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GEOLOGICAL SURVEY OF CANADA

SHORT PAPERS CONTAINING RESULTS OF ECONOMIC INTEREST DERIVED FROM 1973 FIELD WORK IN THE NORTHWEST TERRITORIES AND YUKON

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O.F. 175:

The following short papers that will appear in the Report of Activities Part A, to be published in January 1974 are being given an earlier release on Open File as they contain material of possible economic interest that will be discussed at the forthcoming meetings of the Yukon and Northwest Territories Chambers of Mines:

Watterson Lake (west half) and Ferguson Lake (west half) map-areas, District of Keewatin; K.E. Eade and F.W. Chandler.

Geology of the Indin Lake area (86B), District of Mackenzie; R.A. Frith, Rosaline Frith, H. Helmstaedt, J. Hill and R. Leatherbarrow.

Bear Province lithogeochemical survey; R.G. Garrett.

Volcanism and plutonism, Sloan River map-area (86K) Great Bear Lake, District of Mackenzie; P.F. Hoffman and M.P. Cecile.

Archean volcanic studies in the Slave-Bear Province; M.B. Lambert.

Structural and stratigraphic studies in the northern Canadian Cordillera; D.K. Norris.

Penrhyn Group Metamorphic Complex, Melville Peninsula, District of Franklin; J.E. Reesor.

Gamma-ray spectrometry investigations 1973; K.A. Richardson and B.W. Charbonneau.

Volcanic stratigraphy and metallogeny of the Kaminak Group, Spi Lake area, District of Keewatin; R.H. Ridler.

Volcanic rocks of the Prince Albert Group; Mikkel Schau.

Stratigraphy and structure of Pelly Mountains; D. Tempelman-Kluit; G. Abbott and B. Read.

Follow-investigations on the Bear-Slave geochemical operation; E.M. Cameron and C.C. Durham.

Geological Reconnaissance of Northern Melville Peninsula, District of Keewatin (Parts of 47A, B, C, D); W.W. Heywood.

Geology of the Calder River map-area, District of Mackenzie (86F); J.C. McGlynn.

Paragneisses of the Prince Albert Group; F.H.A. Campbell.

Drift prospecting in the Ennadai-Rankin Inlet Greenstone Belt, District of Keewatin; W.W. Shilts.

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CONTENTS

WATTERSON LAKE (WEST HALF) AND FERGUSON LAKE (WEST HALF) MAP-AREAS DISTRICT OF KEEWATIN

K.E. Eade and F.W. Chandler

The continuation of this project, a study of the stratigraphic and structural relations of the Precambrian rocks in the southern District of Keewatin, is intended to enhance the knowledge of the Precambrian geology and to assess the mineral potential of areas previously mapped on a scale of 1 inch to eight miles (Wright, 1967). The mapping, for publication on a scale of 1:250,000 combined helicopter and ground traversing.

Ferguson Lake map-area (65 I west half)

West and north of Imikula Lake, in the south central part of the map-area Aphebian Hurwitz Group rocks consist for the most part of impure quartzite to subgreywacke or quartz-mica schist probably correlative with the uppermost unit of the Hurwitz Group in the area to the south (Eade, 1964). Dolomite, phyllite, and orthoquartzite of the Hurwitz Group occur in only a few places, close to Imikula Lake.

The southeast part of the map-area consists of a mixed assemblage of granodiorite gneiss and paragneiss, probably of Archean age, in part migmatized and partially assimilated by quartz monzonite of probable Aphebian age.

Metavolcanic rocks, ranging in composition from basalt to rhyolite are present in northeastward-trending band approximately four miles wide in the southern part of the map-area intersecting the south end of Yathkyed Lake. Cherty magnetite iron-formation and chert-pyrite beds are associated with the metavolcanic rocks. To the south of the southwest corner of Tyrrell Arm of Yathkyed Lake, close to the southeast boundary of the metavolcanic rocks, chert-pyrite beds with total thickness ranging from 50 to 80 feet have been traced over a strike length of four miles. Metabasalts occurring on islands in the northern part of Yathkyed Lake are part of a separate band of metavolcanic rocks.

To the northwest of the main metavolcanic band are northeast trending quartz-feldspar-biotite paragneiss to migmatitie, in part garnetiferous, with some accompanying bands of amphibolite. Numerous small zones of pyrite and pyrrhotite mineralization occur in the amphibolite bands. A small pluton of adamellite intrudes these rocks near the east boundary of the map-area.

An east-west fault at 62°45' N is the north boundary of the paragneiss and migmatite bands. To the north of this fault the major rock type is hornblende-biotite gneiss ranging in composition from granodiorite to quartz diorite and trending east to northeast. Within the gneiss are some amphibolite bands, derived at least in part from metavolcanic rocks. Metagabbro dykes and sills intrude the gneisses.

These gneisses are bounded on the north by another east-trending fault at approximately 62°52' N latitude. North of this fault and extending to the north boundary of the map-area is a mixed assemblage of gneisses of granodiorite to quartz diorite composition, with some amphibolite, cut by a diorite to quartz diorite pluton and some small plutons of syenite to monzonite composition. The syenite and monzonite are probably equivalent to the Martel syenite occurring in the map-area to the east (Bell, 1971).

Watterson Lake map-area (65 G west half)

Hurwitz Group rocks are restricted to the southern half of the map-area, in a north-south elongated basin, centred on Watterson Lake and in a north-south striking belt in the extreme southwest. The stratigraphy in the basin, in ascending order is as follows:

(a) greywacke paraconglomerate of very restricted distribution;
(b) white orthoquartzite;
(c) phyllite and paper slate, intruded by a meta-gabbro sill;
(d) cream weathering dolomite;
(e) shale, slate, phyllite, siltstone;
(f) rusty weathering dolomite;
(g) fine-grained, cleaved greywacke;
(h) light grey arenite.

The axial plane of the basin dips westward and lower units are partly faulted out on the west side of the basin.

The southwestern belt of Hurwitz Group rocks is bounded on the west and north by faults and continues southward out of the map-area (Eade, 1973). Units (a) to (c) above are recognizable but the upper part of the section is represented by undivided biotite schist, biotite metasandstone, hornblende-bearing calc-silicate rock and minor magnetite iron-formation.

Sedimentary rocks of probable Aphebian age, occurring near Bate Lake in the eastern part of the map-area, consist of dolomite and phyllite overlying arkose to subgreywacke. The dolomite and phyllite are contiguous with that mapped in the area to the east (Eade, 1966) but the arkose to subgreywacke was not found there. A similar succession, arkose to subgreywacke, dolomite and phyllite, and their metamorphosed equivalents, occurs to the south, about six miles north of Watterson Lake. There, they are close to the Hurwitz Group rocks but the stratigraphic relations are unknown.

A band of basic metavolcanic rocks, five miles northeast of Watterson Lake is a continuation of those rocks from north of Griffin Lake in the map-area to the east (Eade, 1966). On the north side of the band in this map-area, a zone of ultrabasic composition, with spinifex texture was recognized. These rocks have some associated pyrite and pyrrhotite mineralization.

The metavolcanic band south of Sutcliff Lake, on the reconnaissance map (Wright, 1967), which extends to the east north of Bate Lake (Eade, 1966) continues to the west and northwest as a band $1\frac{1}{2}$ to 2 miles wide. It passes three miles north of Boland Lake and then swings to the northwest and north, crossing the north boundary of the map-area at longitude $99^{o}45'$ W. The rocks range in composition from metabasalt to rhyolite but there are more rocks of acid to intermediate composition in this band than are found in the other volcanic bands of these map-areas. Small occurrences of pyrite and pyrrhotite mineralization are abundant in these rocks.

In the north part of the map-area, around longitude $99^{o}15'$ W, lies a northeast-trending band of metagreywacke of probable Archean age. To the east, the greywacke passes gradationally into paragneiss but on the west it is intruded by a north-trending body of fresh anorthosite approximately $1\frac{1}{2}$ miles wide. To the west of the anorthosite, occurs paragneiss with some amphibolite bands.

The north-central part of the map-area, east of Boland and Hicks Lakes consists of biotite granodiorite gneiss and quartz-plagioclase-biotite paragneiss intruded by plutons of quartz monzonite to granite.

These plutons are, in part at least, of Aphebian age.

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GEOLOGY OF THE INDIN LAKE AREA (86B) DISTRICT OF MACKENZIE

R.A. Frith, Rosaline Frith[1], H. Helmstaedt[1], J. Hill[2], R. Leatherbarrow[3]

Introduction

During the 1973 field season geologic mapping was carried out in the Grenville Lake and Cotterill-Snare Lakes area (Fig. 1). Structural studies at 3,000 feet to the inch were conducted in the Chalco-Ranji Lake area and in the Arjeno Lake (W ½) map-area. Several cross-sectional areas were mapped in detail to study contact relationships between rock units (for locations see Fig. 1). In addition, preliminary results of geochronological work on samples collected during the previous field season (Frith, 1973) by Rosaline Frith in the Isotopic Laboratory at McGill, under the supervision of Professor R. Doig are reported.

The Indin Lake map-area lies along the Bear-Slave Province boundary between latitudes 64° and 65°N and longitudes 114° and 116°W. In the Slave Province a north-south belt of supracrustal rocks belonging to the Yellowknife Supergroup occurs throughout the map-area. The preservation of abundant primary structures in the low-grade metamorphic central part of this belt, between Hewitt Lake and the eastern margin of Indin Lake, made it possible to unravel the structural history and fold geometry of this area. To date, the structural studies of the boundaries between the supracrustal rocks of the Yellowknife Supergroup and the adjacent granitic gneisses can be interpreted as faults, as along the eastern margin, or in the case of the western margin, as intrusive contacts along which the supracrustal rocks are separated from diapiric granitic intrusions by a migmatitic zone (Smith, 1966a,b). The nature of the faulted boundaries was studied in some detail and much of the accumulated field evidence suggests that areas of granitic rocks occurring along parts of the eastern margin of the supracrustal belt may represent a pre-Yellowknife Supergroup basement. Gneiss domes occurring immediately to the west of the Bear-Slave boundary, in the Arseno Lake (W ½) map-area (Frith, 1973) are surrounded by metasedimentary rocks of the Aphebian Snare Group. Structural relationships in and around some of these domes were studied in detail.

Geochronology

The following six Rb-Sr whole rock age determinations are pertinent to the area covered in this report. At this stage of the investigation the age data must still be considered as preliminary and may be subject to revision. The disintegration constant used for Rb^{87} is $1.39 \times 10^{-11}\ y^{-1}$. Errors are expressed as one standard deviation. Locations 1-6 are shown on Figure 1.

(1) Arseno Lake (W ½). Granitic core of gneiss dome; 2712 ± 89 m.y. with an initial ratio of 0.7014.

(2) Arseno Lake (W ½). Alaskitic granite intruded into Snare metasediments; 1808 ± 43 m.y. with an initial ratio of 0.7142.

(3) Arseno Lake (W ½). Porphyroblastic (porphyritic?) biotite granite intruded with frozen contacts into Snare metasediments, between 1335 and 2316 m.y. with initial ratios between 0.700 and 0.728.

1 McGill University
2 Acadia University
3 Carleton University

(4) Mesa Lake (E $\frac{1}{2}$). Biotite granitic gneiss inter-stratified with hornblende gneiss forming a rock unit adjacent to Yellowknife metavolcanic rocks; 3002 ± 20 m.y. with an initial ratio of 0.6997.
(5) Grenville (W $\frac{1}{2}$). Muscovite granite pegmatitie with no apparent deformation fabric; 1935 ± 75 m.y. with an initial ratio of 0.7248.
(6) Strachan Lake (W $\frac{1}{2}$). Granodiorite cutting Yellowknife Supergroup rocks but with a N-S deformation fabric (S_2); 1928 ± 73 m.y. with an initial ratio of 0.7021.

Arseno Lake (W $\frac{1}{2}$)

In this area gneiss domes occur within Aphebian Snare Group sediments which in turn are sandwiched between two granitic bodies of higher relief, the Archean to the east and a Proterozoic (?) plutonic body of porphyritic (porphyroblastic?) granite of wide extent to the west (see also Lord, 1942, and Ross and McGlynn, 1965). More detailed mapping was carried out in order to determine the age and origin of the domes.

Field and age determination work outlined the following rock units:
(1) Gneisses forming the basement to the Snare Group metasediments consist mainly of medium-even-grained biotite gneiss of granodioritic (McGlynn and Ross, 1966) to granitic composition. Locally these gneisses are migmatized and cut by pegmatites.
(2) The mantling gneisses are metasedimentary rocks of the Snare Group which locally contain quartz-pebble conglomerates (basal and intraformational) sandstones, and dolomite, but for the most part consist of rusty weathering biotite gneiss.
(3) Alaskitic-pegmatitic granite of limited extent occurs within the Snare metasediments. Isotopic data suggest that the granites were formed *in situ* during the Hudsonian orogeny.
(4) Coarse-grained porphyritic (porphyroblastic?) granite, possibly a high level intrusion that shows frozen contacts with the Snare metasediments along the eastern margin.

The core of the central dome is massive and was dated by a Rb-Sr whole rock isochron at 2712 m.y. The gneissosity of the mantling gneisses is generally concentric and increases in intensity and dips toward the margins. Close to the dome margin, hypabyssal granites of Aphebian age (1808 m.y.) occur in the surrounding gneisses, which contain sillimanite, garnet and cordierite.

Intraformational conglomerate marker beds can be used to outline the macroscopic geometry around the gneiss domes fold. Their distribution is controlled by the higher topographic level of the dome areas.

Two major folding phases can be distinguished: phase 1 caused isoclinal folds which are in part recumbent. Phase 2 folds are tight to open and have N-S trending axial planes. Phase 1 folds are present throughout the area, whereas phase 2 folds are poorly developed in the southern part of the Arseno Lake map-sheet. They are quite strongly developed in the central dome areas and are also present south of the Arseno Lake map-sheet in the Castor Lake area.

Three hypotheses were entertained in explaining the gneiss dome area:

(1) ancient topographic highs
(2) superposed fold structures
(3) mobilization and gravitational emplacement into the overlying metasedimentary rocks.

Further work is in progress to determine whether the deformation within the cores and the mantling gneisses is compatible with a vertical gravitational rise of the domes.

The Grenville Lake Area

During the 1972 field season, rocks in the northwest corner of the Grenville Lake map-sheet were found to be remarkably similar to biotite-plagioclase-gneisses from the Grenville Province, Quebec, which were dated at 3021 ± 146 m.y. (Frith, 1971). A preliminary age of 3002 m.y. of the Grenville Lake rocks locality 4, Fig. 1 shows that they probably represent an older basement to the Yellowknife Supergroup. Extensive mapping (1973) at 1/50,000 to outline this rock type (Figures 3 and 4) showed that the rock is highly deformed and closely associated with hornblende-gneiss interlayers. The rock is essentially a quartz-diorite, but in most places shows potash metasomatism by later pegmatitic phases. The extent of the basal unit (1) is shown in Figure 3. On the east side of Grenville Lake this rock unit is deformed in an ENE-WSW direction that can be related to a similar direction of deformation within the Yellowknife Supergroup rocks.

Studies along the Truce Lake section south of Grenville Lake (Fig. 1) showed that these older rock types are absent, but large areas of migmatite of suspected Yellowknife supracrustal parentage were outlined.

The Cotterill-Snare Lakes Area

The area was mapped at 1/50,000 and an attempt was made to subdivide the grantic rocks that comprise most of the area. Migmatities are defined here in a descriptive sense. For mapping purposes, where the origin of the restite is known or suspected, map-units were proposed. In most cases the mobile phase can be demonstrated as secondary and introduced. Migmatites were found to be the most abundant rocks and their mobile phase was found to be related to extensive porphyritic (porphyroblastic?) granites and in some areas to finer-grained biotite alaskitic granites. It was possible to subdivide the migmatites into those derived from (1) biotite-quartz-plagioclase gneiss, (2) metasedimentary and (3) metavolcanic rocks. Mappable areas of older restite quartz dioritic gneisses were found along the eastern margin of the Yellowknife belt, as outlined in Figure 4.

The Chalco-Ranji Lake Area

The grade of metamorphism in the rocks of the Yellowknife Supergroup belt in the Chalco-Ranji Lake area increases from greenschist facies in the centre to the upper amphibolite facies in the margins. The structural-metamorphic sequence recognized in this belt is as follows:

1. First period of deformation (D_1)

Structures resulting from this period of deformation are approximately east-west trending, steeply plunging folds (F_1) on the mesoscopic and macroscopic scales. A penetrative schistosity (S_1) which is axial planar to F_1 is well developed only in the higher grade metamorphosed marginal areas not greatly affected by D_2.

During a late to post-D_1 thermal event, porphyroblasts of sillimanite or andalusite and cordierite overgrew S_1. These porphyroblasts were retrogressively altered during further movement along S_1. In the final phase of this deformation garnet formed and can be seen to have overgrown retrograded porphyroblasts as well as their pressure shadows.

2. Second period of deformation (D_2)

The second period of deformation was responsible for the northeasterly lithologic trends in the central parts of the Yellowknife Supergroup belt. Effects of this period of deformation are greatest and best recognized in the lower grade rocks of the centre of the belt where primary sedimentary structures are abundant. Tight and steeply plunging, northeasterly trending folds (F_2) overprint and in part obliterate earlier F_1 folds causing Type 3 interference patterns (Ramsay, 1967) (see Figure 5). Mesoscopie F_1 and F_2 folds have parallel axial planes and are co-axial on the limbs of macroscopic F_2 folds. A penetrative S_2 cleavage is axial planar to the F_2 folds. In the centre of the belt, where S_1 is virtually absent, S_2 is a slaty cleavage which represents the most pronounced tectonic fabric in the rocks. In volcanic rocks, S_2 is present as a schistosity of varying intensity. At the margins of the belt the effects of D_2 are less evident in the supracrustal rocks. F_2 folds are open and generally evident only on the mesoscopic scale and S_2 is locally developed as crenulation cleavage further obliterating the porphyroblasts of the post-D_1 thermal event. S_2 is also recognized around and within granodiorite intrusions along the eastern margin of the belt. Within small round plugs of this granodiorite in the Strachan Lake area (see No. 6, Figure 1) S_2 overprints a concentric cataclastic fabric probably related to late stage movements during emplacement. This granodiorite yielded an absolute age of 1929 ± 7.3 m.y., hence establishing an age of S_2.

Possibly related to or slightly postdating D_2 are large north-northwesterly striking faults with apparent left-handed displacements. A locally developed, late fracture cleavage (S_3) strike more or less parallel to these faults.

Conclusions:

1. Possible pre-Yellowknife Supergroup basement was recognized in the eastern part of the map-area.
2. Two major periods of deformation have affected the Slave Province part of the map-area. The first of these was closely followed by diapiric emplacement of granitic plutons about 2570 m.y. ago (McGlynn, 1972) immediately to the east of the Bear-Slave boundary.
   The second period of deformation postdates the emplacement of the approximately 1930 m.y. old granodiorite intrusions (locality 6, Fig.1). It indicates that this part of the Slave Province was affected by extensive and penetrative post-Kenoran deformation.
3. It is possible that the large NW faults in the Slave Province and the early diabase dykes (approx. 2000 m.y.) are closely related in time to the second period of penetrative deformation.
4. Although considerable crustal shortening may have occurred during the two periods of deformation, the tectonic development of the area must have involved large vertical movements. Such movements are thought to have brought possible pre-Yellowknife Supergroup basement into juxtaposition with the supracrustal rocks along the eastern margin of the belt.
5. Archean basement was positively identified within the folded Aphebian rocks immediately to the west of the Bear-Slave boundary.
6. It is interesting to note that the gold occurrences in the Chalco-Ranji Lake area are confined to the low-grade metamorphic parts of the Yellowknife Supergroup. The gold-bearing quartz veins formed in fractures opened during the second period of deformation.

