devonian





2. Selective solution of trace amounts of Pb and Zn (with minor amounts of Cu and other metals) from sediments by the saline brines and transport of metals in chlorine complexes. There is reason to believe that the Lower Paleozoic sediments of the basin are unusually rich in trace amounts of Pb and Zn as are beds of similar age in other parts of the world.
3. Migration of brines upward from deeper levels of the basin through fracture zones and more permeable strata under the influence of temperature and pressure gradients created by orogeny and metamorphism. The localization of deposits near major lineaments and their intersections implies that migration of brines through fracture zones may have been more important than migration within certain stratigraphic units; this suggestion is further strengthened by the fact that deposits occur at different levels in rocks of different ages ranging from Middle-Upper Cambrian to Middle-Upper Devonian.
4. Under proper temperature and pressure conditions, metal-charged brines may have mixed with sulfide-rich waters derived from black shales or encountered reducing environments where sulfide was released from organic matter causing precipitation of pyrite, galena and sphalerite; the influence of increased pH in carbonate rocks may have also been operative in causing precipitation. The presence of organics and carbonates in host rocks of all major deposits indicates the importance of these chemical barriers in localizing mineralization. Ore bodies in the Anvil district clearly show the effect of the facies boundary grading from phyllites into graphitic phyllites as a stratigraphic or chemical trap against which deposition probably occurred. Mineralization at the Tom property is in limestones which appear to become richer in organics along strike from ore zones. It is possible that the observed localization of deposits within anticlinoria or uplifts associated with granitic intrusions indicates that these structures had a range of temperature and pressure which was favourable for deposition of sulfides.

In summary, it is reasonable to conclude that the similarities in mineralogy, texture, alteration, host rock lithology and structural-stratigraphic setting of the deposits is not fortuitous and is a reflection of a process of origin which is common to all of them. This reasoning strengthens the argument that exploration for other stratiform Pb-Zn deposits should be directed to geologic environments which resemble those of major deposits.

## EXPLORATION METHODS

Much of the Selwyn basin has received preliminary prospecting by conventional methods but stratiform lead-zinc mineralization may be difficult to recognize and it is believed that many favorable areas have been walked over. This fact became apparent to Canex Placer prospectors during the Nahanni find; most mineralization is not visible and heft of the rock became the only reliable field method available to them for finding metal-bearing rock.

The only deposits which are known to respond to geophysical methods are massive sulfide ores in the Anvil district. Ore at the Tom group and Fortin Lake is not sufficiently massive to respond to electromagnetics or to gravity methods and magnetic minerals do not occur.

The only indirect exploration technique which has successfully shown all deposits (except Swim Lakes, most of which is deeply buried) is geochemistry. The Anvil and Vangorda ore bodies respond well to Pb-Zn-Cu stream silt and gossan sampling. The Tom property responds to Pb-Zn-Mo soil sampling although the stream draining the mineralized area is so acidic that Zn is "carried over" and is not detectable in silts; another peculiarity is that silts are strongly diluted by talus chips which causes Pb to be detectable only in coarser fractions. The Fortin Lake deposit is reflected in an intense soil anomaly as well as in silts and small gossans. The locale of the Nahanni property was found by high Pb results in silts and mineralization was located by using Pb-Zn bedrock geochemical techniques.

Because of the presence of organic-rich black shales containing unusually high trace amounts of metals in many parts of the Selwyn basin, geochemical results may be confused by non-significant anomalies. Trace element analyses of samples from a region of Lower Paleozoic strata in the eastern Yukon (Fletcher, 1971; Doyle, 1971) demonstrates that zinc and several of its possible pathfinder elements (molybdenum, vanadium, copper, nickel, chromium, cobalt, manganese and strontium) occur in patterns related to outcrop of beds high in background metal content and probably are not usable as indicators of mineralization. Zinc geochemistry is further confused by broad dispersion patterns caused by its high mobility in surface waters. In addition, in acid streams (pH lower than 5) draining pyrite-rich bedrock or mineralized areas, zinc does not precipitate or adsorb on clays or Fe-Mn oxides in silts but is carried over to come out of solution in waters of higher pH - sometimes several miles from the source.

Lead is a relatively insoluble element in surface environments and as such is found close to its source in the detrital fraction of stream silts. It has been found that Pb may be masked by dilution of non-mineralized material, such as at the Tom property, but that anomalous values may be obtained by analyzing fractions coarser than 80 mesh.

I have used geochemical exploration methods in conjunction with geologic mapping for several years in the search for lead-zinc ore in the Selwyn basin. I have conducted research in the field with Dr. R.E. Delavault, Professor of Geochemistry at the University of British Columbia, and have contributed to research by Dr. K.W. Fletcher, Assistant Professor of Geochemistry at U.B.C. I have come to believe that the best method of geochemical prospecting in the Selwyn basin consists of analyzing stream silts taken at  $\frac{1}{4}$ - $\frac{1}{2}$  mile intervals for Pb, Zn and other possible pathfinder elements combined with bedrock geochemical analyses of areas which are geologically mapped on a scale no greater than 1"= $\frac{1}{2}$  mile. Lead should be analyzed from three or four mesh sizes of 80 mesh and greater. Streams should be tested for pH at all sample stations. Geologic information should be co-ordinated with bedrock geochemistry and both should be applied in the interpretation of geochemical silt results.

#### NAHANNI SYNDICATE PROJECT AREA, METHODS AND PERSONNEL

Project area. The Nahanni Syndicate project will be conducted within an area of about 1000 square miles bounded by the South Nahanni River on the southwest, the Broken Skull River on the east and the O'Grady batholith on the north (Fig. 4). This area is a highly favorable geologic environment which is strikingly similar to those associated with the major Pb-Zn deposits of the Selwyn basin and includes the following characteristics which are in common with the environments of the major deposits. (1) The project area is made distinct by the presence of three northwesterly-trending anticlinoria which are parallel and marginal to a broad section of Proterozoic arch. (2) Strata folded into the structures consist mainly of carbonates and fine clastics and range in age from Proterozoic to Middle-Upper Devonian; included are all systems acting as host rocks for mineralization at the major deposits. (3) The project area is bounded by two pronounced lineaments - the Hess-South Nahanni on the west (the Tom group is north of the area along this structure) and the Broken Skull Fault on the east. It includes an area of intersection with the Nahanni lineament (which passes through the Nahanni property) and other northeasterly fractures as well as the O'Grady lineament and related fractures. (4) The most persistent facies boundary in the Selwyn basin, which is reflected in all Lower Paleozoic systems, passes through or near the area; the Tom group is located near this boundary. (5) Granitic intrusions occur adjacent to the area to the southeast, west and northwest; two granitic plutons have been mapped within the area and a small body of quartz latite porphyry crops out to the north.

The project area has received little attention from prospectors. Most work in the region has been devoted to tungsten prospecting north of Cantung, preliminary coverage by the Mackenzie Syndicate in the early 1960's, recent

exploration by Canex Placer to the west and a 1972 venture by Arrow Inter-America Corp. centered at O'Grady Lake northwest of the project area. The area is relatively accessible, lying centered about 35 miles north of Cantung which may be reached by all-weather road from Watson Lake on the Alaska Highway. Float-equipped aircraft may land on the broad South Nahanni and Broken Skull rivers as well as on several small lakes scattered through the region. Elevations range from 2500 to 7000 feet and rock exposure is almost total except for glacial covered river valleys which support buckbrush and small trees. Exploration season is generally from early June to late September or early October.

Methods and personnel. The goal of the Nahanni Syndicate will be to conduct a thorough reconnaissance examination of the project area with a nine-man crew during a three and one-half month field season (June 15 - September 30, 1973) and to locate and stake targets worthy of additional work to be undertaken the following season.

The crew will be made up of project manager, three geologists, three geochemical samplers, a camp manager-draftsman and a cook. (In addition, there will be a two-man helicopter crew supplied by a helicopter contractor). Crews will consist of geologist and geochemical sampler and will be set out on traverses each day and brought in to base camp each evening. Base camps will be moved perhaps every three-four weeks in order to provide the best access to the entire project area. Sixty days will be allotted to reconnaissance coverage, 25 days to follow-up and detailed coverage and 20 days to camp moves, bad weather and general contingencies.