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LOCATION MAP

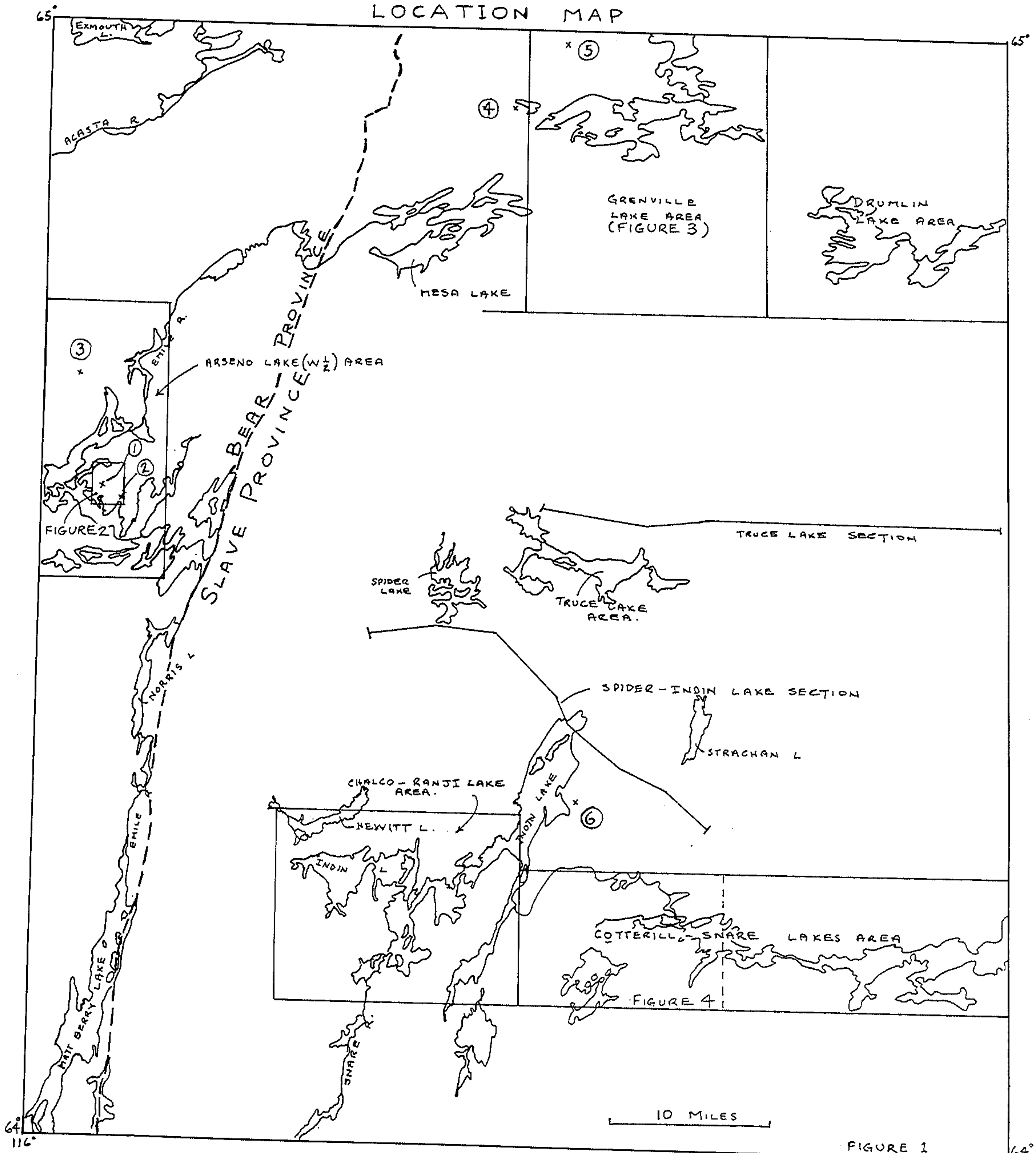
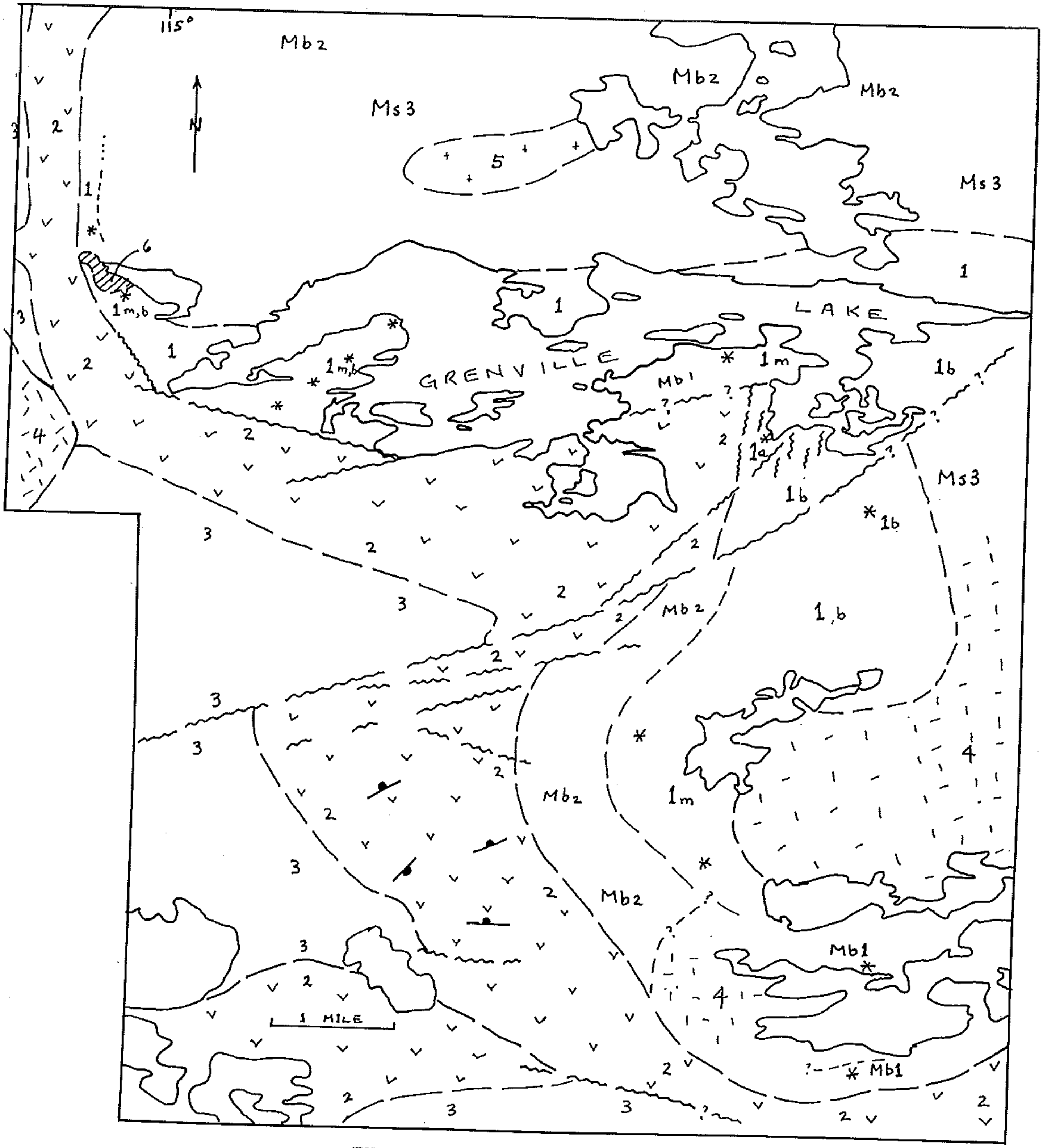


FIGURE 1

INDIN LAKE (86B)

Figure 2: The central gneiss dome showing the core, mantling gneisses, basal conglomerate and dolomite along with interlayered biotite granite. An intra-formational conglomerate horizon runs north-south along the eastern margin, (EMR Photo 8973-114).



THE GRENVILLE LAKE AREA FIGURE 3

LEGEND Figure 3

6 — Muscovite-bearing pegmatitic granite no penetrative fabric observed

5 — Alaskitic granite similar to the mobile phase of the adjacent migmatites

4 — Biotite-granite-gneiss, massive in places

3 — Yellowknife Supergroup metasediments

2 — Yellowknife Supergroup metavolcanics

1 — Unnamed gneiss complex. 1a is a quartz-dioritic gneiss, 1b is a hornblende metagabbroic gneiss and 1m is a metasomatized quartz-dioritic gneiss

M — Migmatite undifferentiated. Mb is the banded type, Ms is the schlieran type, Mm is the metasomatized type. Numbers refer to the above rock-units that occur as the restite phase of the migmatite

Fault

Strike and dip of pillow

Quartz-dioritic gneiss observed

COTTERILL – SNARE LAKES AREA

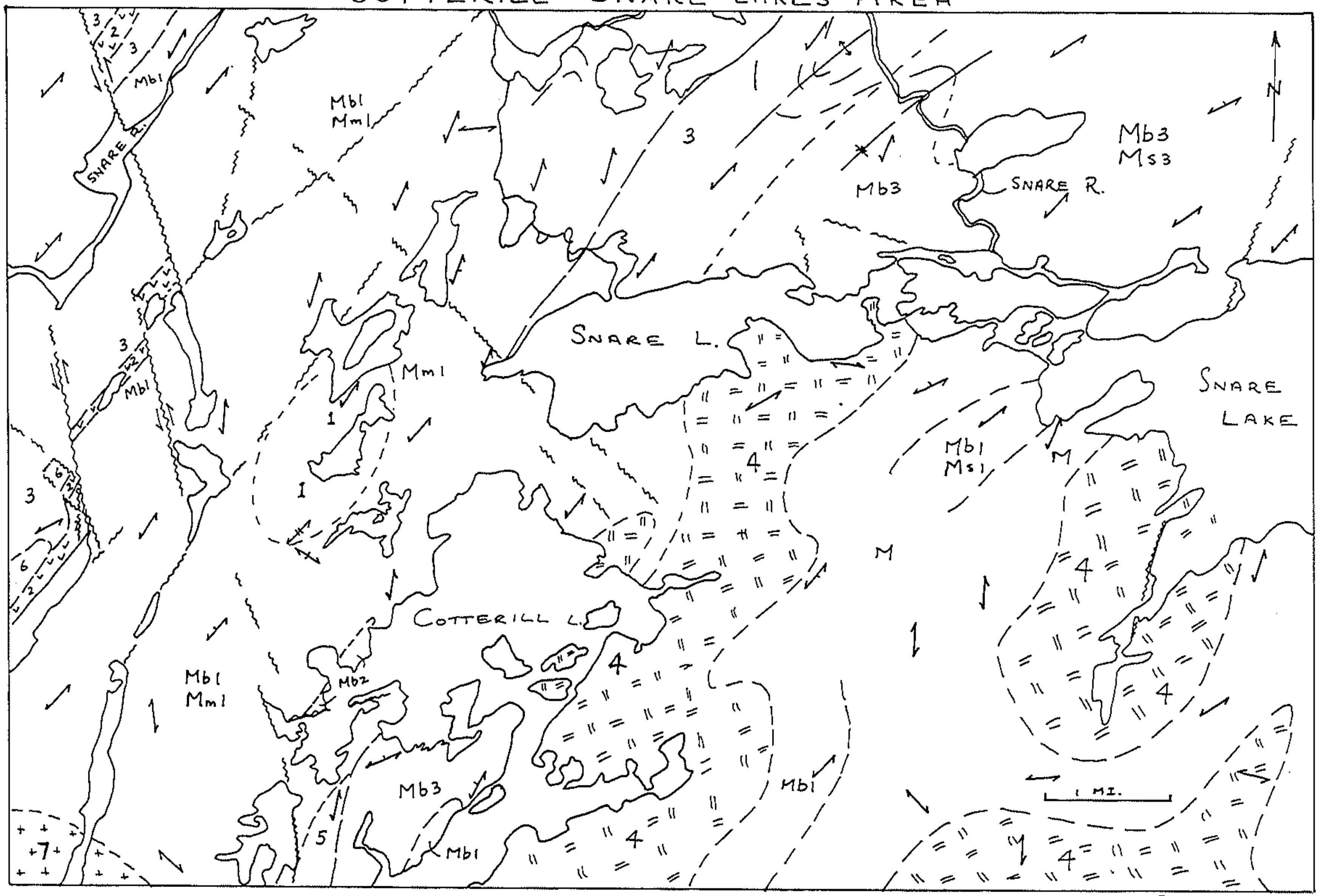


FIGURE 4

LEGEND *Figure 4.*

7	Biotite granodiorite intruded along the contact of the Yellowknife supracrustal rocks and the granitic rocks to the east
6	Biotite syenite intruded into 1 and 2
5	Biotite granite similar to the mobile phase of the adjacent migmatite
4	Porphyritic (porphyroblastic?) biotite granite with gradational contacts with the surrounding migmatites
3	Yellowknife Supergroup metasedimentary rocks
2	Yellowknife Supergroup metavolcanic rocks
1	Biotite-quartz-plagioclase gneiss with generally less than 35% alaskitic pegmatite
M	Migmatite undifferentiated. Mb is banded type, Ms is the schlieren type and Mm is a metasomatized type. Numbers refer to the above rock units that occur as the restite phase of the migmatite
	Foliation (S1, S2)
	Fault
	Rock contacts (probable to assumed)

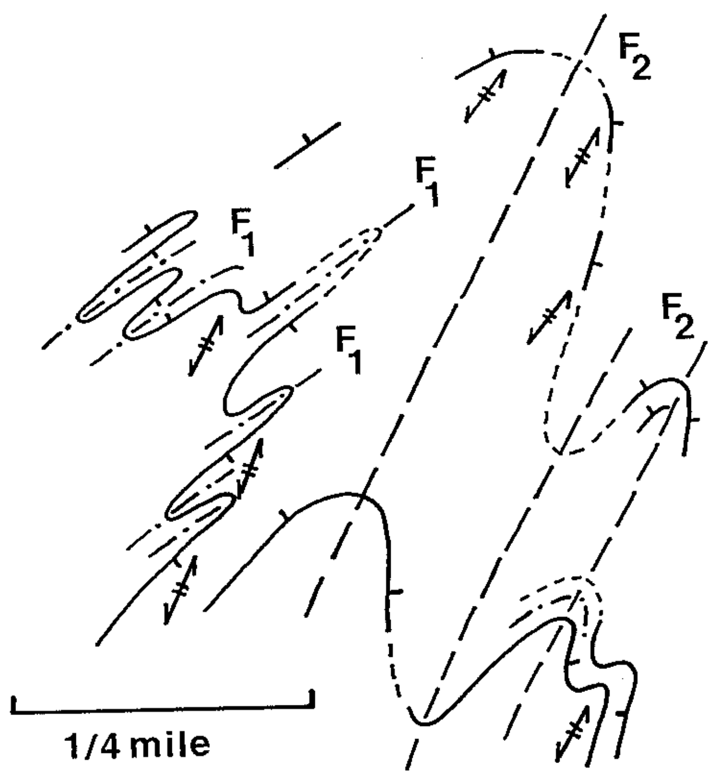


Figure 5: Interference pattern between F_1 and F_2 folds in vertically dipping greywacke-slate sequence at Indin Lake, east of Float Lake.

BEAR PROVINCE LITHOGEOCHEMICAL SURVEY

R. G. Garrett

During the 1973 field season those rocks mapped as dominantly intrusive quartz, feldspar and quartz-feldspar porphyries were systematically sampled in the Wopmay Geological Sub-province from the vicinity of the abandoned Rayrock mine in the south to as far north as latitude 66°N.

The porphyry units are of Proterozoic age and show variable relations to the granitoid plutonics west of the Wopmay fault, but overlie unconformably the rocks of the Hepburn batholith to the east (see McGlynn and Hoffman in this report). During the field sampling a possible unconformity was noted 2 miles west of Hardisty Lake where felsic volcanics appear to lie unconformably on quartz monzonite. The porphyry units are complex in nature. The composition of volcanic extrusive and hypabyssal rocks vary from andesitic to rhyolitic. The mapped units also contain sediments and considerable thicknesses of pyroclastics. The currently available published geological maps of the area do not truly reflect the complexity of the volcanic units.

In addition to the regional sampling detailed sampling was undertaken in three areas where more recent mapping was available. These areas were around Hardisty (86C) and Maclaren (86K) Lakes and in the Camsell River silver district (86F). The data derived from these sampling programs will be used to aid in the interpretation of the regional survey. In total some 2200 rock samples were collected and are being analysed for 15 major, minor and trace elements.

During the regional sampling, copper staining, believed to be previously unreported, was observed. Neither of these localities yielded any significant sulphides in the brief time spent at them; the localities are given in order that they be permanently recorded. Firstly, east of Mazenod Lake (85N) at UTM 504300 7069800 and secondly, south of Jaciar Lake (86K) at UTM 515800 7387200. Both localities occur in areas of red fine-grained volcanics.

A variety of sulphide mineral showings occur in the survey area in addition to the economically important silver deposits. Many of these occurrences were visited and two are considered to be particular genetic interest. In the vicinity of Tommie Lake (86F 494200 7252500) a number of chalcopyrite bearing veins were investigated in 1962. Close by these veins are apparently conformable units containing chert, magnetite ironstone and jaspilites lying with rocks postulated to be felsic pyroclastics, both the magnetite and jaspilite units contain disseminated pyrite. At a point west of Clut Lake (86F, UTM 459800 7272400) a breccia pipe where pyrite and chalcopyrite cement porphyry fragments intrudes relatively flat lying felsic volcanics. In the volcanic pile both magnetite-chert and black sedimentary horizons containing disseminated pyrite were observed. On the basis of these field observations it is suggested that the Wopmay geological sub-province felsic volcanic units might be favourable loci for volcanic exhalative type sulphide accumulations.

VOLCANISM AND PLUTONISM, SLOAN RIVER MAP-AREA (86K) GREAT BEAR LAKE, DISTRICT OF MACKENZIE

P.F. Hoffman and M.P. Cecile

The 1973 field season was the first in a three year project to map, at 1:250,000 scale, the Sloan River map area in the west half of the Bear Province. The area is a small part of that mapped during the helicopter reconnaissance of the north-central district of Mackenzie (Fraser *et al.*, 1960). In the current project, special emphasis is on the late Aphebian (1750 million-year-old) volcanic and plutonic rocks of the Great Bear Batholith (Fraser *et al.*, 1972; Hoffman, 1973). They underlie all but the northwest corner and eastern boundary of the map area. In 1973, mapping was concentrated in the largest volcanic belt (Fig. 1), extending for 50 miles from Dumas Lake west along the Sloan River to Great Bear Lake. Mapping was done by ground traverses from seven base camps during the unusually long season of fourteen weeks.

Volcanic Stratigraphy

The internal stratigraphy of the Sloan River volcanic belt was established, a task facilitated by its simple structure-- a northeast-facing homocline with a few broad folds (*see* cross-section in Fig. 1). Thus, volcanics high in the stratigraphic sequence occur in the east and those lower in the sequence to the west.

The volcanic rocks are mainly rhyolitic to andesitic welded ash flow tuffs (ignimbrites) and make up a conformable sequence of great thickness (Fig. 2). The tuffs consist of broken phenocrysts of plagioclase, alkali feldspar, quartz, hornblende and biotite, scattered in a dense aphanitic groundmass. The field term "rhyolite" is used where the phenocrysts are dominantly alkali feldspar and quartz, "andesite" where dominantly plagioclase and hornblende. These identifications are supported by a limited number of chemical analyses of samples collected near Dumas Lake and Jaciar Lake.

The ash flow tuffs are unstratified and some are massive, but most contain fragments of porphyritic pumice, more or less recrystallized, strongly flattened parallel to the depositional surface (eutaxitic structure). The pumice fragments (fiamme) are equant, not elongate, in the plane of flattening, thus indicating that the flattening is due to compaction not flowage. A few of the tuffs contain unflattened pebble- to boulder-sized clasts of tuff or intrusive porphyry. In parts of the sequence, particularly on the west side of Doghead Peninsula (see Fig. 1), individual cooling units (Ross and Smith, 1961) can be distinguished by variation in the degree of flattening of the pumice fragments.

The sequence was divided into four formations (Units 2-5 in Figs. 1-2) and many members, to be formally defined in a later publication.

Unit 5: A diverse unit with well defined and consistent internal stratigraphy. Dominant are thick rhyolitic to rhyodacitic crystal-rich ash flow tuffs, eutaxitic in the lower part and massive above. The tuffs are mostly orange, pink or mauve and contain discontinuous crossbedded sandstones derived from them. Between the tuffs are conglomerates, composed of tuff, porphyry and basalt clasts; mudstones, with varve-like laminations and graded turbidites; basalt flows, commonly amygdaloidal, porphyritic and rarely pillowed; and laccoliths of porphyry containing alkali feldspar megacrysts. The pophyries were intruded during volcanism as they provide boulders to the conglomerates and, on the basis of phenocryst similarity, are interpreted to be intrusive equivalents of the ash flow tuffs.

Unit 4: A less diverse unit, lacking sedimentary rocks, but with a highly variable internal stratigraphy. The background component is red rhyolitic crystal-poor ash flow tuff with excellent eutaxitic structure, within which are *en echelon* shield volcanoes, many miles in diameter, of dark green andesitic crystal-rich ash flow tuff. The flanks of the volcanoes are strongly eutaxitic, the flattened pumice fragments commonly recrystallized to clear granophyre, whereas the centres consist of massive finely-porphyritic andesite rich in biotite and unflattened pumice fragments. This unit, and those below, are intruded by discordant to peneconcordant masses of coarsely porphyritic dacite.

Unit 3: A weakly differentiated unit, mostly without sedimentary interbeds, of orange to purple, rhyolitic to dacitic ash flow tuff. Most of the tuffs are crystal-rich, many are strongly eutaxitic and others weakly so, and some are notable in having lithic clasts of tuff and porphyry.