Based on my experience with all of the major deposits in the region, I believe that any of them could have been discovered (either geologically or geochemically) with traverses, running at right angles to the strike of the deposits, spaced a minimum of two-three miles apart. Looking for similar deposits in an area of good outcrop, I believe that using a two-mile traverse spacing would be more than adequate. Because the targets are stratiform bodies and the strike of the rock units is generally northwesterly, traverses should be run northeasterly. The project area is about 50 miles long and averages about 20 miles across. Using a traverse spacing of two miles, this means 25 traverses of about 18 miles or a total of about 450 line miles of traverse. Using a period of 60 days, this is an average of  $7\frac{1}{2}$  miles of traverse per day, or  $2\frac{1}{2}$  miles per crew per day. This is believed a reasonable figure in outcrop country with a minimum of underbrush.

Geologists will be expected to gather detailed information particularly with regard to rock type variations and stratigraphic characteristics. Bed-rock geochemical samples will be taken at intervals corresponding with rock variations and streams will be silted at intervals of  $\frac{1}{4}$ - $\frac{1}{2}$  miles. Rock units will be correlated along strike and variations in lithology and chemistry along strike will be the primary means of defining target areas for follow-up work.

BUDGET ESTIMATE

## I) TRANSPORTATION

## A) Fixed-wing flights (Beaver aircraft)

- 1) Base camp moves - assume putting in base camp, three moves during season and pulling out camp. (Flight distances: Watson Lake to Flat Lake and return is 400 mi.; Flat L. to center of project area and return is 70 mi.; total mileage estimate of about 4000 mi.)
- @ \$1.00 / mi. . . . . \$ 4,000
- 2) Weekly supply flights - assume 12 flights of 400 mi.; total mileage estimate of about 5000 mi.
- @ \$1.00 / mi. . . . . 5,000
- 3) Transport of helicopter fuel - assume require 120 - 45 gal. drums; total mileage estimate of about 4000 mi.
- @ \$1.00 / mi. . . . . 4,000

## B) Fixed-wing flights (Cessna 180 aircraft)

- 1) Visits to project by Syndicate members and occasional trips by project manager; assume six flights of 400 mi.; total mileage estimate of 2500 mi.
- @ \$0.80 / mi. . . . . 2,000

## C) Helicopter (assume G3B1)

- 1) Contract for 3½ mo. season with minimum of 80 hours/month; total project estimate of 300 hours
- @ \$140.00 / hr. . . . . 42,000
- 2) Fuel purchase; assume require 120 - 45 gal. drums
- @ \$27.00 / drum . . . . . 3,200

## D) Shipment of equipment and non-perishable food from Vancouver to Flat L. and return of equipment

. . . . . 1,000

## E) Mobilization and demobilization of personnel from Vancouver to Watson Lake; nine men plus occasional trips by project manager; assume 22 one-way trips

@ \$125.00 /man/trip . . . . . 2,700

\$63,900

Say \$64,000

## II) PERSONNEL

## A) Salaries

Project manager @ \$100/day	.....	\$10,500	
Camp manager @ \$1,000/mo	.....	3,500	
3 geologists @ \$3,000/mo.	.....	10,500	
3 geochemical samplers @ \$2,100/mo.	.....	7,350	
Cook @ \$700/mo.	.....	<u>2,450</u>	
			\$34,300

Benefits (Workmans Compensation, Unemployment Insurance, etc.); assume 15% of salaries total	.....		5,100
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## B) Subsistence

Total crew of 11 men (including helicopter crew); costs for food, general camp maintenance

@ \$10.00/man/day	.....		11,500
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## C) Pre- and post-field expenses

Project co-ordination, personnel hiring, report writing, etc.; assume 40 man-days for project and camp managers

@ \$50.00/day	.....		2,000
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D) Accounting-Legal	.....		<u>2,000</u>
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\$54,900

Say			\$55,000
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## III) SERVICES - PURCHASES

## A) Geochemical laboratory costs

- 1) Silt samples - taking samples an average of  $\frac{1}{4}$  mi. apart along traverse lines; assume total of 2000 samples to be run for Pb and Zn

@ \$1.30/sample ..... \$ 2,600

- 2) Bedrock samples - assume total of 4000 samples to be run for Pb, Zn, Cu and Ag

@ \$1.90/sample ..... 7,600

## B) Geochemical consultant

Dr. K.W. Fletcher; assume total of 10 days of field consulting

@ \$100.00/day ..... 1,000

- C) Purchase of air photographs of project area, maps, drafting and office supplies; rental of binocular microscope

..... 1,500

## D) Communications and expediting

Rental of single-side-band radio with generator; expediting services from Watson Lake