Unit 2: This unit is most like Unit 5 in having thick sedimentary interbeds. Dominant are thick and thin, rhyolitic to dacitic, massive to strongly eutaxitic, crystal-rich ash flow tuffs, several with large clasts of red porphyry. The sedimentary rocks are conglomerate and crossbedded pebbly sandstone, with clasts of tuff, porphyry, hornfelsed sediment and granitoid rocks; laminated calcareous mudstone, with mudcracks and beds of stromatolitic dolomite; and silicified mudstone with turbidites. There are also thin intervals of basaltic flows, tuffs and breccia; laccoliths of coarsely porphyritic dacite; and discordant intrusions of finely porphyritic rhyolite. The internal stratigraphy is complicated by abrupt facies changes across high-angle faults active during volcanism.

Basement Rocks and Nature of the Wopmay Fault

The Wopmay Fault (Hoffman, 1973) separates the volcanic sequence from the high grade Hepburn Metamorphic Plutonic Belt (Fraser *et al.*, 1972) of the east half of the Bear Province. The nature of the fault and the age relation of the volcanic sequence to the Hepburn gneisses, previously unknown, was determined east of Dumas Lake (*see* Fig. 1). There, the uppermost volcanic and sedimentary rocks of Unit 5 (*see* Fig. 2) overlap the fault trace and lie unconformably on granodiorite and migmatite of the Hepburn Belt. Thus, the volcanic sequence is younger than the Hepburn Belt and movement on the Wopmay Fault was complete before the end of volcanism. The fault must have provided great structural relief during volcanism in order to truncate the great thickness of volcanic rocks that project beneath the unconformity a few miles ot the west (*see* cross-section in Fig. 1). West of the fault, basement to the volcanic sequence is not exposed in the area mapped.

Plutonism not Coeval with Volcanism

Two generations of undeformed discordant epizonal plutons intrude the volcanic sequence (see Fig. 1). The older plutons are vertical-sided intrusions of granodiorite, commonly with central areas of alkali-feldspar-porphyritic quartz monzonite, and locally with quartz diorite in embayments into the country rocks. Distinctly younger are plutons of coarse grained granite, the roofs of which are close to the present erosion surface. Trending southwestward from Spence Lake is a dense swarm of granitic porphyry dykes that issues from the roof of one of the granite plutons.

The plutons and their host rocks must have been relatively dry as pegmatite, miarolitic cavities, explosion breccias, muscovite and hydrothermal alteration are lacking.

Although the compositional range of the plutons is similar to that of the volcanic sequence, there is no evidence that volcanism and plutonism were coeval. The two may be comagmatic but emplacement of the plutons clearly post-dates deformation of the entire volcanic sequence. The only conglomerates to contain plutonic clasts are those in the lowest parts of the sequence, presumably derived from basement. The porphyry laccoliths of the volcanic sequence, common as clasts in the conglomerates, are texturally distinct from the porphyry dyke swarms related to plutonism.

Late Faulting

Map patterns are greatly complicated by late faults that displace the plutons and all older rocks (see Fig. 1). The faults strike northeast and have both right-lateral strike-slip and normal movement. The fault traces occupy lineaments commonly marked by quartz stockworks. Prominent north-striking lineaments have no displacement and are probably recessive dykes, not faults.

Helikian Weathering Beneath the Hornby Bay Group

The gently dipping Helikian Hornby Bay Group (Baragar and Donaldson, 1973) has a basal unit of red polymictic conglomerate, mudstone and sandstone. The red beds are overlain by light grey friable kaolinitic cross-bedded sandstone and conglomerate. Beneath the basal unconformity, the volcanic rocks of the Sloan River belt are weathered to a reddish brown earthy saprolite. The weathered rocks extend for miles from the trace of the unconformity in the region east of Hornby Bay and along the east shore of Great Bear Lake. Where deeply weathered, the subtle differences between the volcanic units are exceedingly difficult to map.

Great Bear Batholith not an Andean-type Arc

The association of silicic volcanics and plutons prompted Hoffman (1972) and Badham (1973) to suggest that the Great Bear Batholith may be a volcano-plutonic arc of Andean type generated above a subduction zone along a convergent plate boundary. There are major objections to this hypothesis. Andean arcs typically have greatly thickened crust and therefore, for reasons of isostasy, are regions of great uplift. Ancient Andean-type arcs, such as the Sierra Nevada Batholith of California (Hamilton, 1969a), are deeply eroded. In contrast, the unmetamorphosed volcanics and epizonal plutons of the Great Bear Batholith have not been deeply eroded. Rather, the great thickness of conformable volcanic rocks indicates profound subsidence during volcanism, subsidence not later countered by uplift.

The foregoing requires an environment of crustal attenuation, where upon the combined effects of volcanism and plutonism serve to restore the crust to normal thickness. Crustal attenuation can be accomplished by slippage of normal fault blocks during the early stages of volcanism. If the normal faults are predominantly west side down, as is the case of the Wopmay Fault, then a conformable homocline can be accommodated with an apparent thickness far in excess of what need be stacked in any one place (Fig. 3), a comfort in view of the outrageous thickness of volcanics represented by the stratigraphic column in Figure 2. Therefore, a better analogue than the Andes may be the Basin and Range Province of the western United States, a region of normal faulting, crustal attenuation and voluminous silicic ash flow eruptions in the Cenozoic (Hamilton and Myers, 1966).

It may be that the mesozonal batholiths of the Hepburn Belt, source of the flysch wedges in the Coronation Geosyncline (Hoffman, 1973), occupy the deeply eroded arc. For they have the same temporal relation to the Sloan River volcanics that the Sierra Nevada Batholith (Cretaceous) has to the Basin and Range volcanics (Hamilton, 1969b).

Absence of "Porphyry Copper" Mineralization

The intimate association of silicic volcanics, intrusive porphyries and epizonal plutons seems ideal for disseminated copper sulphide mineralization. Yet none was found, nor any of the intense hydrothermal alteration with which "porphyry copper" is intimately associated.

There is local copper mineralization in quartz stockworks associated with the northeast faults but this is minor and is not limited to the Great Bear Batholith. (There are similar occurrences in the east arm of Great Slave Lake.) There is disseminated pyrite in an anomalously sheared area of rhyolitic ash flow tuff (Unit 5) southeast of Junius Lake (see Fig. 1).

Whether the lack of obvious mineralization is related to lack of water in the magmas and/or country rocks, the non-arc affinities of the magmas, the level or erosion, or other factors is an intriguing academic question. But unless other parts of the Great Bear Batholith are substantially different, estimates of its potential for large low grade copper mineralization should be revised downward.

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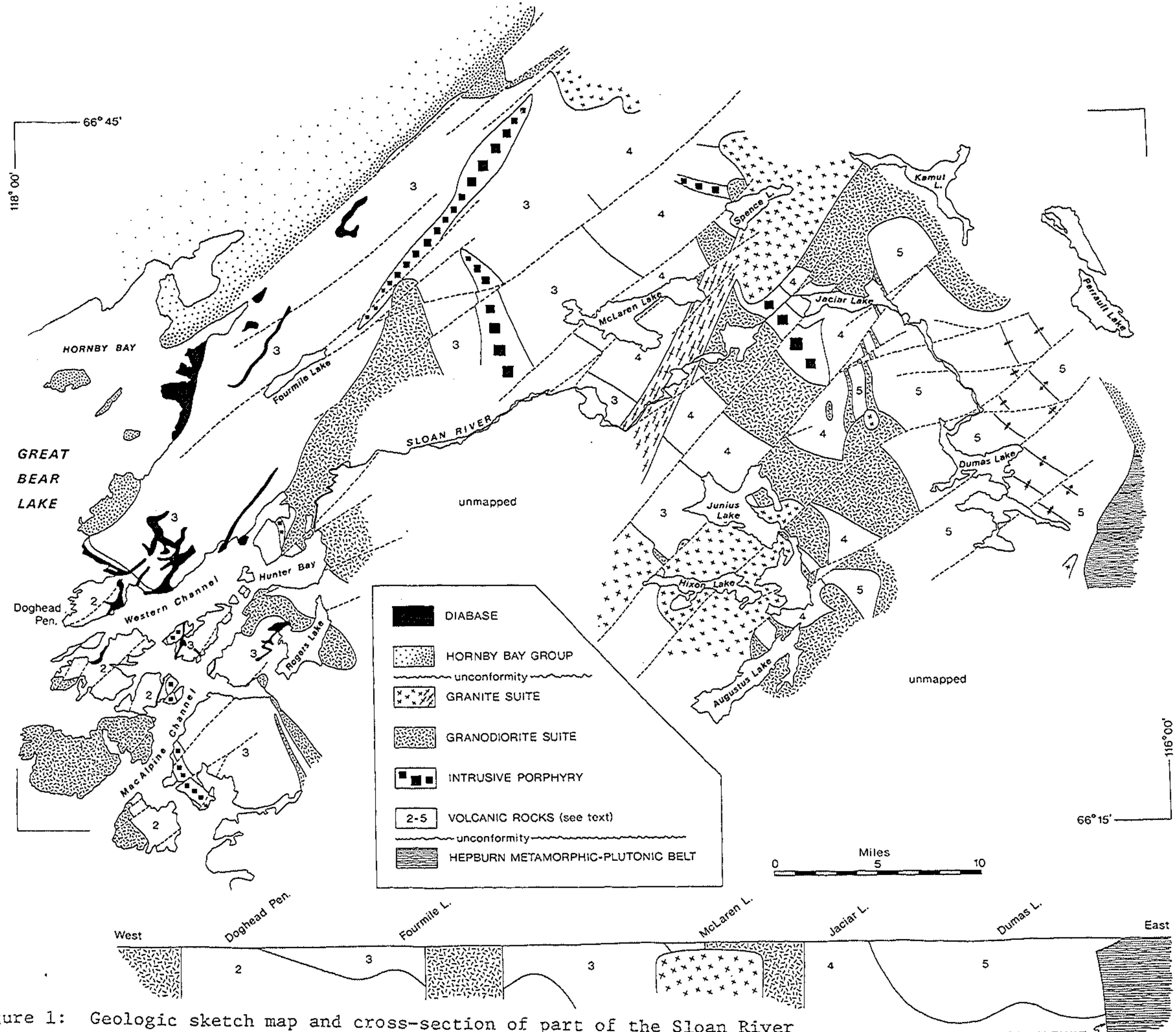

Figure 1: Geologic sketch map and cross-section of part of the Sloan River Map-area (86K). Many more units were mapped than are shown here.

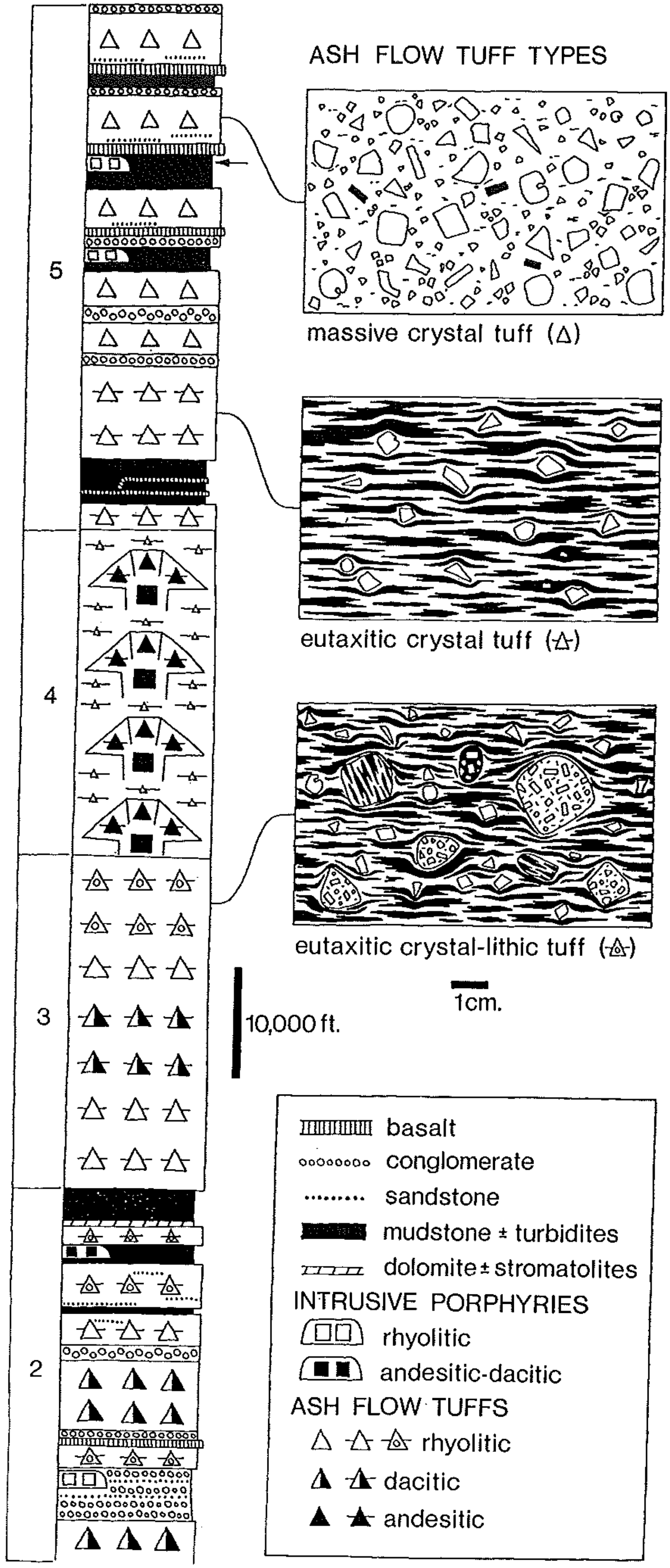

Figure 2: Aggregate stratigraphic column of the Sloan River volcanic belt. The arrow to the right of the column in Unit 5 indicates the level of the unconformity east of the Wopmay Fault. Insets show typical structures in the ash flow tuffs. Unit numbers are keyed to Fig. 1.

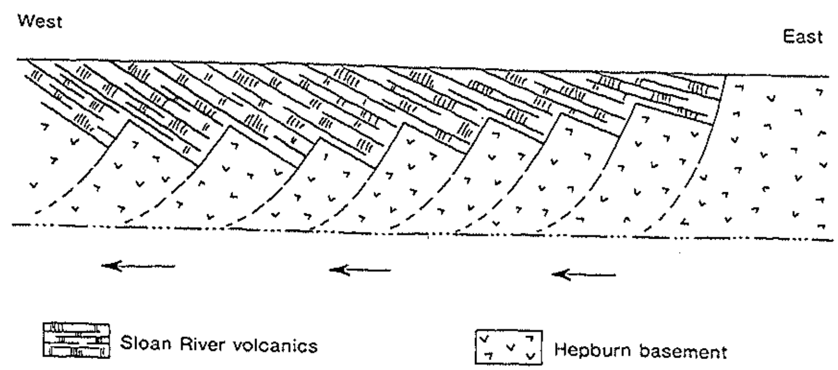

Figure 3: Tectonic model in which a homoclinal sequence of volcanic rocks is preserved in a region of crustal attenuation by slippage along listric normal faults. Arrows show direction of shear stress.

ARCHEAN VOLCANIC STUDIES IN THE SLAVE BEAR PROVINCE

M.B. Lambert

Geological mapping of Archean volcanic rocks in the Hearne Lake map-area, begun in 1972 (Henderson et al., 1972), was completed this year. The belts were mapped on a scale of 1:50,000 with the aim of determining the stratigraphic and structural relations in the belt, the sequence and types of volcanic eruptions and their environment of deposition, and the relationship of mineral deposits to volcanic stratigraphy and volcanic processes.

Specific gravities of about 250 hand specimens were measured with the hope of correlating them with the chemical compositions of the volcanic rocks. Three sections across the belt, near Allan and Sunset Lakes, were sampled at 500 to 1,000 foot intervals for chemical analyses.

The work was carried out mainly by ground traverse with helicopter support of a two week period.

Stratigraphy

The volcanic pile is divided into three major units (Figure 1: basal mafic volcanics, including rocks of basalt and andesite compositions, metamorphosed to amphibolite grade; middle intermediate volcanics, dominantly dacite with minor andestie; and upper salic volcanics, dominantly rhyolite but including some dacite.

Mafic volcanics are generally dark green, fine-grained amphibolites of basaltic composition that have specific gravities ranging from 2.8 to 3.15. They comprise pillow lava, pillow breccia, tuff breccia and tuff. Parts of the mafic volcanic succession, that are medium green, feldspathic amphibolites, with specific gravities ranging from 2.75 to 2.85, may be meta-andesites.

Intermediate volcanics are typically pale green, sparsely porphyritic pillow lavas and tuffs that have quartz of feldspar phenocrysts. These very fine grained to aphanitic rocks, that contain little or no visible amphibole, and with specific gravities ranging from 2.68 to 2.76, were called dacite in the field.

Salic volcanic units are white, pale grey and buff weathering rhyolite containing quartz and feldspar phenocrysts. They include crystal tuffs, ash-flow tuffs, and dykes, sills and lava flows. Specific gravities of these rocks range from 2.6 to 2.7. The salic volcanic units southeast of Trout Lake are dominantly massive and eutaxitic ash-flow tuffs. Near the contact with granitic plutons, some rhyolite units are very fine grained, and have well-developed schistosity in contrast to the normal aphanitic rhyolite.

The contact between salic and mafic volcanic successions is conformable. The volcanic succession is overlain conformably by metasediments. At this contact sediments and volcanics are interbedded. Northeast of Webb Lake, where volcanics are in contact with granitic gneisses, considered by Davidson (1971) to be basement to the volcanic pile, gneissosity makes an angle of 30 degrees with the trend of flattening in the volcanic belt, indicating that the contact is an unconformity.

The stratigraphy varies considerably from one part of the belt to another. In the Cameron River belt the succession is dominantly basalt pillow lavas with minor andesite, dacit and rhyolite units as pods and discontinuous beds near the top of the succession. The pillow lavas are intruded by large amphibolite dykes and sills on the east and central parts of this belt. Between Ross and Victory Lakes the volcanic belt pinches out southward.

The belt from Victory Lake to Tumpline and Turnback Lakes contains subequal amounts of salic and mafic units. Near Sunset Lake the succession is mixed andesite and dacite pillow lavas and tuffs with minor rhyolite crystal tuffs, lava flows and sills west of Sunset Lake. Compositions become more mafic towards the eastern and western sides of the belt.

South of Payne Lake, the southeast-trending arm of the belt comprises schistose tuffs of intermediate composition, minor rhyolite and mafic pillow lavas, and water laid volcanic sediments.

Three miles north of Turnback Lake, 4 miles northeast of Turnback Lake and south of Detour Lake, the contact between salic volcanics and metasediments is marked by a dark grey weathering carbonate unit locally up to 250 feet wide. This unit can be traced intermittantly around the belt to the vicinity of Ross Lake. Carbonate bearing units also occur at the contact between salic volcanics and sediments southeast of Sunset Lake, as the matrix of a rhyolite boulder conglomerate and breccia northeast of Ross Lake, and as thin zones in intermediate tuff north of Sunset Lake. The carbonate unit contains up to 40 per cent rhyolite lenses, screens, and in some cases, complete small scale folds of rhyolite in a carbonate matrix. Layering in the unit is defined by preferred orientation of salic clasts, which generally have the same attitude as layering in the adjacent volcanic units. These carbonate units generally are not distinct beds, but are carbonate rich zones in salic volcanics that have boundaries gradational over distances of 1 to 20 feet.

Amphibolite dykes form massive medium- to coarse-grained bodies with steeply dipping mineral streaking defined by preferred orientation of hornblende crystals, and locally with layered margins. Specific gravities of these dykes generally fall in the range of 2.95 to 3.1. Amphibolite forms swarms of dykes and sills within the mafic and felsic volcanic successions. Dense swarms of amphibolite dykes penetrate granitic rocks notably along the southeast side of the Cameron River belt and along the northeast side of the Beaulieu River belt.

Fresh pyroxene diabase dykes cut across virtually all volcanic formations, following along the layering of the volcanic belt and cutting across it at high angles.

Structure

The contact between volcanic and sedimentary successions in the Hearne Lake map-area suggest that the volcanic belts outline a large scale anticline-syncline pair with an amplitude of at least 25 miles. The style of folding baries in different parts of the belt.

The Cameron River belt is essentially a northeast-trending homoclinal succession in which pillows are both flattened in a plane parallel to the trend of the belt and drawn out into steeply plunging rods. Phyllitic cleavages are developed parallel to the plane of pillow flattening. Southwest of Webb Lake, small scale folds in tuffs and gentle warps in the flattened pillows, have axial planes that make a high angle (azimuths ca. 340 to 360 degrees) to flattened pillows. Metasediments that lie to the west of the Cameron River belt, preserve delicate structures that indicate at least three periods of deformation. These features are rarely preserved in the more massive units of the volcanic belt.

South of Victory and Detour Lakes the belt defines two northwest trending tightly folded isoclines. Axial planes of these folds conform to the boundary of a large pluton (Davidson, 1971) that lies north of Detour

Lake. Near Tumpline and Turnback Lakes axial planes of major folds trend north-northeast, whereas near Sunset and Payne Lakes they trend roughly north-south. Southeast of Turnback Lake the east-southeast trending arms of the volcanic belt may be parts of one or more isoclinal folds.

Several granitic plutons have intruded and deformed the volcanic belt. Southeast of Tumpline Lake, layering in the volcanic belt makes abrupt changes in trend to warp around two small plutons. The layering generally conforms to the margins of these plutons, but in detail the plutons cut across it. West of Turnback Lake, a large north-northeast trending pluton forms the core of a large anticline. The western and southern margins of this pluton contain slivers and screens of volcanic rock. Attitudes of layering within these inclusions is essentially the same as that in the adjacent volcanic units, and thus the inclusions outline the stratigraphy and at least two large folds in the intruded volcanic succession. West of Sunset Lake a large roughly north-south trending pluton has intruded along the centre of the volcanic belt.

Mineral Occurrences

No new deposits of economic significance were discovered. Sulphides, mainly pyrite, are ubiquitous but generally appear to be more abundant in the eastern and southern parts of the belt than in the Cameron River belt. In almost all parts of the belt sulphides are most abundant at the contact between salic volcanics and metasediments. These gossans are very prominent adjacent to the thick carbonate units near Turnback and Detour Lakes. Garnet and diopside rich scarn zones, up to 25 feet wide occur at the contact of granitic bodies where they intrude the carbonate unit north of Turnback Lake.

Interpretation

The general stratigraphy indicates that there was one major cycle of eruption in which the composition of the magma changed from mafic to salic with time. Interbedded mafic and salic volcanics suggest either that magma of different compositions effused penecontemporaneously from different eruptive centres, or that there were periodic fluctuations in magma compositions near the end of the cycle. That most of the volcanic succession was deposited in a subaqueous environment is indicated by extensive pillow lava successions. Local thick welded ash-flow tuff units, however, suggest that part of the volcanic pile, near the end of the cycle, emerged above the surface of the ocean. Carbonate units have features strongly suggesting that they are of exhalative origin.

The northwests trending folds south of Detour Lake may be the noses of refolded isoclines. The sudden swing in trend of the belt in this vicinity may be due partly to superposed folding and partly to forcing aside of the volcanic and sedimentary succession by large granitic plutons that lie to the north of Detour Lake. Several smaller granitic plutons in the vicinity of Tumpline, Turnback and Sunset Lakes, have forcefully intruded and wedged aside parts of the volcanic and sedimentary successions.

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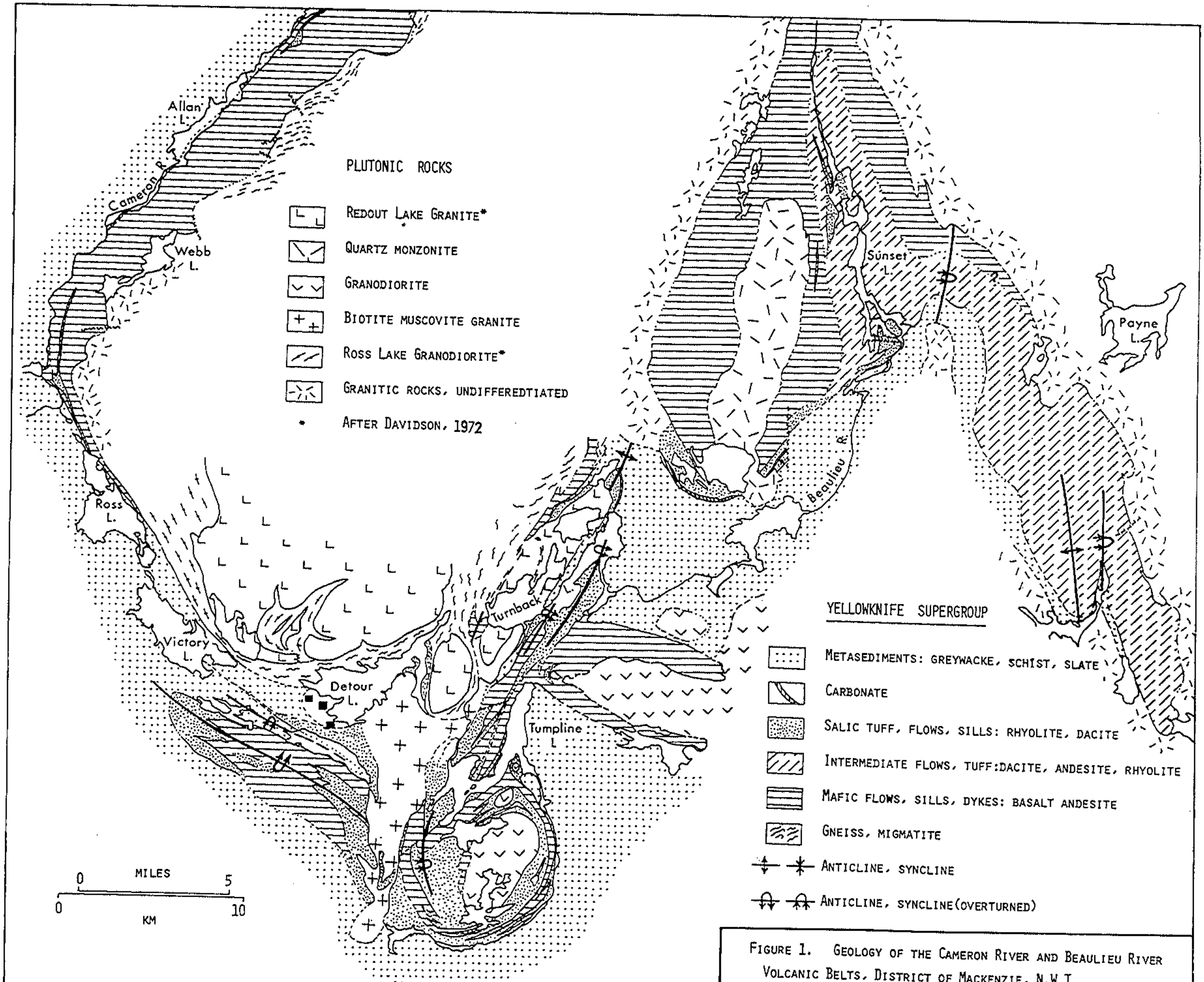

FIGURE 1. GEOLOGY OF THE CAMERON RIVER AND BEAULIEU RIVER VOLCANIC BELTS, DISTRICT OF MACKENZIE, N.W.T.

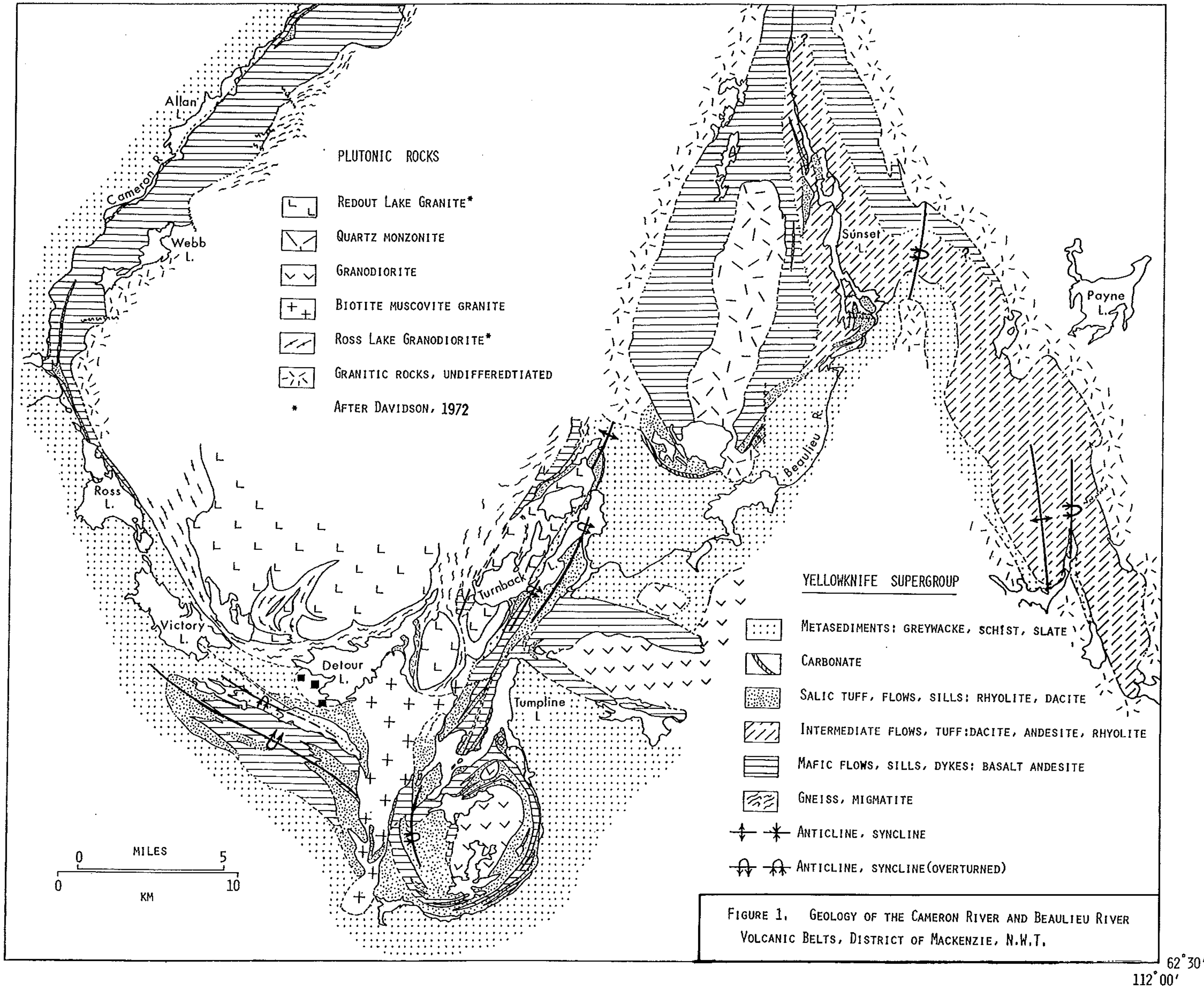

Figure 1. Geology of the Cameron River and Beaulieu River Volcanic Belts, District of Mackenzie, N.W.T.

STRUCTURAL AND STRATIGRAPHIC STUDIES IN THE NORTHERN CANADIAN CORDILLERA

D. K. Norris

In the 1973 field season approximately ten weeks were devoted to the gathering of additional structural, stratigraphic and paleontologic control required in the rpoduction of 1:250,000 scale geological maps of the Canadian Cordillera and adjacent Interior Platform north of Latitude 65° and west of Longitude 132°. The writer, in addition, maintained a base camp and provided logistical support and scientific direction for field work carried out by L. D. Dyke, W. H. Fritz and R. W. Macqueen as well as by J. A. Jeletzky and F. G. Young.

As a consequence of this work, the writer wished to report the occurrence of specular hematite in the Lower Cambrian on the east flank of Richardson Anticlinorium, of galena in the Lower Cambrian in the core of the anticlinorium, of copper and asbestos in Proterozoic rocks in the core of Taiga-Nahoni Fold Belt, of anthracitic coal in the Mesozoic on the northwest flank of Aklavik Arch, and of oil-saturated ironstone and sandstone in the upper Paleozoic and the Lower Cretaceous respectively, on the west flank of Richardson Anticlinorium. Because of the reconnaissance nature of the projects, the true economic significance of these occurrences could not be established. They may be of interest to the reader, however, because they identify selected areas and stratigraphic levels at which mineral potential may be localized and prospected.

In addition, some significant emendations have been made to the Correlation Chart (Table 1) summarizing the stratigraphic framework of the Cordilleran Orogenic System within the project areas. Other corrections will necessarily depend upon further office and laboratory. Moreover, the writer re-established and augmented basic geologic control in the Snake River map-area (106F), because maps and notes were almost totally lost in the Margaret Lake fire in 1970.

In conjunction with N. N. Reiser of the U.S. Geological Survey, the writer re-examined the lithostratigraphy of the Neruokpuk Formation in Romanzof Uplift on both sides of the Yukon-Alaska border, and visited the type area of the Neruokpuk in the vicinity of Lake Peters, in Mount Michelson Quadrangle (Reiser et al. 1971) in northeastern Alaska. The coarse-grained, grey quartzites and associated grey, slaty argillites found there are noted to be very similar to lithologies observed in the Neruokpuk in Romanzof Uplift in Canada. This and other lithostratigraphic assemblages in the Neruokpuk which are recognized by U.S. geologists can be extended into Canada and mapped southeastward through the uplift to about Trail River where they are covered by Mississippian and younger sedimentary rocks. A closer study of the contact between the lower Paleozoic volcanic and limestone unit (see Table 1) and the underlying Neruokpuk would suggest that it is not angular as proposed by the writer (Norris, in press), but rather that the two rest in structural conformity with one another. Thus the Neruokpuk there is older than the late Early Cambrian but, depending on the structural and stratigraphic relations between this assemblage and that northeastward of it in the uplift, some of the Neruokpuk may be early Paleozoic in age. Indeed, a single Late Ordovician graptolite was found (Dutro et al., 1971) in dark grey, slaty argillite on the north flank of Romanzof Uplift along the International Boundary, and the occurrence of rocks coeval with part of the Road River Formation in Barn Uplift and in Richardson Anticlinorium was established.

The feldspathized, phyllitic argillites exposed on the east flank of Richardson Anticlinorium (see Norris et al. 1963) were restudied, their areal extent outlined, and their contact relations with the overlying Cambrian defined. According to W. H. Fritz (pers. com., 1973), trilobites collected from light grey limestone approximately 115 feet stratigraphically above the phyllites are late Early Cambrian in age, and the phyllites must be correspondingly older. The whole comprises an uplifted block, bounded on both flanks by north-northwest trending, nearly vertical faults. These limestones are particularly interesting because specular hematite (E. Ghent, University of Calgary, pers. com., 1973) was noted in limestone breccia at one locality immediately above the phyllites. The mineral occurrence is located near the headwaters of Caribou River in Trail River map-area (106L) at Latitude 66° 15.4'N, and Longitude 135° 23'W. Its precise location may be found on NAPL air photograph A13754-161, at the following Cartesian co-ordinates* measured with respect to the centre of the photograph where the positive Y-axis corresponds to the north direction: X =-0.50 cm., Y = + 1.58 cm. Moreover, J. Pilon of the Geological Survey reports (pers. com., 1973) the occurrence of galena in a sinkhole in this same (unnamed) limestone formation 15 miles to the southwest in Trail River map-area at Latitude 66° 07.0'N, Longitude 135° 48'W. Its location may be found on NAPL air photograph A14133-5 at the following co-ordinates: X = -1.53 cm., Y = -2.65 cm. The formation is exposed over an area of approximately 25 square miles in the core of the anticlinorium as well as in fault blocks on its east flank and it may warrant closer examination than that given it by the writer in the course of regional mapping.

A thirteen thousand, five hundred-foot section of Proterozoic clastics and carbonates (no base) immediately east of Blackstone River (Latitude 65° 01'N, Longitude 138° 05'W) in the extreme southeast corner of Ogilvie River map-area (116G) was restudied by L. D. Dyke, following the total loss of field notes in the 1970 fire. This examination was part of a broader study to establish the basic stratigraphic framework of the Proterozoic rocks in the project area. Noteworthy was his observation (L. D. Dyke, pers. com., 1973) of minor copper mineralization as well as some thin veins of fibrous asbestos in the contact zones of basic igneous dykes which have intruded, and appear to be confined to, the Proterozoic succession. The latter can be subdivided there into three bulk lithostratigraphic units, a lower argillite and quartzite unit, 7,500 feet thick, a middle quartzite unit, 1,500 feet thick, and an upper orange-weathering, stromatolite-bearing unit, 4,500 feet thick. The lower argillite and quartzite would appear to correlate with Unit 1 in adjacent Dawson, Larsen Creek and Nash Creek map-areas (Green, 1972), and the remainder to Unit 2.

A second Proterozoic section was measured by Dyke still farther west near the headwaters of Tatonduk River (Latitude 65° 22'N, Longitude 140° 16'W), with the objective of correlating these rocks exposed in the cores of anticlines and uplifted blocks in Taiga-Nahoni Fold Belt with the Tindir Group along the Alaska border. In this section he observed two units, a lower quartzite unit, 900 feet thick, and and upper, orange-weathering dolomite unit 775 feet thick. A spectacular angular unconformity separates the latter from the overlying Lower Cambrian carbonates. The two would appear to correspond to the upper units of the Blackstone River Section, and in turn

*For further details on this technique for precise location of points on the ground, the reader may wish to refer to Norris, 1972a.

to Green's (op. cit.) Unit 2. The hematite-rich shales and quartzites reported by Cairnes (1914, p. 53) in the vicinity of Tindir Creek along the Alaska border were not recognized by Dyke in either the Blackstone or Tatonduk sections. Although precise correlations with the Tindir are not yet worked out, the writer tentatively suggests that the stromatolite-bearing, orange-weathering dolomite and the quartzite unit underlying it may correspond to the "dolomite and shale" member (Brabb and Churkin, 1969), and the argillite and quartzite unit to the "shale" member. The latter two members comprise the basal units of the Tindir Group in the Charlie River Quadrangle (Brabb and Churkin, ibid.) in Alaska immediately adjacent to the Tatonduk section. Still younger parts of the Tindir would appear to have been removed at the sub-Cambrian unconformity.

Another granitic stock was discovered in northern Yukon Territory in Old Crow map-area (116-O) a few miles north of Porcupine River and about halfway between Mount Schaeffer and Driftwood River (Latitude 67° 35.7'N, Longitude 139° 15.0'W). There the intrusion is composed of two distinct phases, a grey, relatively fresh granite which would appear to be suitable for a radiometric age determination, and a pink, rather highly altered, fluorite-rich phase. Because of poor exposure, it was not possible to establish the contact relations between the two rock types or with the Tindir Group. It seems, however, that they belong to the family of Devonian or older, discordant, acid igneous intrusions in this part of the Cordilleran Orogenic System. Their presence should not detract from the hydrocarbon potential in Mississippian and younger rocks beneath Old Crow Plain.

Bright coal, determined to be anthracite (A. Cameron, pers. com., 1973) was discovered on the left (north) bank of a tributary of Bell River in Bell River map-area (116P) at Latitude 67° 55.5'N, Longitude 136° 57'W. It occurs in seams up to one foot thick as interbeds in dark grey, fine-grained sandstone deformed into tight folds with steeply south-plunging axes. Although no macrofossils were found with which to date these coal-bearing rocks, it would appear from regional mapping that they are Late Jurassic or Early Cretaceous in age. This is the third horizon at which coal is now known to be present in northern Yukon Territory, the first being anthracite in the Mississippian Kayak Formation (Norris, 1972b), on the periphery of Barn and Romanzof Uplifts, and the second being high volatile bituminous "C" coal in the Upper Cretaceous Moose Channel Formation (Norris, ibid.) on the Arctic Coastal Plain. The high rank of the Mississippian and Jurassic(?) coals clearly identifies deep burial and/or thermal metamorphism of the associated rocks and does not augur well for favourable hydrocarbon potential of stratigraphic levels below the Upper Cretaceous in this part of the orogenic system.

While mapping along the eastern margin of Eagle Plain, the writer revisited an outcrop of shale with septarian, ironstone nodules rich in fossil hash and saturated with natural hydrocarbons. The locality is in Eagle River map-area (116I) on a tributary from the west of Eagle River. It occurs at Latitude 66° 26'N, Longitude 137° 00'W, and may be precisely located on NAPL air photograph A12133-36 at the following co-ordinates: X = -3.34 cm., Y = -4.32 cm. According to E. W. Bamber (pers. com., 1973) the fossils would indicate that the rock is most probably late Paleozoic in age, and the writer, on the basis of its lithology, stratigraphic position and age, would assign the rock to the Mississippian Hart River Formation. Some nodules contain an abundance of saturated and aromatic hydrocarbons whereas the associated shales are essentially barren (L. Snowdon, pers. com., 1973).

In addition, the writer discovered an oil-saturated, porous, ridge-forming, fine-grained, quartz arenite four miles to the west of the septarian nodule occurrence in Eagle River map-area. The locality is at Latitude 66° 22.5'N, Longitude 137° 04'W, and may be located on NAPL air photograph A12133-80 at co-ordinates X = -0.70 cm., Y = +1.38 cm. It is abundantly rich in poorly preserved fossil claims and it is doubtful if a paleontological age can be ascertained. The writer, therefore, assigns the horizon to the lower part (Neocomian) of the Lower Cretaceous because of its stratigraphic position below the Upper Cretaceous Eagle Plain Formation and above the Mississippian Hart River Formation. The absence of lithic fragments, moreover, would not support the postulate that the horizon is part of the upper (Aptian-Albian) Lower Cretaceous sequence. According to L. Snowdon (pers. com., 1973), the sandstone also contains abundant saturated and aromatic hydrocarbons and the fact that the horizon is traceable for many miles to the north and to the south of the locality examined would suggest that significant oil-sand reserves may be present there.