..... 4,000

## E) Purchase of field equipment

..... 4,000

\$20,700

Say \$21,000

## IV) CONTINGENCIES

A) Staking of 100 claims \$ \$100.00/claim	.....	\$10,000
B) General budget contingency	.....	<u>10,000</u>
		\$20,000

BUDGET TOTALS

Transportation	\$ 64,000
Personnel	55,000
Services - Purchases	21,000
Contingencies	<u>20,000</u>
GRAND TOTAL	\$ <u>160,000</u>

## NAHANNI SYNDICATE STRUCTURE

The Nahanni Syndicate will be capitalized with \$160,000 (see Budget for details) to be divided into eight units of \$20,000 each. One additional unit is to be granted to Dr. C.L. Smith as consideration for organization and management of the Syndicate. A Syndicate member may purchase one or more units.

Following completion of the Syndicate stage, claim groups may be transferred to a debt-free, private, specially limited company incorporated in British Columbia. The maximum stock allowed by the B.C. Securities Commission will be issued to Syndicate members in amounts equivalent to their unit holdings in the Syndicate. The private company shall have the discretion to be converted to a public company within a reasonable period of time.

Under terms of the Northern Mineral Assistance Grant, up to 40% of the exploration costs on mining properties located in the Yukon and Northwest Territories may be recovered by Canadian companies. Exploration costs recovered by the Syndicate may be placed in the treasury for further work or distributed back to members.

RESUME

Clyde L. SMITH, Ph.D., P.Eng.

R.R. # 1 - Bluff Road  
Galiano Island

Age: 35  
Married, three children

Positions Held:

Nov. 1969 - Consulting Geologist - Clyde L. Smith Consultants Ltd.  
Present

Major clients and projects: Quintana Minerals - evaluation base metal deposit, Yukon; Nippon Mining of Canada - financed a porphyry copper exploration syndicate organized by self, central Vancouver Island; Cities Service Minerals - literature research study of copper deposits and exploration potential of western Canada, also numerous property evaluations; Skyline Explorations - financed syndicate organized by self to evaluate several high grade copper properties on Vancouver Island; Consulting responsibility and management of large silver mine in Durango, Mexico (Aprovechamiento Minero) for Canadian and Mexican clients.

Dec. 1967 - Director and Exploration Manager - Spartan Explorations Ltd.  
Nov. 1969

Responsibilities: Management of lead-zinc, tungsten and porphyry copper-molybdenum exploration projects in eastern Yukon (one year); porphyry copper projects, northern Vancouver Island and Highland Valley (half year); detailed studies and diamond drilling of porphyry copper and lead-zinc deposits in Stikine River and Cassiar regions (half year). Also, numerous property examinations and direction of smaller projects in several areas of Yukon, B.C., and western U.S.

Sept. 1966 - Chief Geologist - Atlas Explorations Ltd.  
Dec. 1967

Major responsibilities: Geologic supervision of two lead-zinc exploration projects in Anvil region and central Yukon. Large zinc deposit (Fortin Lake) discovered by project under direction of self; deposit drilled under joint venture with Mitsui Mining.

June 1965 - Senior Geologist - Kerr Addison Mines Ltd.  
Sept. 1966

Major responsibilities: Geologic supervision of detailed studies and diamond drilling of porphyry copper-molybdenum deposit in Stikine River region (half year) and reconnaissance lead-zinc exploration project, Anvil region, Yukon (one year).

Sept. 1963 - Geologist - Division of Lands & Minerals, State of Minnesota  
 July 1964