With H. N. Reiser, the writer also examined the relatively fresh Tertiary or Quaternary amygdaloidal basalts in the vicinity of Porcupine River, 15 miles west of the Yukon-Alaska border (Brosgé and Reiser, 1969), and compared them with the hydrothermally altered and mildly cleaved basic volcanics on Lone Mountain (Latitude 67° 17.5'N, Longitude 139° 37'W) in Old Crow map-area. It was immediately apparent that the Lone Mountain volcanics were most likely older. Their proximity to highly sheared, basic dykes trending northeast along a major, nearly vertical fault a few miles north of Porcupine River, moreover, would suggest that they may be genetically related to the dykes. From regional considerations, activity on this fault would appear to have taken place in Middle to Late Cretaceous time and it is tentatively suggested that the Lone Mountain volcanics as well as these dykes may possibly have been emplaced in the Late Cretaceous.

Because of the tectonic significance and hydrocarbon potential of Upper Cretaceous and Lower Tertiary clastic rocks beneath the Mackenzie Delta and the Tuktoyaktuk Peninsula (Norris, in press) the writer restudied a well exposed partial section of these rocks on the right bank of Trail River in Herschel Island map-area (117D). It is located at Latitude 69° 02'N, Longitude 138° 32'W, and may be located on NAPL air photograph A13383-159 at co-ordinates X = +7.72 cm., Y = -9.37 cm. There a 155-foot sequence of interbedded sandstones, shales and conglomerates, assigned to the Moose Channel Formation, is almost completely exposed and is described below. The units in the section are identified by their respective numbers on Plate 2. Of particular interest is the Late Cretaceous (Senonian) age of Unit 3 (W. W. Brideaux, Internal Report, 1972), and the stratabound, faulted, overturned folds with southwest-dipping axial surfaces in Unit 5. The succession is considered by the writer to lie at the shoreward feather edge of the coarse, Moose Channel clastics and to face a depocentre offshore near the mouth of Babbage River (see Norris, in press, Fig. 1) The section has many of the attributes of wildflysch and is interpreted to represent rapidly deposited, channelled and slumped, soft sediments in a marine environment on the flank of the northeastwardly migrating Laramide foredeep. The section is as follows:

Unit	Description	Thickness (Feet)	Height Above Base
6	Sandstone and shale: sandstone, light grey, fine grained, platy to block weathering, in beds 1 inch to 4 feet thick; interbedded with shale, dark grey, fissile, in beds ½ inch to 13 inches thick. Unit is about 60% sandstone, 40% shale. No samples at this point. Beds are essentially flat lying.	6	155
5	Sandstone and shale: interbedded and acutely deformed by folding and faulting. Axial surfaces of folds commonly dip 45° south. Folds bounded and truncated by reverse faults dipping 20° to 70° south. Both folds and faults suggest differential northward transport of the unit with respect to nearly flat lying beds above and below. No samples here.	34	149
4	Conglomerate, poorly sorted but with textural layering quite apparent; flat lying. Phenoclasts subangular to subrounded, comprising banded medium and dark grey chert, green chert, light and medium-grey quartzite, soft, medium-grey shale, medium-grey quartz-chert fine-and medium-grained sandstone, and coarse-grained biotite granite. Sparse pale yellowish brown weathering, dark grey, coarsely recrystallized limestone. Large channels up to 130 feet across and 15 feet deep (see Plate 2).	47	115
3	Shale, dark grey, fissile, with thin pale yellowish grey and rusty brown weathering bentonitic layers up to ½ inch thick. GSC loc. C-18162 from bottom one foot of unit. GSC loc. C-18163 from top one foot of unit.	11	68
2	Conglomerate, poorly sorted but with textural layering quite apparent as in Unit 4. Phenoclasts of chert and quartzite, subangular to subrounded, commonly 1 inch to 3 inches maximum observed dimension but with occasional tabular blocks of medium grey, rusty weathering, conglomeratic sandstone up to 2 feet thick and 8 feet long. Flame structure in some of the blocks suggest indigenous origin for some blocks.	53	57
1	Conglomerate, very poorly sorted, with angular to subangular to subrounded clasts commonly 3 to 6 inches maximum observed dimension. Some tabular sandstone blocks measure up to 4 feet long and one foot thick. Base of exposure at river level.	4	4

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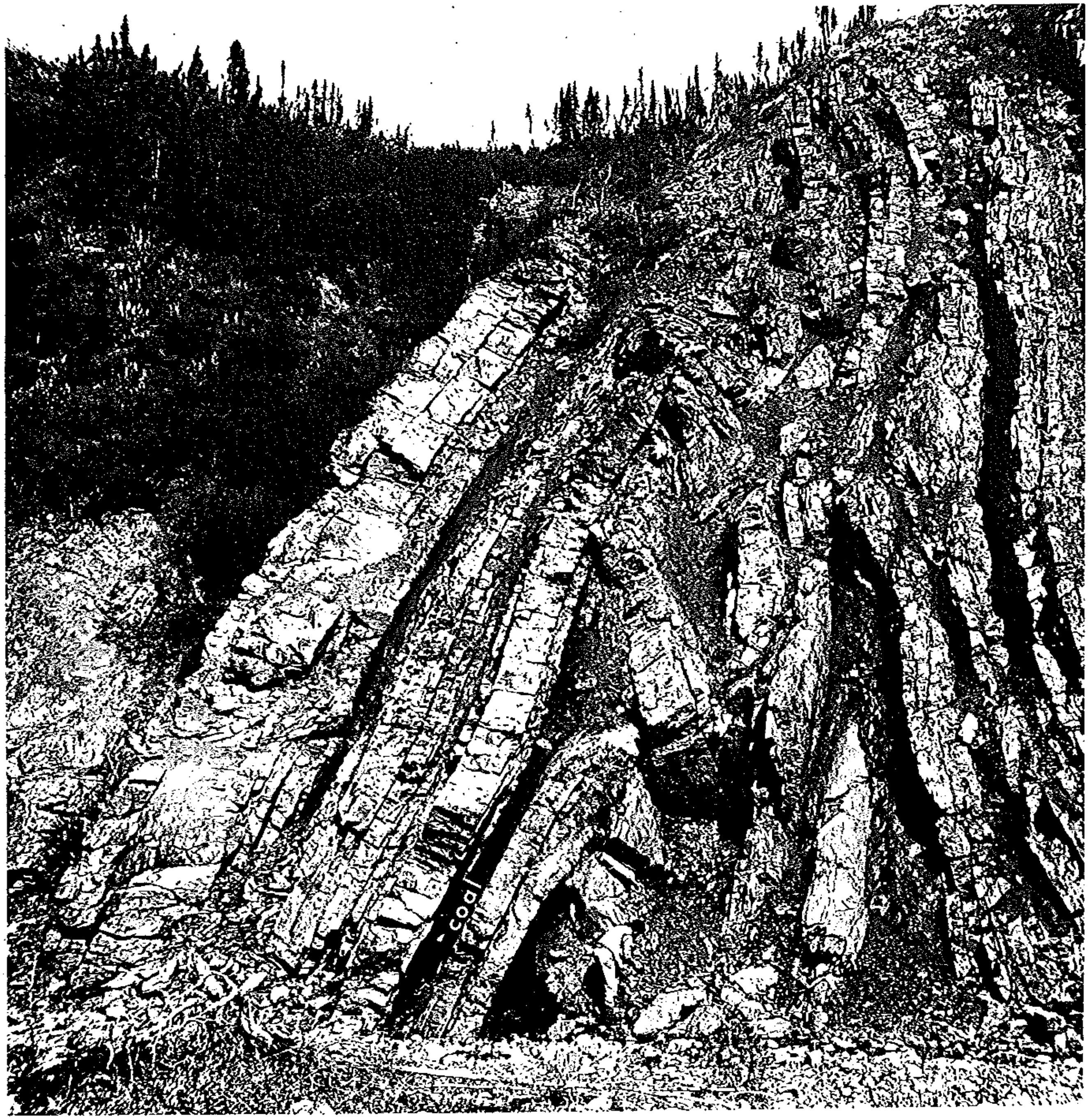


Plate 1. View to the north of acutely folded, coal-bearing rocks of Jurassic (?) age on the northwest flank of Aklavik Arch, northern Yukon Territory. Photo DKN, 1973.

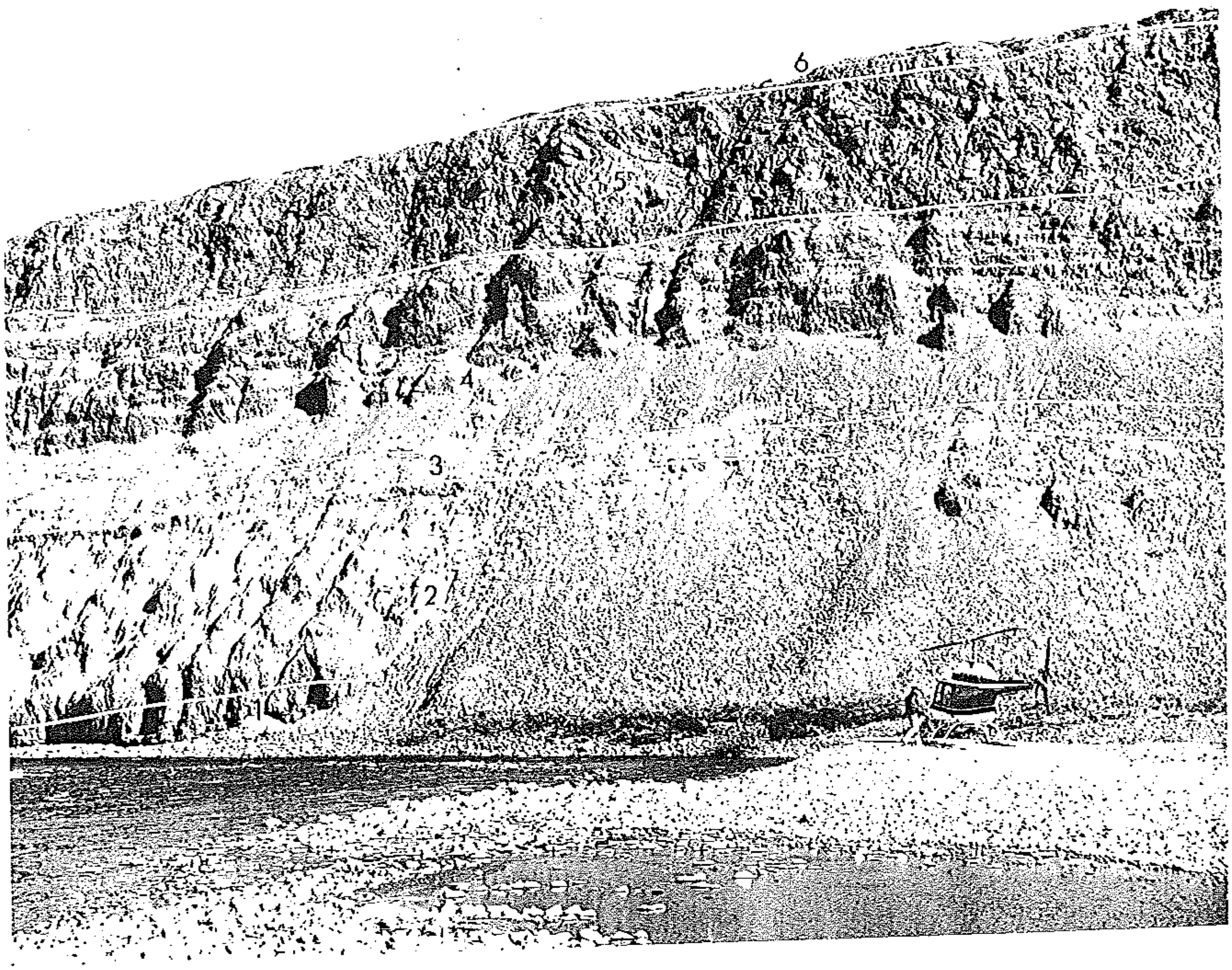
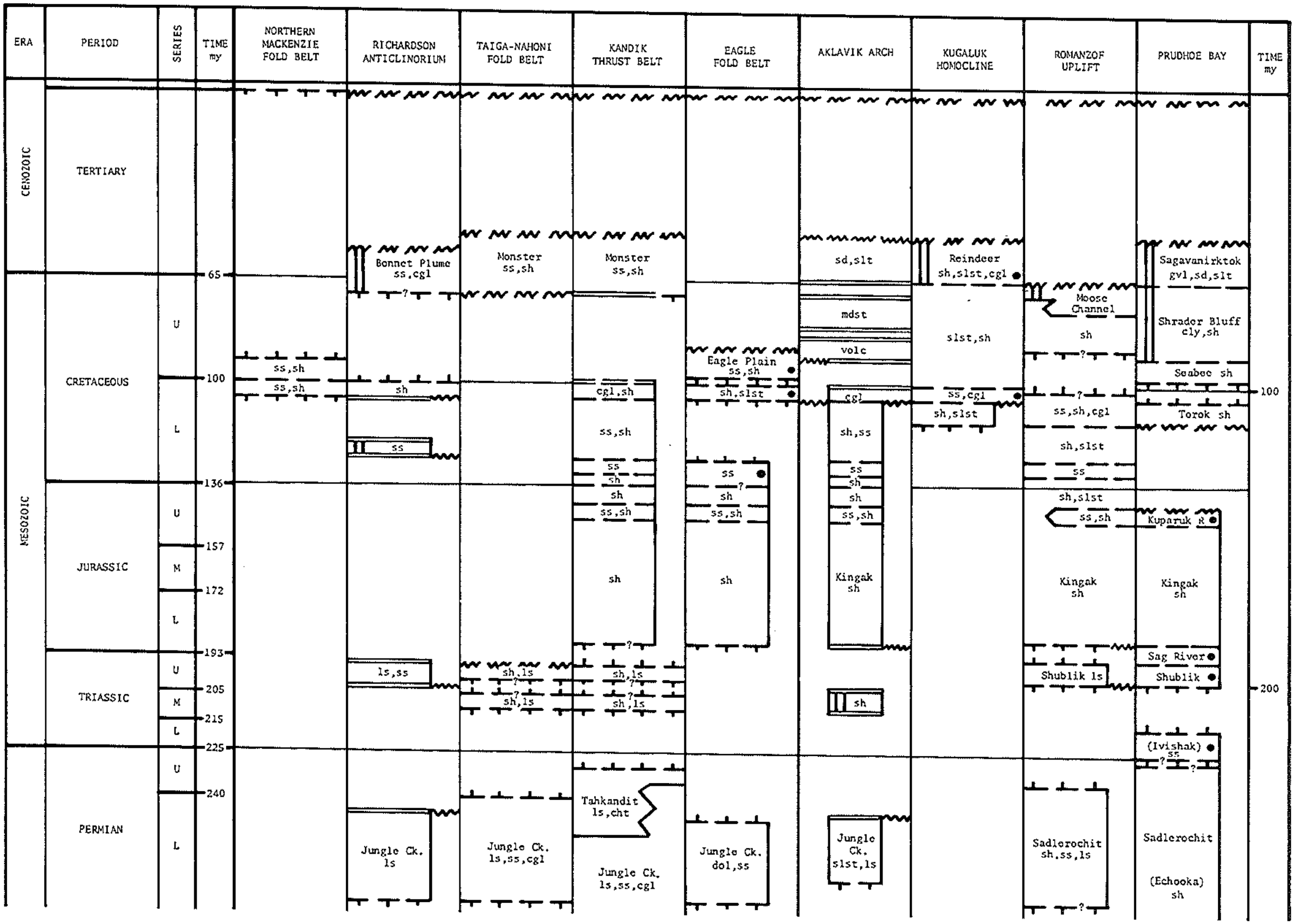


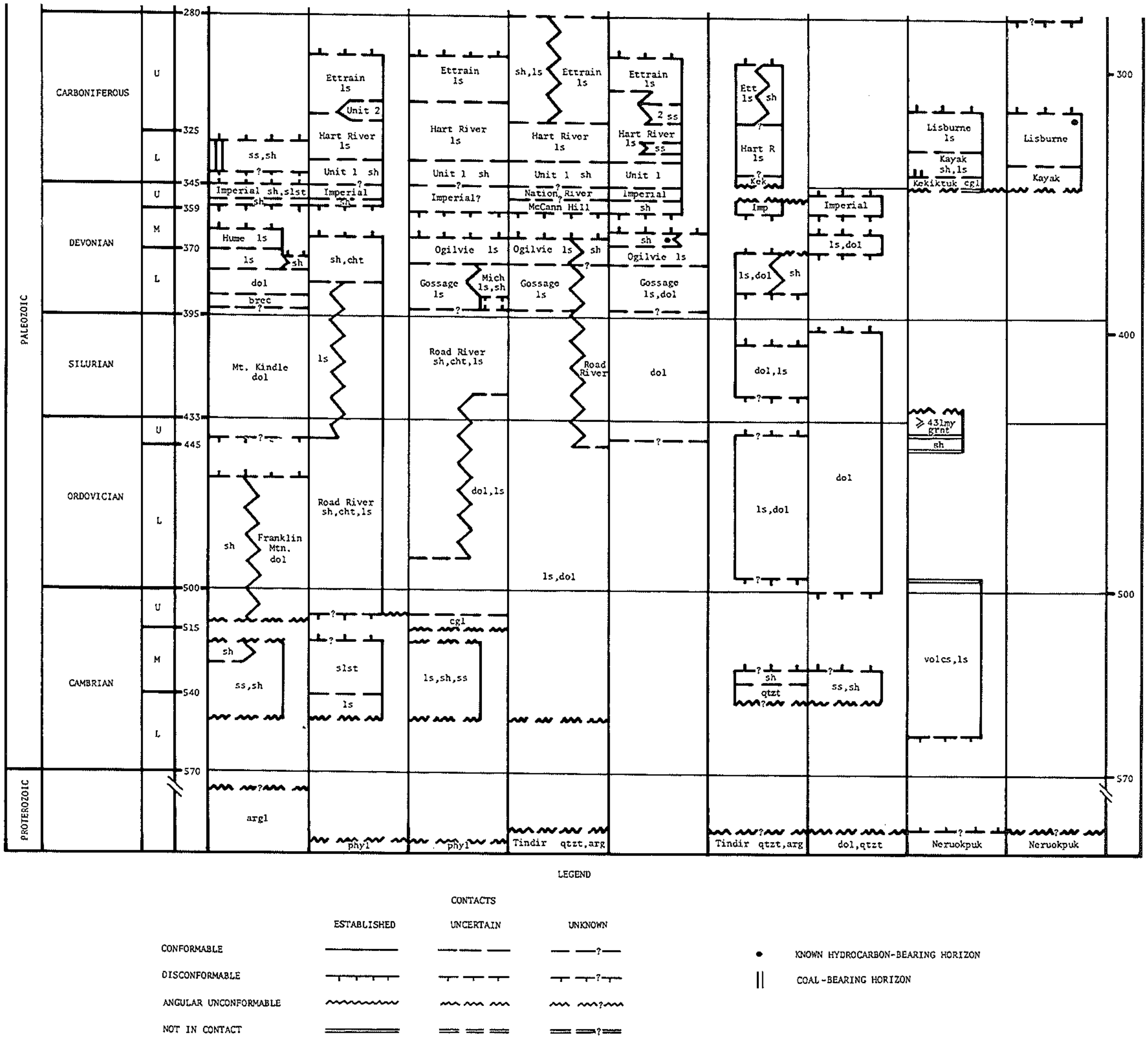
Plate 2. View to the southeast of Upper Cretaceous clastic sequence on lower Trail River in Arctic Coastal Plain, northern Yukon Territory. Photo DKN, 1973.

Table 1

CORRELATION CHART

NORTHERN YUKON TERRITORY, NORTHWESTERN DISTRICT OF MACKENZIE AND PRUDHOE BAY




PALEOZOIC
PROTEROZOIC
CARBONIFEROUS
DEVONIAN
SILURIAN
ORDOVICIAN
CAMBRIAN
U
L
M
280
325
345
359
370
395
433
445
500
515
540
570
300
400
Ettrain ls
Unit 2
Hart River ls
Unit 1 sh
Imperial
Imperial?
ss,sh
sh,slst
Hume ls
ls
dol
brec
sh,cht
Mt. Kindle dol
Franklin Mtn. dol
sh
Road River sh,cht,ls
Ogilvie ls
Gossage ls
Mich ls,sh
dol,ls
sh,ls
Nation River
McCann Hill
Road River
ls,dol
Gossage ls,dol
Ett ls
Hart R ls
Kek
Imp
dol,ls
Lisburne ls
Kayak sh,ls
Kekiktuk cgl
Lisburne
Kayak
431my grnt
volcs,ls
cgl
slst
ls,sh,ss
ss,sh
qtzt
argl
phyl
Tindir qtzt,arg
dol,qtzt
Neruokpuk
LEGEND
CONTACTS
ESTABLISHED
UNCERTAIN
UNKNOWN
CONFORMABLE
DISCONFORMABLE
ANGULAR UNCONFORMABLE
NOT IN CONTACT
KNOWN HYDROCARBON-BEARING HORIZON
COAL-BEARING HORIZON

PENRHYN GROUP METAMORPHIC COMPLEX, MELVILLE PENINSULA DISTRICT OF FRANKLIN

J. E. Reesor

During the field season, about two and one-half months were spent in the Penrhyn Group metasediments and the underlying basement granodiorite and granitic gneisses.[1] The work was concentrated along the boundary between NTS map-sheets 46 N and 46 K, with some work in the southwest corner of 46 O,P. A metamorphic age of about 1750 m.y. is indicated by a Rb/Sr isochron on Penrhyn metasediments and on a hornblende (K/Ar) from basement granodiorite gneiss. A $^{207}Pb/^{206}Pb$ age from granodiorite gneiss is about 2600 m.y., indicating an Archean age for the gneisses that are basement to the Penrhyn Group.

Metamorphic rocks of the Penrhyn Group consist of a well-differentiated, well-bedded sequence ranging from orthoquartzite, marble, and calcium silicate gneiss to schist, paragneiss, and impure quartzite. In spite of a high grade of metamorphism throughout the area examined, as well as evidence for three episodes of folding, a rude structural-lithological sequence can be recognized. The granodiorite-granite gneiss of the basement is in many places followed by a thin white orthoquartzite unit 35 metres or less in thickness. This is followed by a thin schist and then by a coarse-grained calcite marble. This is in turn followed by a biotite-quartz-feldspar paragneiss and schist with some feldspathic grey quartzite. This unit is commonly characterized by small, white, quartzo-feldspathic segregations arranged parallel to the compositional layering and the foliation defined by micaceous minerals. The succeeding unit is characterized by calcium-silicate gneiss with minor marble, some schist and some biotite-quartz-plagioclase paragneiss. This unit is again followed by biotite-quartz-plagioclase paragneiss, schist and grey feldspathic-quartzite. Although the 'stratigraphic' relations are not so far known, a few thin beds of magnetite iron-formation associated with a grey fine-grained biotite-feldspar quarzite and amphibolite layers has been found at scattered intervals, striking diagonally across map-sheet 46 N-3 from the northeast to the southwest corner.

Particularly within map-sheets 46 N-1 and 46 N-2 are rusty graphitic schists and sheared quartzo-feldspathic rocks. Brilliant colours of hematitic red or limonitic yellow characterize these gossan-like horizons. Locally they are characterized by massive pyrite and rarely may contain a little chalcopyrite. They occur at various stratigraphic horizons commonly not far from basement gneiss or granitic contacts.

Pelitic gneisses commonly contain the assemblages biotite-garnet-cordierite-quartz-sillimanite and biotite-garnet-sillimanite-potassium feldspar, as well as biotite-quartz-feldspar. Assemblages in marble and calcium-silicate gneisses consist of calcite-diopside-graphite, calcite-serpentine-diopside, calcite-quartz-diopside, calcite-humite group-spinel-graphite, diopside-quartz-scapolite-calcite, diopside-forsterite-calcite. Thus the level of metamorphism throughout the area examined lies in the uppermost amphibolite facies.

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[1] W. W. Heywood, 1967: Geological notes, northeastern District of Keewatin and southern Melville peninsula, District of Franklin, Northwest Territories (Parts of 46, 47, 56, 57); Geol. Surv. Can., Paper 66-40.

An east-northeast-trending structural culmination centred within map-sheets 46 N-1 and N-2 has resulted from the interfolding of basement and cover rocks. The folding is characterized by broad doubly plunging anticlinal zones of basement gneiss with narrow, tight, synclinal infolds of cover metasediments. This extensive deformation of basement and cover rocks is attributed to a second phase of folding, and evidence for extensive diapiric movement of basement gneiss into cover rocks has not been found.

An earlier phase of folding is attested in part by abrupt terminations of metasedimentary units within the succession with no evidence of faulting, and in part from refolding of layers (thrust slices?) of basement gneiss within the metasediments by second phase folds. On the other hand, a third phase of folding is evident and is best developed in areas peripheral to the 'domal' culminations. They are well developed in map-sheet 46 O-4 to the east of the culmination and there have a northeast trend. They are similarly well developed northwest of the culmination in 46 N-3 and are here trending northwestward where they result in preservation of metasediments with northeast trending second-phase folds in northwest trending synformal depressions and in exposure of basement gneiss in antiformal culminations.

Granite and granite pegmatite are found not only in regions dominated by basement gneiss, but throughout areas of metasediments as well. Granitoid bodies are in places structurally controlled and occur in sheets parallel with dominant compositional layering or in axial zones of large second-phase folds. It is not uncommon for such granitoid units to be concentrated in zones of great structural complexity. Pegmatites are commonly boudinaged and in places foliated. Thus the emplacement of these granitoid rocks was closely associated with the second phase of folding.

GAMMA-RAY SPECTROMETRY INVESTIGATIONS 1973

K. A. Richardson and B. W. Charbonneau

Major accomplishments of the airborne gamma-ray spectrometry programme in 1973 included surveys in northern Saskatchewan and Northwest Territories. In northern Saskatchewan, 7000 line kilometres (4400 line miles) of data were collected along east-west flight lines at 50 km line spacing. This was a cooperative project with the Department of Northern Saskatchewan, aimed at locating any regional trends of anomalous radioelement concentration that might have high potential for economic mineral occurrence. Results of the survey are published as GSC Open File No. 169 (Richardson et al, 1973).

In the District of Mackenzie, N.W.T., a 9600 line km (6000 line mile) survey covered NTS sheets 85 N, O, P and 75 M, at 5 km line spacing. Results of this work will be analyzed and prepared for Open File release early in 1974.

In addition, two cross country reconnaissance profiles were flown between Ottawa and Yellowknife, and two small areas were flown in the vicinity of Ottawa. A detailed survey of 960 line km (600 line miles) was flown over the Deloro stock on map sheet 31 C/12, to investigate the distribution of uranium within the intrusion (Grasty and Charbonneau, 1973). 800 line km (500 line miles) of data were collected over the Pembroke map sheet, 31 F, to complete the coverage of this map sheet at 10 km line spacing.

High sensitivity airborne gamma-ray spectrometry data collected since 1970 in the Northwest Territories cover fifteen 1:250,000 map sheets. The areas surveyed are outlined on Figure 1. To aid in the interpretation of the airborne data, and to evaluate the potential economic significance of different types of variations in radioelement concentrations and ratios, ground investigations were carried out in 1973. One hundred and twelve locations shown on Figure 1, were examined on the ground using a portable gamma-ray spectrometer. Some of the more interesting findings are outlined below.

Many of the locations visited were characterized by broad increases in airborne radioactivity levels, and these were generally found to relate to granitic rocks with thorium concentrations on the order of 50 - 100 ppm and uranium concentrations on the order of 20 ppm. Some of these showed evidence of secondary uranium mineralization as surface coatings of uranophane (e.g. Location 34)

Within the Bear Batholith (locations 2, 6, 11, 12, 13, 15, 19) a wide variety of granitic rocks have high radioelement contents and they contrasted with the generally low radioelement content in the terrain to the east. In the Slave province radioactivity levels in the granites between Yellowknife and Fort Rae (locations 31 - 37) show an increase westward towards the boundary of the Bear Province. North of the East Arm of Great Slave Lake, locations 60 - 69, mainly porphritic rocks, had high uranium and thorium concentrations.

Other areas with high uranium/thorium ratio values (locations 16-18, 22 - 27, 52 - 58) related to muscovite granite bodies between the East Arm and Indin Lake. In the Fort Smith survey south of the East Arm and within the Churchill province a belt of porphyroblastic granitic rocks was found to occupy the core of the anomalous zone. These rocks had particularly high thorium contents, with average levels of 200 ppm thorium and 15 ppm uranium along a three mile traverse at location 89. Anomalous uranium/thorium ratio values were found in the Fort Smith belt, related to granites peripheral to the high thorium porphyroblastic zone and in places (location 75) uranium concentrations exceeded 50 ppm.

A number of the ground locations visited had relatively narrow airborne anomalies. Several of these were associated with previously known uranium occurrences (localities 50, 59, 96). Three locations (locations 1, 25, 28) within the Bear province showed uranium concentrations not previously reported.

At Greenrock Lake (location 1) a sheared quartz-feldspar porphyry contained finely disseminated pitchblende with hematite, pyrite and minor chalcopyrite. Near Indin Lake (location 25) micaceous pegmatitic zones contained spot highs in excess of 100 ppm uranium. North of Winter Lake (location 28) a zone of quartz-rich, uranophane-stained granitic rocks intruding paragneiss showed ground concentrations exceeding 300 ppm urnium in spots.

Preliminary evaluation of these ground investigations suggests the most favourable airborne indications of uranium mineralization in the area of this investigation are the relatively narrow U with U/Th anomalies within or near regions of high general radioelement concentration.

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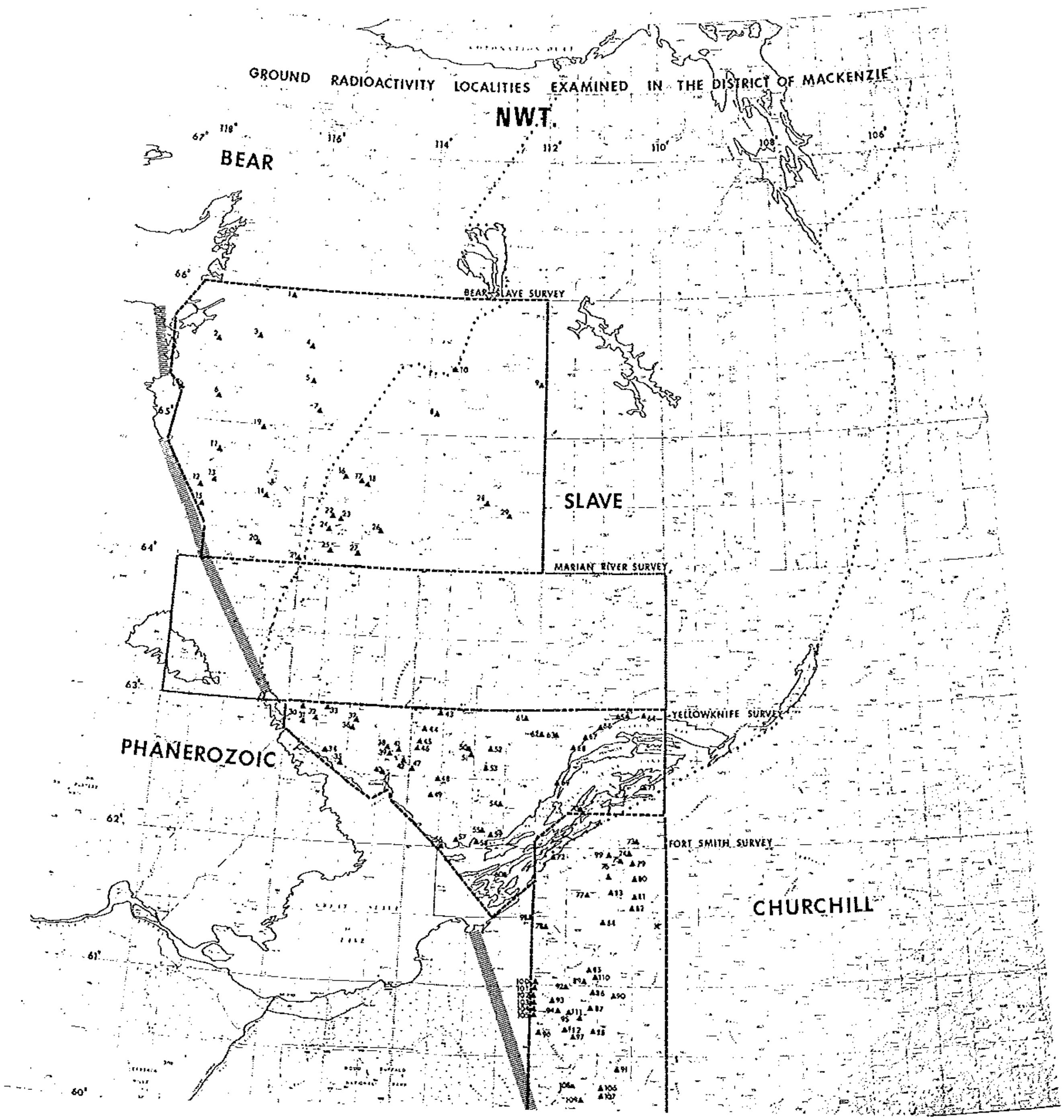
<u>Figure One</u> Location of airborne radio activity survey blocks in The Dist. of Mackenzie N.W.T. and positions of ground radio activity localities examined.


GROUND RADIOACTIVITY LOCALITIES EXAMINED IN THE DISTRICT OF MACKENZIE
N.W.T.
BEAR
SLAVE
PHANEROZOIC
CHURCHILL
BEAR-SLAVE SURVEY
MARIAN RIVER SURVEY
YELLOWKNIFE SURVEY
FORT SMITH SURVEY
118°
116°
114°
112°
110°
108°
106°
67°
66°
65°
64°
63°
62°
61°
60°

VOLCANIC STRATIGRAPHY AND METALLOGENY OF THE KAMINAK GROUP, SPI LAKE AREA DISTRICT OF KEEWATIN

R. H. Ridler

Fifty seven chemical analyses of volcanic rocks from the Spi Lake area, not reported previously, are presented (Fig. 1: Table I). Detailed structural information collected principally during the field season of 1972 (Ridler, 1973) but augmented by a single day's activity during August, 1973, are also presented (Fig.1).

Six fragments of sphalerite-rich massive sulphide exhalite were discovered on island "A" in Spi Lake (Fig. 1) by W. Shilts and two were analyzed (Shilts, 1974). The outcrops on islands "A" and "B" were examined subsequently by the author in August.

Island "A" is composed of a medium-grained polymictic breccia of overall intermadiate composition apparently correlative with the similar andesite unit defined by samples 12 and 13 on Fig. 1. Zones a few feet thick containing a small percentage of fragments of massive sulphide are present locally. The largest sulphide fragment observed was one inch in diameter. Island "B" is predominantly a massive, quartz-eye bearing rhyolite, apparently corralative with the similar rhyolite unit defined by samples 8,9,10, and 11 on Fig. 1 and the similar rhyolite at the main Spi Lake showing (sample 3006, Fig. 1). The outcrop displayed tuffaceous banding at only one locality on the southwest shore (Fig. 1). On the northeast shore is a small gossan developed on a network of veins of pyrite and minor chalcopyrite associated with quartz-eye bearing chloritite. Just south of sample locality 10 (Fig. 1), towards the top of the rhyolite unit, is a zone of irregularly distributed pyritic mineralization. North-northeast trending diabase dykes intersect island "B".

The main exhalite zone thus appears to pass between the two islands as indicated on Fig. 1. It lies towards or at the top of a prominent thyolite unit which at the main showing and on island "B" possesses typical stratygraphic hanging-wall alteration. It is overlain by an andesite breccia unit and has probably contributed the sulphide fragments present in that unit. The fragments of massive sulphide found in the glacial drift on island "A" appear to have been plucked from the main exhalite zone by glacial action within a short distance up ice from where they were found.

The Spi Lake area has been extensively faulted. Offsets are to be expected along the diabase dykes and their associated fracture system. In addition, the prominent north-south fracture cleavage axial planar to the anticline east of Spi Lake has been the locus of faulting. Dextral offsets of the older, north 60° east, mineral foliation and bedding have been observed but sinistral offsets may also be present (Fig. 1). Thus, correlation across the axial zone of the anticline is difficult and apparent thicknesses of the major stratigraphic units are only approximate. The siderite exhalite zone in the vicinity of samples 28 and 29 (Fig. 1) may not be correlative with the main Spi Lake zone, as was originally thought, but lie several thousand stratigraphic feet above it. A prominent zone of highly foliated rocks, perhaps a mylonite zone, occurs in the vicinity of samples 195 to 200 on Fig. 1. The zone strikes approximately north 45° east and lies exactly along strike from the Kaminak Lake - Quartzite Lake through of the Hurwitz Group. It may well be a member of the fault system controlling the disposition of the trough and undoubtedly adds to the structural complexity of the area. Considering these factors, it is possible that a block containing the main exhalite zone north of island

"A" gas been faulted south in the vicinity of the southeast end of the island such that the newly discovered massive sulphide fragments may be within a few feet of their source.

The fold pattern shown of Fig. 1 is an attempt to accommodate the diverse and complex relation observed using an "interference" type of fold model. In this case the syncline indicated is a "first" fold and the two anticlines are "second" folds. Regardless of whatever model is used to interpret the folding, the observed pattern is very complex and bedding orientations may be expected to be extremely diverse. More detailed mapping will undoubtedly modify the preliminary pattern.

The chemical analyses (Table I) speak for themselves. The Spi Lake area is obviously one of the world's major concentrations of Archean intermediate to felsic volcanic rocks.

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TABLE I Chemical Analyses of Volcanic Rocks, Spi Lake Area

Sample Number	Rock Type	MnO	TiO_2	CaO	K_2O	SiO_2	Al_2O_3	MgO	FeO	Fe_2O_3	Na_2O	P_2O_5	CO_2	H_2OT	Total
1	Dacite Breccia	0.07	0.52	3.9	1.2	59.1	17.0	3.6	4.1	1.6	2.8	0.09	2.2	3.6	99.8
2	Andesite(?) Pillow Lava	0.10	0.75	7.1	1.4	56.9	15.9	2.5	5.1	1.7	1.3	0.13	4.7	3.7	101.3
3	Andesite(?) Breccia	0.11	0.82	4.9	0.3	51.5	15.1	5.5	6.9	2.4	3.5	0.12	4.3	4.1	99.5
4	Andesite(?) Breccia	0.13	0.73	8.5	1.3	51.9	15.0	5.4	5.1	2.2	2.1	0.13	5.6	3.4	101.5
5	Dacite Breccia	0.12	0.74	6.7	1.9	58.3	14.8	1.4	5.2	1.7	0.9	0.12	5.0	3.3	100.1
6	Dacite Breccia(?)	0.08	0.84	2.6	0.9	62.3	14.1	2.1	5.3	2.7	4.2	0.13	1.6	2.8	99.6
7	Basalt Pillow Lava	0.14	0.76	8.0	0.0	49.3	13.8	8.2	7.1	3.0	3.2	0.13	3.5	4.3	101.5
8	Rhyolite Tuff	0.05	0.22	4.4	1.8	71.8	12.8	0.8	2.2	0.5	0.7	0.04	3.3	2.0	100.6
9	Rhyolite Tuff	0.07	0.19	3.4	2.5	69.1	15.1	1.2	1.9	0.5	1.9	0.03	3.0	1.8	100.7
10	Rhyolite Breccia	0.06	0.31	2.2	2.2	72.4	14.0	1.2	3.0	0.2	1.3	0.06	1.7	2.2	100.8
11	Rhyolite Flow(?)	0.05	0.35	2.7	1.7	71.1	14.5	0.7	2.8	0.3	3.5	0.06	1.8	1.7	101.3
12	Andesite Breccia	0.14	0.74	7.7	1.1	53.5	15.4	4.8	5.5	2.0	2.3	0.12	5.2	3.4	101.9
13	Andesite(?) Breccia	0.10	0.69	6.0	0.7	56.4	16.8	4.2	6.1	0.9	2.9	0.08	4.6	3.7	103.1
14	Rhyodacite Flow(?)	0.06	0.69	3.2	1.3	66.1	15.3	1.4	4.4	0.6	3.1	0.12	2.6	2.7	101.6
15	Rhyodacite(?) Breccia	Initial analysis inaccurate													
16	Rhyodacite Breccia	0.03	0.68	1.9	1.3	65.5	15.7	2.2	4.6	1.1	3.0	0.12	1.6	3.2	101.0
17	Rhyodacite(?) Breccia	Initial analysis inaccurate													
18	Dacite Breccia	0.09	0.59	2.3	1.0	63.6	14.2	2.8	4.9	1.7	4.7	0.09	2.6	2.6	101.2
19	Dacite Flow	0.14	0.88	4.1	0.5	63.6	14.0	1.8	5.0	1.7	5.5	0.12	2.1	1.9	101.4