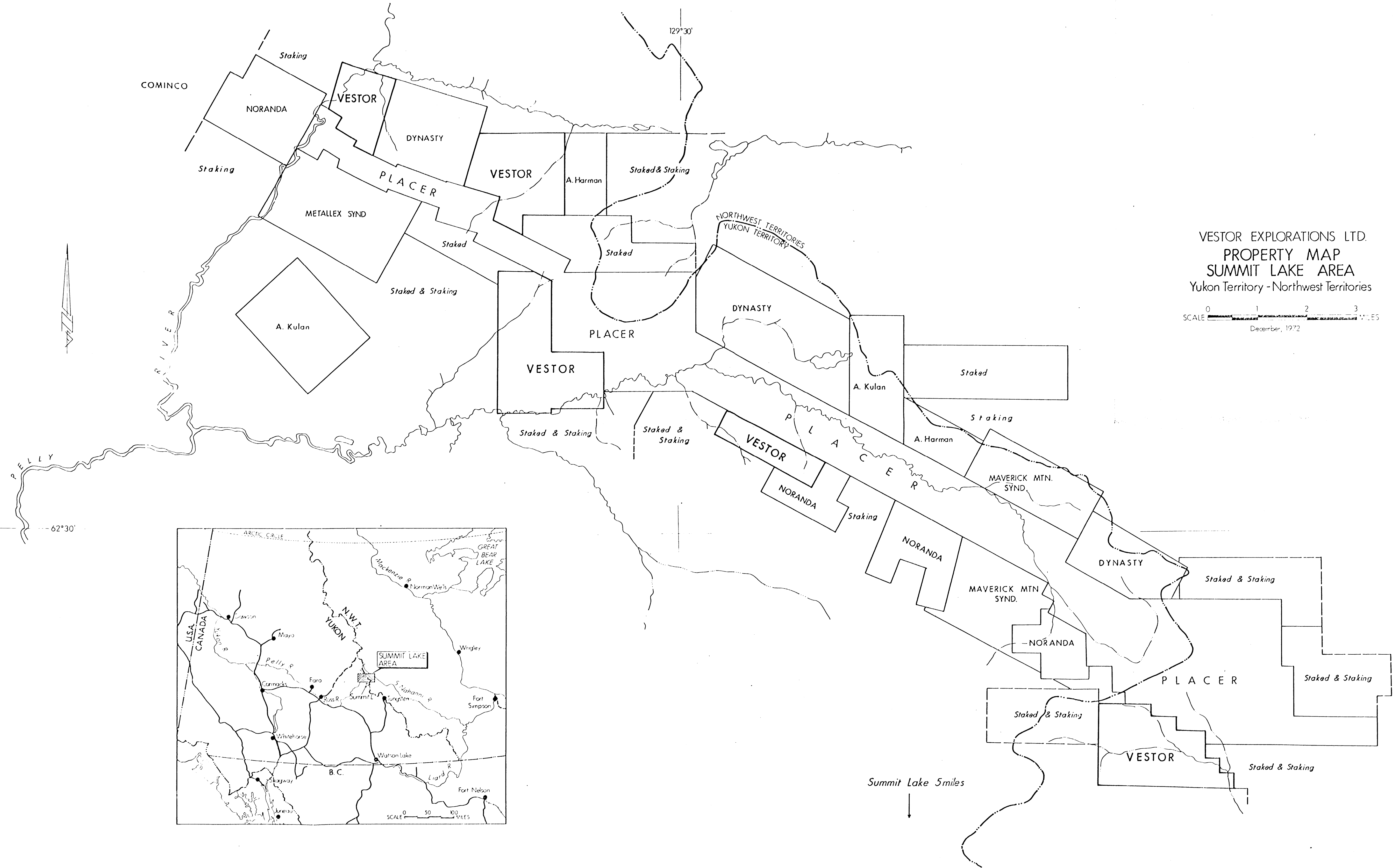
Conducted literature study of mineral potential of several counties in northern Minnesota.

Summer Work:

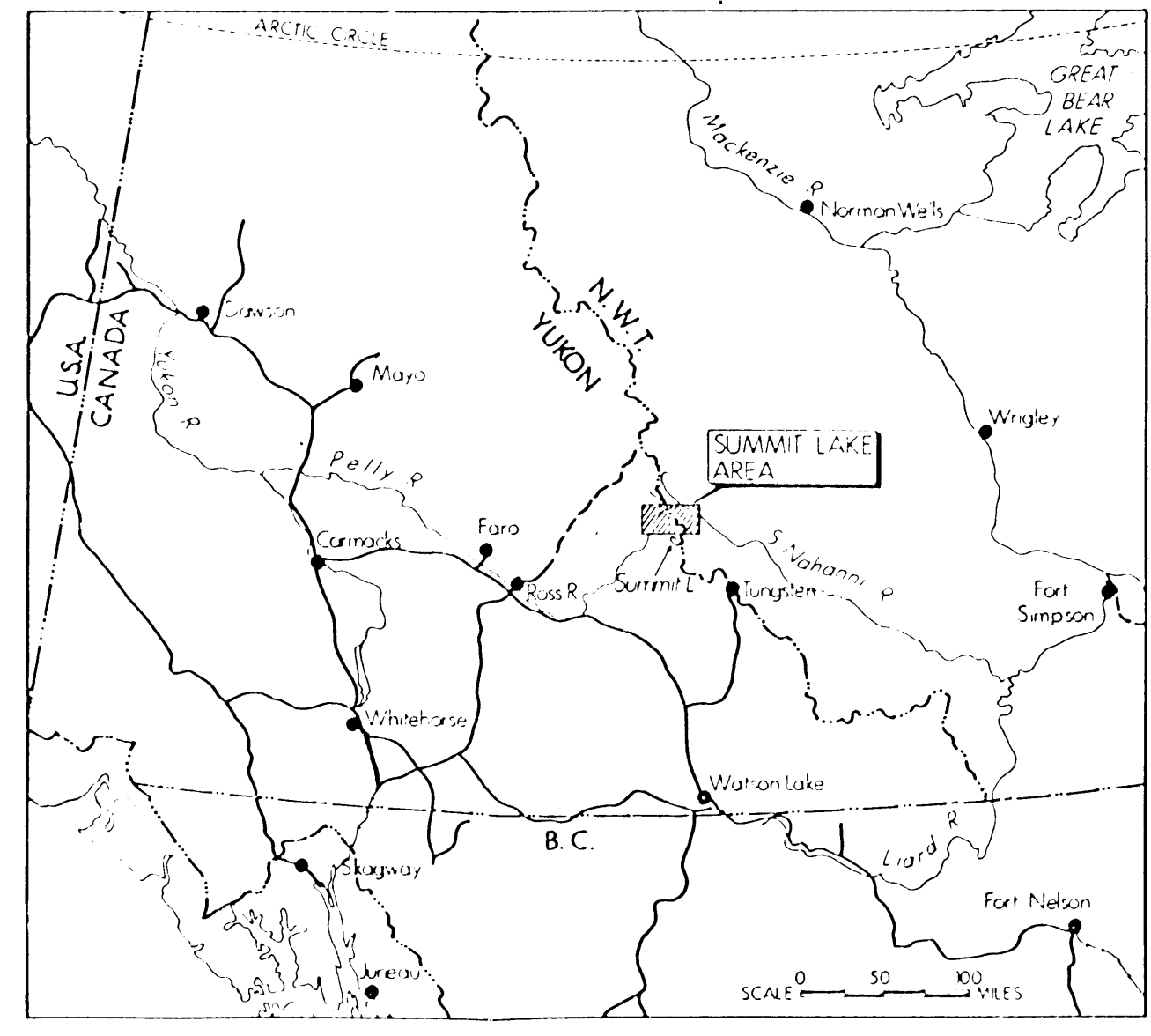
- 1964, 1963 Geologic mapping of 200 sq.mi. Ph.D. thesis area in south-central Idaho under research grants from National Science Foundation and Idaho Bureau of Mines and Geology. Thesis involved structural geology of basin-range faulting and stratigraphy and petrology of Tertiary volcanics along southern margin of Idaho batholith.
- 1962 Senior Geologist, Amax Explorations Ltd. Geologic mapping of porphyry molybdenum deposit and surrounding areas on Hudson Bay Mt., Smithers, B.C.
- 1961 Geologist, Amax Explorations Ltd. Reconnaissance porphyry molybdenum exploration in large parts of Alaska Range.
- 1960 Geologist, Division of Mines & Geology, State of Washington. Study of limestone deposits of western Washington and M.Sc. thesis mapping of late Paleozoic limestone formations.
- 1959 Geologist, Jones & Laughlin Steel Corp., Negaunee, Michigan office. Geologic mapping and magnetic study of Pre-Cambrian iron deposits, west-central Wisconsin.
- 1958 Assistant to University of Illinois Ph.D. candidate doing thesis mapping of igneous and metamorphic geology, coast of Maine.
- 1957 Magnetometer operator, U.S. Steel, Duluth, Minnesota office. Magnetics in Cuyuna Range and Mesabi Range areas, Minnesota.