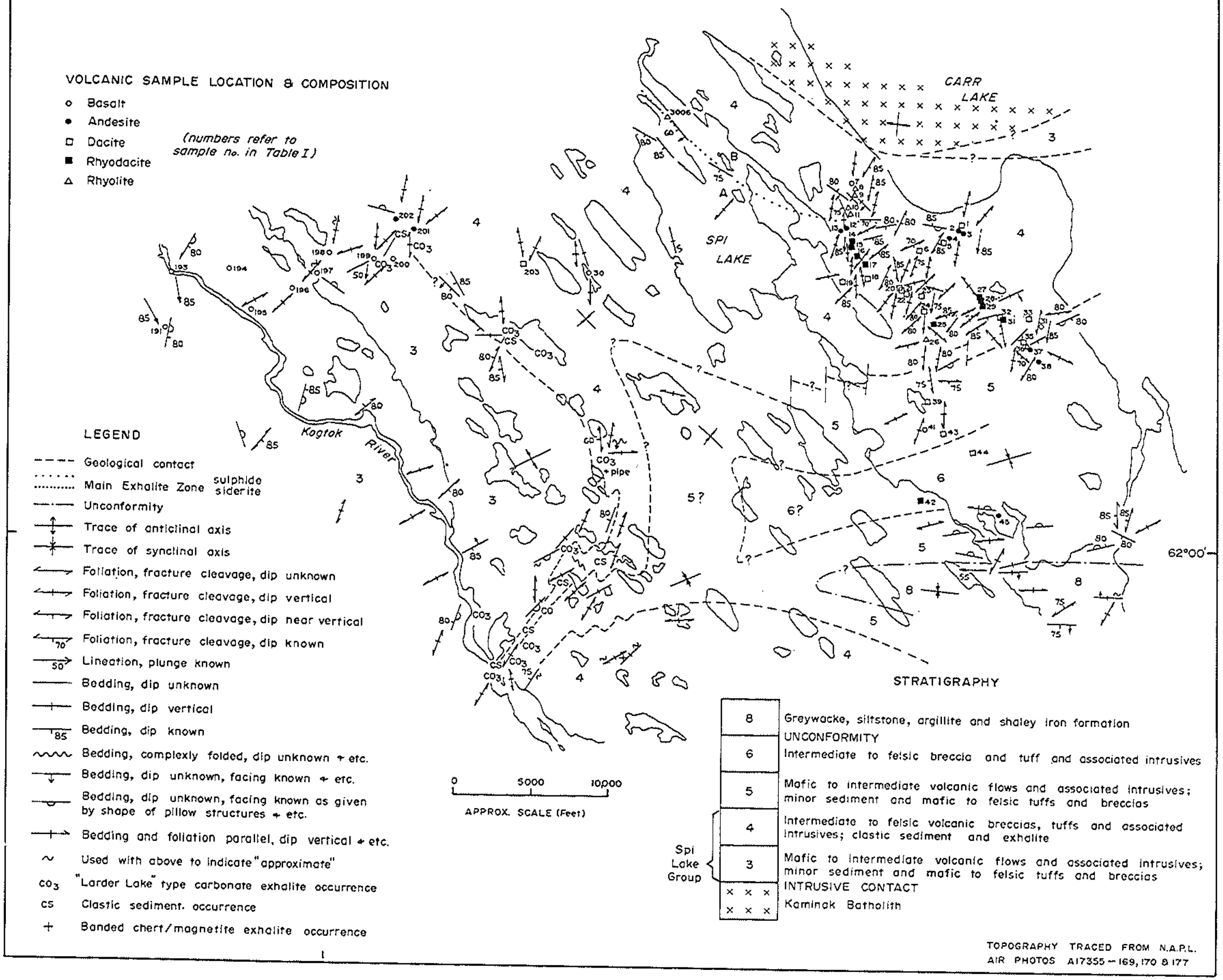
TABLE I (cont'd)

Sample Number	Rock Type	MnO	TiO_2	CaO	K_2O	SiO_2	Al_2O_3	MgO	FeO	Fe_2O_3	Na_2O	P_2O_5	CO_2	H_2OT	Total
20	Dacite Breccia	0.09	0.58	1.9	0.6	59.4	16.5	5.5	4.4	2.5	4.9	0.09	1.7	3.0	100.3
21	Dacite Tuff	0.09	0.44	4.8	3.0	62.4	14.3	3.2	3.7	1.2	1.0	0.10	3.6	3.2	101.0
22	Dacite Flow	0.07	0.42	3.0	0.1	60.9	15.5	5.1	4.9	1.8	5.0	0.10	0.5	3.0	100.4
23	Dacite Breccia	0.15	0.45	5.0	2.7	60.1	14.3	2.2	4.8	1.6	0.9	0.10	4.5	3.4	100.3
24	Dacite Breccia	0.10	0.55	6.0	1.2	62.3	14.9	1.4	3.1	0.7	3.1	0.13	4.0	2.5	100.0
25	Rhyodacite Breccia	0.03	0.45	4.0	1.2	66.4	16.2	0.5	2.0	0.2	4.5	0.11	2.6	1.7	99.9
26	Rhyolite(?) Breccia	Initial analysis inaccurate													
27	Rhyodacite Flow	0.07	0.50	5.0	1.0	64.5	15.4	0.8	2.4	0.7	4.6	0.19	3.2	1.8	100.2
28	Rhyodacite Altered	Initial analysis inaccurate													
29	Rhyodacite Breccia	0.13	0.47	5.4	1.0	65.1	15.5	0.6	3.0	0.5	3.0	0.11	3.9	2.0	100.7
30	Basalt Breccia	0.16	0.70	8.0	1.2	47.5	14.7	9.1	5.7	2.3	3.7	0.11	4.5	3.7	101.4
31	Rhyodacite Flow	0.05	0.32	5.5	1.0	68.1	15.1	0.2	1.0	0.0	4.8	0.10	3.6	1.1	100.9
32	Dacite Breccia	0.15	0.50	3.7	1.0	61.8	17.4	1.0	3.9	1.6	4.2	0.12	3.1	2.4	100.9
33	Dacite Breccia	0.04	0.42	5.5	1.3	62.7	15.6	1.0	1.9	0.2	4.3	0.10	5.9	1.4	100.4
34	Basalt Pillow Lava	0.16	0.65	11.1	1.3	50.4	15.0	5.5	5.0	1.7	1.6	0.13	7.5	1.3	101.3
35	Dacite Pillow Lava	0.07	0.38	4.5	1.6	64.5	15.5	2.3	3.3	1.5	3.9	0.07	2.0	2.0	101.6
36	Rhyolite Flow(?)	0.01	0.09	1.7	2.8	74.6	13.8	0.4	1.4	0.1	3.2	0.00	1.2	1.2	100.4
37	Andesite Pillow Lava	0.13	0.92	5.7	0.9	53.5	16.0	3.4	5.7	2.8	3.5	0.23	5.0	3.2	101.0
38	Andesite Breccia	0.16	0.86	6.3	0.2	53.3	14.0	3.8	5.6	4.8	4.5	0.22	2.9	1.3	97.9

TABLE I (cont'd)

Sample Number	Rock Type	MnO	TiO_2	CaO	K_2O	SiO_2	Al_2O_3	MgO	FeO	Fe_2O_3	Na_2O	P_2O_5	CO_2	H_2OT	Total
39	Diorite	0.10	0.85	5.0	0.6	60.5	14.2	3.7	6.0	2.5	4.4	0.19	0.6	2.9	101.5
41	Gabbro	0.17	0.69	5.6	1.0	51.6	13.3	10.5	8.5	2.8	2.6	0.13	0.2	3.8	101.0
42	Rhyodacite Breccia	0.12	0.93	3.1	1.4	65.6	14.7	1.7	5.7	1.2	4.3	0.26	0.2	1.8	101.0
43	Dacite Breccia	0.11	0.74	7.2	1.1	60.7	15.1	4.6	5.3	1.9	2.4	0.11	0.0	2.8	102.6
44	Gabbro	0.09	0.63	7.2	0.5	60.4	15.7	3.4	4.3	2.1	3.9	0.15	0.4	1.4	100.2
45	Andesite Pillow Lava	0.09	0.64	6.0	1.7	56.2	16.7	5.2	5.8	1.6	3.1	0.13	0.1	2.9	100.2
191	Basalt Pillow Lava	0.17	1.45	11.6	0.7	48.6	14.4	2.4	5.8	1.8	4.3	0.26	6.1	2.8	100.4
193	Basalt Pillow Lava	Initial analysis inaccurate													
194	Basalt Pillow Lava	0.22	1.03	12.7	0.0	41.5	12.7	7.1	8.8	3.3	2.5	0.07	5.5	4.3	99.7
195	Basalt Pillow Lava	0.29	1.05	13.8	0.1	41.5	13.4	5.7	9.1	2.4	2.2	0.06	7.1	4.7	101.4
196	Basalt Ropey Lava	0.26	1.62	11.7	0.5	42.6	13.0	4.4	8.6	3.4	4.2	0.12	6.5	3.2	100.1
197	Basalt Flow	0.32	1.19	10.8	0.0	40.9	12.6	7.2	10.9	3.3	2.9	0.08	6.0	4.3	100.5
198	Basalt Flow	Initial analysis inaccurate													
199	Basalt Pillow Lava	0.28	1.22	7.6	0.2	39.7	14.1	8.0	12.4	6.2	2.8	0.07	1.7	5.0	99.3
200	Gabbro	0.28	1.14	6.7	0.0	42.9	12.5	9.6	12.7	5.2	2.7	0.10	0.1	4.5	98.4
201	Andesite Breccia	0.13	1.50	6.0	1.1	52.5	15.2	3.1	7.3	2.8	3.9	0.41	3.6	3.0	100.5
202	Andesite Pillow Lava	0.14	1.59	6.0	0.9	52.6	14.3	2.9	7.1	1.9	4.7	0.37	5.8	2.4	100.7
203	Dacite Breccia	0.05	0.84	1.6	2.5	61.5	19.3	1.8	5.6	0.9	2.3	0.12	0.9	3.2	100.6
3006	Rhyolite Breccia	0.07	0.61	3.4	1.7	69.8	14.0	1.5	3.8	0.5	3.6	0.10	0.6	1.7	101.4

Geological Sketch Map, Spi Lake Area, N.W.T.



VOLCANIC ROCKS OF THE PRINCE ALBERT GROUP

Mikkel Schau

Detailed mapping of the distribution of the basic remnants of the highly but variably deformed Archean or lower Proterozoic supracrustal rocks which now form the Prince Albert Group was started in NTS 56 J, K. Exemplary assistance was rendered by S.W. Campbell (senior), G. Campbell, L. deBie and P. Marchand (juniors). Base camp was established between June 17, and August 24 on the Hayes River, approximately 156 miles west of Repulse Bay.

The results of most interest include the locating and shipping of soapstone suitable for carving to Repulse Bay and the discovery of sparsely disseminated molybdenite and chalcopyrite in seriate to porphyritic granitic rocks. The establishement of the probable presence of gneissic basement, the presence of a thin ultramafic complex whose areal demensions must approach that of the Bushveld Complex, and the recognition of areal variation in structural style and metamorphic grade constitute the important geological results.

The rocks of the Prince Albert Group are thought to rest upon a basement of diverse character. One kind of basement gneiss is a foliated and gneissic tonalite. Another kind is a schist-pegmatite complex in which "dent de cheval" up to 10 cm are common and in which at least 4 differently folded sets of pegmatite dykes are emplaced. Other kinds of gneisses, although not easily distinguished from later gneiss, are also thought to be basement. Contacts between Prince Albert Group and basement are not usually exposed or they are masked by ultramafic sills. In one place the unconformity is exposed. Here, vertically foliated tonalite grades over 10 m into well layered vertically dipping metasedimentary rock. Flattened discs (pebbles?) of felsic material are found in the above interval. One hundred metres away, within a metagreywacke rare crossbeds and ripple-marks indicate the gneiss must underlie the sediment. Indirect evidence that some gneisses are basement is given by the fact that ultramafic dykes traverse them as well as the Prince Albert Group. In younger gneisses the ultramafic dykes have been tectonically disrupted.

Rocks of the group are mainly schist with only a few rock preserving primary sedimentary structures. About a third are chlorite or actinolite schists, another third are phyllite, biotite schists, or gneissic metasedimentary rocks. Of the remainder, metamorphosed iron formations and very pure quartzites are approximately equally abundant. Greenstones and amphibolites constitute a tenth of the belt and limy rocks account for less than 1% of the total. Primary volcanic features noted include cobble and pebble breccias, local tuff horizons as well as quartz and feldspar porphyry dykes. Sedimentary structures are exceedingly rare but crossbedding and ripple-marks have been seen in metagreywacke. The stratigraphy has not yet been solved. Iron-formations structurally underlie metavolcanic rocks and rest upon quarta-rich metasedimentary rocks, yet indicators within the sequence suggest that quartizite is younger than greenstone and iron-formation.

Ultrabasic rocks were emplaced as sills and dykes in the Prince Albert Group near iron-formations and along the unconformity with the gneisses. The ultramafic units vary in thickness from a few metres to hundreds of metres and the lateral extent of the complex is in excess of 300 km. Temporally associated but somewhat spatially removed is a thick sill and thin dykes of doubly folded-meta-anorthosite with avoid gabbro emplaced in the group and basement gneiss. The presence of spinifex texture in a khaki-coloured actinolite biotite bearing dyke rock which cuts the above ultramafic complex but is probably genetically related to it, suggests that the ultramafic complex was emplaced near the surface. The low grade of metamorphism of the ultramafic rocks in NTS 56 K is similar to that noted at Rankin Inlet but no sulphide accumulations were noted.

Gabbro occurs as irregular stock and dyke complexes associated with the metavolcanic rocks. Other gabbro bodies are also commonly found near or cutting ultramafic bodies. Finally, gabbro dykes traverse the region. An older set is sheared and folded; a younger set is fresh diabase and is thought to be part of the MacKenzie swarm.

Metamorphism and intensity of deformation vary in the two map-sheets. Rocks are of low metamorphic grade and are deformed by open but complex and refolded folds in the southwest, whereas rocks are of high metamorphic grade and are deformed by tight refolded isoclinal folds in the east. Kyanite is found in the S.W. whereas sillimanite is found farther east. Whether these variations were due to a lateral increase in temperature or due to differential uplift is not certain, but NS faults whose east side moved up have been mapped in the area. Some of the Prince Albert Group rocks are now gneisses. Attempts to provide criteria which are useful in sub-dividing gneisses are continuing. Preliminary cluster analysis of specific shape and compositional perameters of gneisses yield statistically significant but geologically complex results.

Within the basement gneisses in a region (91° 13'W, 77° 56'N) where porphyritic to seriate granite and gneissic granite are the most abundant rock types, sparse molybdenite and chalcopyrite are found disseminated near, as well as localized on, shear surfaces. The area is small and attempts to define a geochemical halo by testing (by cold extraction) stream silts and bogs, were unsuccessful. Nevertheless, the presence of economically interesting sulphides should renew interest in the granitic rocks in this region. Locally abundant arsenopyrite and pyrite, located near a contact but in a (altered) porphyritic quartz monzonite (93° 17'W, 66° 14'N) reinforces this notion.

STRATIGRAPHY AND STRUCTURE OF PELLY MOUNTAINS

D. Tempelman-Kluit, G. Abbott and B. Read

Study of Lower Paleozoic rocks in the Pelly Mountains was initiated as a follow-up to earlier reconnaissance geological mapping. Work was aimed at comparing and contrasting the stratigraphic and structural relations of Cambro-Ordovician phyllite at four widely separated localities with similar possible correlative rocks found in Anvil Range where they are host to stratabound zinc-lead mineralization.

A part of Quiet Lake map-area (105F) south of Ross River (N 61° 35' to N 62° 00' and W 132° 15' to W 133° 00') where extensive areas of phyllite have been mapped (i.e. unit 2 of Wheeler, Green and Riddick, 1960) was examined by Tempelman-Kluit. There the belt of phyllite mapped along the southwest side of Tintina Trench is a zone in which northwest trending normal faults expose a variety of rock units. Phyllite, from which trilobites of probable Upper Cambrian age (W. H. Fritz, personal communication) were recovered at two localities, underlie only a small part of this zone. Other rocks include a prominent black slate and argillite unit found in fault blocks near Tintina Trench. Middle Devonian crinoid columnals were discovered in some of these rocks and they may be a facies equivalent of the Silurian and Devonian massive carbonate unit of Wheeler, Green and Roddick (1960), which contains the same fossils. A prominent bright orange weathering cherty tuff unit with large lenses of sandy grey limestone several hundred feet thick is also found in this faulted belt. A well preserved and diverse conodont fauna of probable Middle Upper Triassic age (B. E. B. Cameron, personal communication) was recovered from the limestone.

These Triassic rocks differ markedly from strata of the Lewes River Group, but resemble those found in and north of Tintina Trench elsewhere in Yukon. The limestone is equivalent to unit 8 of Wheeler, Green and Roddick (1960), but unit 8 as mapped by them may include older rocks. A resistant, red-brown weathering thin bedded siltstone and limestone unit whose stratigraphic relations are unknown also occurs in blocks in this faulted belt. The Devonian and Mississippian unit 5 (black clastic and volcanic) of Wheeler, Green and Roddick (1960) is probably equivalent to their unit 6 (volcanic) and the two map-units are apparently time equivalents. Phyllite mapped as unit 2 (Wheeler, Green and Roddick, 1960) around Lapie Lakes differs from that found nearer Tintina Trench (also included in unit 2). The former contains prominent flows and tuffs of intermediate to basic composition and strikingly resembles the lead-zinc host rocks of the Anvil district. The latter does not contain volcanic rocks.

The style of deformation in the faulted belt along Tintina Trench is characterized by northeasterly directed thrust faults involving rocks at least as young as Upper Devonian cut by younger steeply dipping normal faults that are Cretaceous or Tertiary. The significance of the important structural discordance defined by the difference in internal structure between the Siluro-Devonian and older rocks is unknown.

B. Read studied Lower Cambrian rocks near Ketza River in detail and paid particular attention to the relations between these rocks and the overlying phyllite (unit 2 of Wheeler, Green and Roddick, 1960). In the area examined the contact appears conformable. A section measured in the Lower Cambrian rocks is summarized in columnar form in Figure 1.

G. Abbott examined the phyllite at two localities (Mount. Hundere, N 60° 32', W 128° 54' in Watson Lake map-area and near McEvoy Lake, N 61° 48', W 130° 13' in Finlayson Lake map-area) to compare its lithology and structural relationships with that of possible equivalent strata in Anvil Range.

The phyllitic rocks at both localities include a wide variety of lithologies but have some similarities to one another and to those in Anvil District. At Mount Hundere the phyllite (unit 4 of Gabrielse, 1967) commonly includes tuffaceous or volcanogenic phyllite and small greenstone lenses like those of unit 3 in Anvil Range (Tempelman-Kluit, 1972). Near McEvoy Lake the phyllite (unit 2 of Wheeler, Green and Roddick, 1960a) includes gritty quartizite like that of the Proterozoic "Grit Unit" as well as dark spotted hornfels and phyllitic argillite. Light coloured, thinly banded, calc-silicate skarn and hornfels, also included in this unit, closely resembles unit 2 of Tempelman-Kluit (1972), and apparently overlies the gritty rocks.

At Mount Hundere the phyllite is characterized by highly irregular small scale folds outlined by bedding. The foliation related to these folds is itself tightly folded, and this folding has led to development of a new axial plane foloation. A strong foliation cuts bedding in the phyllite at McEvoy Lake, but is not itself folded.

The internal structure of the phyllite differs markedly from that of the overlying Siluro-Devonian rocks at both localities because these younger rocks are not internally deformed. Whether this difference is evidence of unconformable relations, as suggested in the Anvil district, or whether it is the expression of differences in competency of the rocks is not resolved.

The area southwest of Tintina Trench has been considered unfavourable for occurrences of large stratabound base metal showings, and has been neglected in exploration for such deposits. Considering the general similarity between the lower Paleozoic succession of this region and that of Selwyn basin, and considering that carbonate-shale facies boundaries, so prominent in this area, are targets for mineral exploration in more northeasterly parts of Yukon, this neglect seems unwarranted.

An occurrence of finely disseminated galena and sphalerite in light coloured banded skarn was found about six miles south-southeast of the eastern tip of McEvoy Lake.