Education:

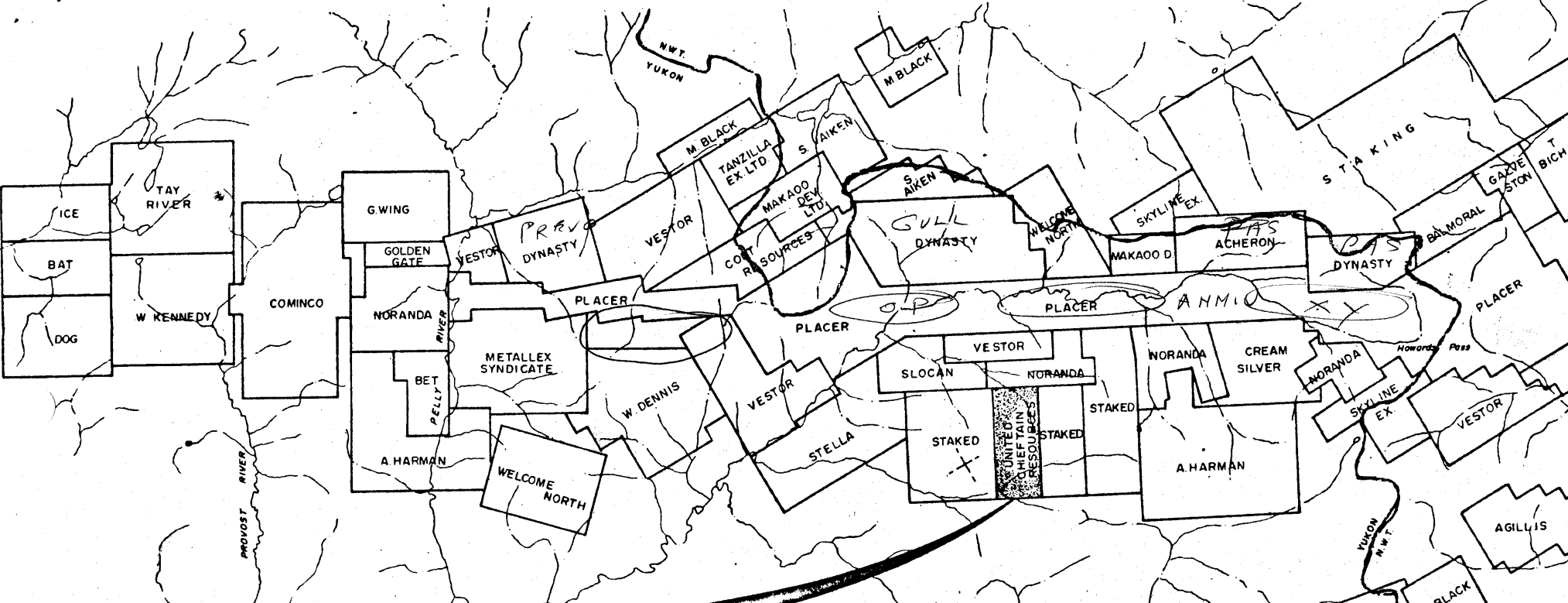
- 1964-65 and 1962-63 University of Idaho, Ph.D. received, 1966. Emphasis on economic, volcanic and structural geology and mining engineering.



VESTOR EXPLORATIONS LTD.  
 PROPERTY MAP  
 SUMMIT LAKE AREA  
 Yukon Territory - Northwest Territories  
 SCALE 0 1 2 3 MILES  
 December, 1972



Summit Lake 5 miles  
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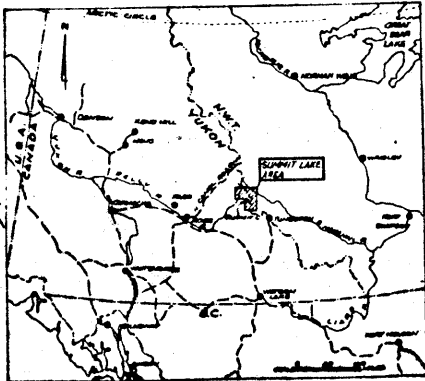


**United Chieftain Resources Ltd.  
N.P.L.**

YUKON AND NORTH WEST TERRITORIES

**PROPERTY  
MAP  
of Summit Lake Area**

POT DRAFTING SERVICES, VANCOUVER, B.C.



THIS MAP HAS BEEN  
COMPILED FROM A RELIABLE  
INFORMATION, BUT EXACT  
LOCATION AND OWNERSHIP  
CLAIMS IS NOT GUARANTEED

MARCH 1973