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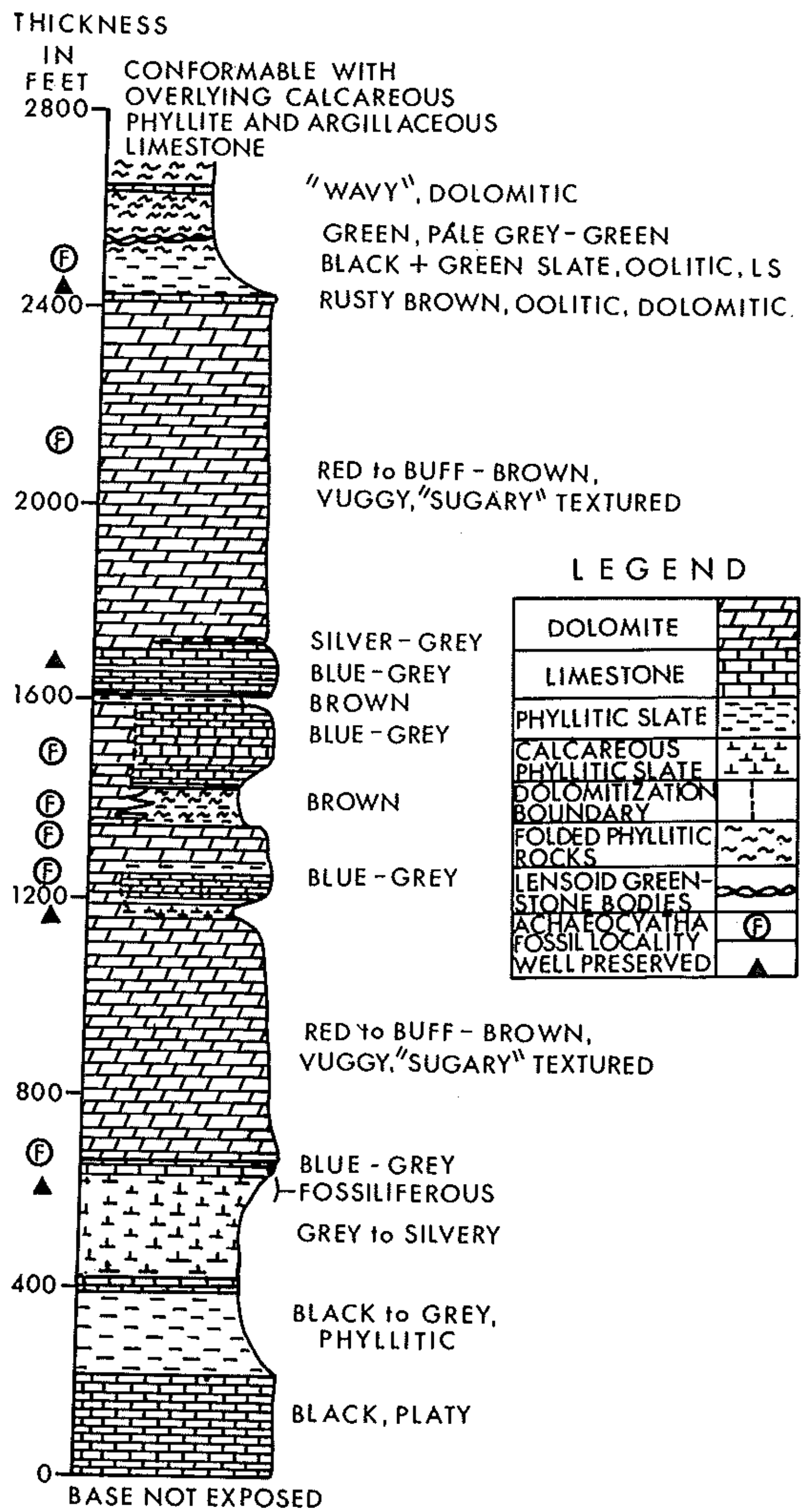
LOWER CAMBRIAN SECTION 5 MILES S.W. OF THE KETZA RIVER 61° 34' 06" N, 122° 23' 36" W



FOLLOW-UP INVESTIGATIONS ON THE BEAR-SLAVE GEOCHEMICAL OPERATION

E. M. Cameron and C. C. Durham

INTRODUCTION

In 1972, a geochemical reconnaissance of 36,000 square miles of the Bear and Slave Geological Provinces was carried out. Near-shore lake sediment samples were collected by helicopter; these samples being analysed in Ottawa for 27 elements. A report and contoured maps for the more economically important elements were published earlier this year (Allan, Cameron and Durham, 1973; Allan and Cameron, 1973a-1973g).

The data obtained from the Bear-Slave operation are of restricted value in untreated form; they acquire wider significance only when interpreted into terms meaningful to economic geologists, or to those concerned with estimating mineral potential. The various anomalies across the survey area can be, in part, interpreted on the basis of our previous studies of primary and secondary geochemical dispersion within selected areas of these geological provinces (Allan, Cameron and Durham, 1972). However, a more authoritative interpretation demands follow-up investigations in the field. This was the purpose of this summer's project.

The region chosen for follow-up work (Fig. 1) is near the eastern boundaries of the Slave Province and the 1972 survey area. It is approximately 1500 square miles in extent. This area was selected, firstly, because it contains a variety of geochemical anomalies, both in metasedimentary and granitic terrane. In addition, apart from a short summer season and uncertain weather, this part of the Barren Lands is splendid country in which to carry out geological work, because of good exposure of the rocks. A further factor was that this region has attracted little exploration activity, so that our studies can help to determine its mineral potential.

The amount of field work was governed by a budgetary limit of 100 hours of helicopter use, plus fixed wing support. Field work was carried out throughout the month of July from a base camp at Regan Lake. A Hiller 12-E helicopter was used mainly for lake sediment sampling and a float-equipped Cessna-180 for rock and soil sampling traverses and gas caching. Follow-up studies of this type require immediate analytical results, in order to guide further sampling. Accordingly, a field laboratory was set up under canvas at Regan Lake where samples of lake sediments, soils and gossans were analysed for Zn and Cu. A related activity in the field area during the summer was aerial colour photography of the southern part of the follow-up area. Also, a mineral exploration company carried out follow-up studies of geochemical anomalies in the eastern part of the 1972 survey area.

Mr. George Thomas (senior assistant) and Mr. Ken Lawrence (helicopter pilot) combined to form a highly efficient lake sampling team. Field analyses were carried out by Mr. Ron Crook and in Ottawa by Mrs. Alice MacLaurin and Miss Elizabeth Ruzgaitis. Mr. Robert Hornal, I.A.N.D. Resident Geologist, and his staff extended many courtesies during the field season. We are most grateful to all of these persons.

ANALYTICAL METHODS

Colorimetric methods were used in the field to determine Zn and Cu in lake sediment, soil and some gossan samples. 2-2 biquinoline was the reagent used for copper and dithizone for zinc. Lead was not determined because of the dangers involved in using the cyanide buffer required for this test in a tent laboratory. As will be described below, this lack of a lead test was a serious omission.

All samples were sieved using 80 and 250-mesh screens. The minus 250-mesh material was used for analysis. The drying and sieving of the samples proved time-consuming, and seriously strained the limited manpower resources of the party. We hope to determine by laboratory studies whether the consistency of analytical data gained by drying and sieving the samples is really essential for field determinations in this region.

Cu, Zn, Pb, Ni, Ag, Mn and Fe are presently being analysed in our Ottawa laboratories by atomic absorption spectrometry, following a hot 4M HNO_3 leach. As is being determined colormetrically using silver diethyldithiocarbamate following a hot 6M HCl leach. In both cases minus 250-mesh material is being analysed. It is important to note that of the above elements Cu, Pb, Ni and Fe in the 1972 Bear-Slave samples were analysed by a different method, namely, direct-reading emission spectrometry. For these elements the results of the two surveys are not directly comparable, since the HNO_3 leach only partly extracts the metal, while the emission spectrometer determines the total metal content. Differences between the two methods are greatest for Pb and Ni, and are only slight for Cu. The detection limit of Pb is approximately 3 ppm. For Ag the detection limit is 0.5 ppm; samples containing less than this amount are assigned a value of 0.2 ppm.

At the time of writing, analysis of rock samples was just commencing; this part of the study will not be discussed in this report.

APPROACH TO FOLLOW-UP STUDIES

The first phase of this year's work was to establish the reliability of the 1972 reconnaissance sampling data. This was done by resampling the 1500 square mile area shown in Figure 1 using different lakes from those sampled in 1972. The contoured maps of the 1972 data show that many of the anomalies are of tens to a few hundred square miles in extent. Others are small, one sample anomalies. The 1973 lake sediment resampling confirmed that the large anomalies and some of the single sample anomalies are reproducible with a different sampling pattern. Some of the single point anomalies are confined to one lake or to part of a lake. These are, of course, not reproducible. This type of anomaly is generally found for those elements that do not migrate in solution in the lake systems, or in areas where environmental conditions tend to fix even the more mobile elements.

The second phase of the study was to determine the variation in the element content of samples taken at intervals along the shores of anomalous lakes. This work will not be discussed in this report.

The third and major part of the work was a study of the primary and secondary geochemical dispersion within a number of anomalous areas. This involved detailed sampling of lake sediments, plus sampling of rocks, soils and any gossans present. The anomalies were selected to represent a variety of different characteristics.

1. Anomalies for Cu*, Zn*, As*, Co*, Ni*, Mn* generally found in areas mapped as metasedimentary.

   Anomaly Y - A large, intense anomaly in the northern part of the Beechey Lake metasedimentary belt (Fig. 1). Anomaly peaks for Zn (230 ppm), Cu (161 ppm) and As (28 ppm) are approximately eight times greater than background values. The anomaly occurs near the margin of the metasedimentary belt and in the adjacent granitic terrane and is approx-

* Elements having a concentration ratio of 3 or greater between anomaly peak and background.

imately 200 square miles in extent.

Anomaly X - This was chosen as a weaker and much less extensive anomaly of this type. It encompasses only a few tens of square miles. It also occurs at the margin of a metasedimentary belt and in adjacent granites.

Anomaly C - Anomaly C was selected as a single point, very intense anomaly. The sample from this anomaly contains 413 ppm Zn, 257 ppm Cu, 219 ppm Ni and 92 ppm Co, all one order of magnitude or more greater than the regional background for these elements. The anomaly occurs near the margin of the Beechey Lake metasedimentary belt.

Prior to visiting the field, the interpretation given these anomalies was they were derived from sulphide mineralization associated with unmapped volcanic rocks that lie along the margin of the Beechey Lake metasedimentary belt.

2. Anomalies for U*, Zn*, Cu*, Mo*, As*, Ni*, Co*, La*, and Li* in areas of granitic rocks.

Anomaly D - This anomaly occurs in a large area of granitic rocks south of the main 1973 survey area (Fig. 1). The anomaly is particularly distinct for U with values to 70 ppm or two orders of magnitude greater than background. Prior to visiting this area it was thought that possibly the anomaly was related to granitic rocks with a high background content of these elements, rather than to mineralization. To test this hypothesis only rock samples were collected from this area.

Anomaly M - This area contains a small anomaly of type 2 in granites and an anomaly of type 1 in the adjacent metasedimentary belt. It was sampled in order to test a possible genetic connection between the composition of granites and mineralization in nearby metasedimentary (or metavolcanic) rocks.

At this time of writing, the analytical data that are available allow only an interpretation of Anomalies X and Y. An interpretation of the other anomalies will be given in a later report, along with a more comprehensive account of Anomalies X and Y.

INTERPRETATION OF ANOMALY Y

The area containing the west-central part and peak of this anomaly is shown in Figure 2, the centre of which is at 65° 36'N, 107° 55'W. The western part of the area shown comprises 7000 feet of near-vertical volcanic rocks of intermediate to acidic compostion. They are in contact with granites to the southwest. Near the centre of this area a very thick sequence of metasediments rests upon the volcanic rocks. Slates form the base of this steeply dipping sequence; being easily eroded the slates form a narrow valley that strikes north-northeast, parallel to the contact with the volcanic rocks. The upper one thousand feet of volcanics are highly siliceous and form a ridge.

A narrow line of gossans derived from sulphide minerals is present along the contact between the volcanic and sedimentary rocks. This is termed the "A" horizon gossans. Another line of gossans - the "B" horizon gossans - is developed stratigraphically below the upper silicious volcanics (Fig. 2). These "B" horizon gossans are restricted in lateral extent, although gossans may be observed in a similar stratigraphic position to the north and south. This gossan horizon is absent or is very thin near the northern and southern margins of the area in Figure 2. It thickens near the centre of the area and its maximum thickness is intersected by Soil Traverse 641. In this zone of maximum thickness the rocks below the gossan have been hydrothermally altered, with almost complete loss of Ca and Na.

The anomalous metal contents of lake sediments in this area we believe were derived from the oxidation of base metal mineralization within horizons "A" and "B". During the oxidation of these sulphides, Pb and Ag were largely fixed in the soils overlying the mineralization, while Zn and Cu were not retained but were dispersed in solution throughout the drainage system. The retention of the former two metals in the soils is caused by the relative insolubility of their sulphates, compared to those of Zn and Cu, plus the lesser tendency of Zn and Cu to complex formation, and their greater ease of hydrolysis. As has an intermediate character; much of this element is retained in the soils, but some is dispersed in the drainage system.

All lake sediments down-drainage from the mineralized volcanic terrane are notably anomalous in Zn and Cu, relative to the regional background of 32 ppm and 20 ppm respectively. Note that Pb and Ag begin to rise above background levels only in the immediate vicinity of the mineralized volcanic rocks. During the 1972 reconnaissance sampling, two lake sediment samples were taken from the area of Figure 2. One is from the lake in the northwestern corner, the other from the southernmost lake along the volcanic/sediment contact.

The four soil sampling traverses shown in Figure 2 were made in order to more closely locate the source of the base metals. Unfortunately, the field determinations for Zn and Cu were of no assistance, because of the leaching of these elements from the soils. The soils were sampled at a depth of 6-8 inches. Table 1 gives chemical data for Soil Traverse 641. Sample 641 is from the eastern end of this traverse, and 658 is the westernmost sample. The intermediate sample numbers missing from Table 1 are for rock samples collected along the traverse. Zn is low, in the range 14-79 ppm over the slates. It rises to twice this range over the volcanic rocks. Cu is also low over the slates, but rises to 858 ppm further along the traverse. Pb and Ag show the most striking anomalies with peaks of 83 ppm Pb and 3.4 ppm Ag over the "A" horizon and 1.3% Pb and 41 ppm Ag over the "B" horizon. As has highly anomalous concentrations over both the slates and the volcanic rocks. In the case of this element, the lake sediment anomalies were probably derived from both of these sources.

The two northern traverse lines show much weaker, but distinct, peaks for Pb and Ag over horizons "A" and "B". Spot samples taken at irregular intervals along the length of horizon "B" are generally anomalous for these two elements, but the highest values occur only in the zone of maximum thickness near Traverse 641. It is significant that by far the highest values for Pb and Ag obtained from lake sediments are found in a lake that overlies the southern extension of horizon "B" (Fig. 2).

Lead is present in soil sample 654 (Table 1) as plumbojarosite and anglesite. These minerals occur as a fine powder or grain coating. No galena is present. The Pb and Ag are fairly evenly distributed between the different size fractions, but Pb reaches a peak of 2.2% in the minus 80, plus 250-mesh fraction.

Notable amounts of the sulphides of Zn, Cu or Pb were not found along either the "A" or "B" horizons, although it should be pointed out an intensive search for these minerals was not made. Pyrite and pyrrhotite are very common. We would suggest that if the former sulphides are present that they have been selectively oxidized, relative to iron sulphides. Minor disseminated sphalerite, that was difficult to identify in the field, was seen in the altered volcanic rocks under the "B" horizon gossans.

Molybdenite was found on a rock sampling traverse near the base of the volcanic sequence shown in Figure 2.

In order to test the hypotheses that Zn and Cu are largely lost from the soild overlying mineralization, we sampled gossans from the Hackett River area to the north. One sample is from the Cleaver Lake zone and two are from the Camp Lake deposit. This deposit is reported to contain in excess of 10 million tons of 8% Pb-Zn, and 300 ppm Ag. The data for these samples is shown in Table 2. Needless to say, three samples are not representative of these very variable gossans, but they do confirm the loss of Zn and the retention of Pb. The data for Ag is ambiguous.

GOSSAN SAMPLE	Zn	Cu	Pb	Ag	As
Gleaver Lake, 1034	173	122	2,800	8.7	97
Camp Lake, 1035	232	209	956	0.2	22
Camp Lake, 1036	99	81	161	0.2	17

Table 2. Zn, Cu, Pb, Ag and As (as ppm) in gossan samples from Hackett River area.

The geochemical data obtained from Anomaly Y area outline targets for more detailed exploration. Gossan horizon "B", near to its intersection with Soil Traverse 641, is a particularly interesting target. It displays the essential features of stratabound, volcanogenic, massive sulphide mineralization (Sangster, 1972a). The mineralization occurs in siliceous volcanic rocks, in which it is distributed along a plane of stratification. It thickens into what appears to be a lenticular-shaped body, which is underlain by altered volcanic rocks, characteristic of those found in feeder pipes. Neither the geochemical data nor the geological evidence allows us to estimate whether the mineralization is any more than an interesting prospect. Like all other exploration methods, only a small proportion of geochemical anomalies disclose economically viable deposits. However, irrespective of such considerations, the area provides an excellent example of geochemical dispersion from mineralization that provides the basis for geochemical methods of exploration and resource appraisal in the northern Shield (Fig. 3).

INTERPRETATION OF ANOMALY X

This area, 25 miles south of the area of Anomaly Y, is very similar geologically to the latter. Near-vertical metavolcanic rocks, that strike east-west are in contact with metasediments to the south. Slates at the contact form a long, narrow valley that contains a chain of lakes. The volcanic sequence is thicker here - in the order of 25,000 feet - and is in contact with granites to the north. A line of gossans, that are equivalent to the "A" horizon gossans to the north, are present along the contact between the volcanic rocks and the sediments. These gossans may be followed for more than 10 miles. Another gossan horizon is present approximately 5,000 feet down the volcanic succession. Like the "B" horizon gossans to the north, these are much more restricted in lateral extent and are associated with hydrothermally altered volcanic rocks. At this location too, the two groups of gossans will be referred to as the "A" and "B" horizons.

The gossans present in the area of Anomalies Y and X are only a few of the many hundreds of gossans that may be seen in the eastern part of the Slave Province. Those that are associated with Anomaly Y are not conspicuous, which may account for us not observing any signs of exploration activity in the area. Gossans were not noted on the field map of the geological party that traversed the ground shown in Figure 2 during Operation Thelon (Wright, 1957). In contrast, those present in the area of Anomaly X are among the most conspicuous in the entire area, and are comparable to those in the Hackett River camp to the north. They have attracted a limited amount of exploration activity, for we observed a few shallow pits. Some parts of the area have, in the past, been staked.

Geochemical dispersion within this area follows the pattern shown in Figure 3, that is from the volcanic areas of high relief south into lakes in the metasedimentary terrane. We have found no evidence of base metal mineralization associated with the "B" horizon gossans in this area, which are developed at 65°18.5'N, 108°08'W. Lake sediment and gossan samples taken here are relatively low in Zn, Cu, Pb, Ag and As. In contrast, samples of sediments taken from lakes immediately adjacent to the "A" horizon gossans are often much richer in Zn and Cu than the samples from Anomaly Y (Fig. 2). Values as high as 948 ppm Zn and 1167 ppm Cu were obtained. The zone of maximum Zn and Cu values in lake sediments extends from 65°18'N, 108°09'W to 65°15'N, 107°55'W. Soil and gossan sampling traverses were carried out along this zone, parallel to the strike. The Zn and Cu content of these samples is much lower than the adjacent lake sediments, attesting again to the leaching of these elements from the soils. Some soil samples are anomalous for Pb, Ag and As, but there are no values as high as those measured on Soil Traverse 641 to the north. The most anomalous sample was taken at 65°16.5 N, 108°02'W and contains 20 ppm Zn, 38 ppm Cu, 134 ppm Pb, 21 ppm Ag and 8 ppm As. The closest lake sediment sample, approximately 750 feet distant, contains 948 ppm Zn, 201 ppm Cu, 2 ppm Pb, 0.2 ppm Ag and 4 ppm As.

Conclusions

Geochemical Methods of Exploration in the Northern Shield

Geochemical methods have had only limited success in mineral exploration in mineral exploration in the southern Shield. The thick glacial cover, disorganized drainage and, in many places, the absence of deep weathering, has discouraged the introduction of such methods in the traditional exploration country. Many exploration geologists and geochemists have extrapolated these considerations to the colder northern Shield and have concluded that it is an even more difficult environment for the application of geochemistry.

Over the past four years, work on the surficial geochemistry of the northern Shield, mainly by our colleagues R.J. Allan, E.H.W. Hornbrook, and W.W. Shilts, has done much to discourage these beliefs. The anomalies that we have studied this summer serve to show that this country is eminently suitable for applied geochemistry; indeed, in places it may be close to ideal. The most critical element in this is that there has been intensive weathering of sulphides. This has allowed the wide dispersion of ore and indicator elements in the drainage systems. Moreover, chemical weathering has had little effect on the rocks and consequently there is a high degree of exposure in the region. This provides a particularly excellent opportunity for the integration of methods based on secondary dispersion with those based on primary geochemical dispersion.

Resource Evaluation in the Northern Shield

Evaluation of the resource potential of Canada's landmass is becoming an increasingly important part of the work of the G.S.C. In the northern Shield this evaluation must depend on the reconnaissance geological mapping carried out since the 1950s and also on aeromagnetic maps. Massive sulphide deposits and gold are most often found in the Shield in areas of siliceous volcanic rocks. Areas containing such rocks are considered to be of high mineral potential. It is, therefore, significant to note that in the reconnaissance surveys of the areas of Anomalies X and Y and the adjacent terrane, that siliceous volcanic rocks were not recognised. At Anomaly Y, the main portion of the volcanic sequence shown in Figure 2 was identified as "gneisses probably derived from Yellowknife sedimentary rocks". The upper one thousand feet, comprising highly siliceous volcanics, was identified as granitic (Wright, 1957). In the south at Anomaly Y the volcanic rocks east of 108° were mapped as granites (Wright, 1957), while those west of 108° and in contact with the gossans were described as white quartzites (Fraser, 1964). It should be noted that the mapping was carried out by some of the most experienced geologists to have worked in the Canadian Shield. Further, similar rocks to the north, at Hackett River, have proven troublesome to identify even when less hurried study of their lithology was possible (Sangster, 1972b). In identifying the critical sections as volcanic rocks, the present writers had the benefit of chemical data and knowledge of the debate over similar rocks at Hackett River.

The point which we wish to make is that if terrane in the Shield is classified as quartzitic or granitic, estimates of mineral potential for the area are likely to be low. In contrast, if siliceous volcanics are known to occur, the area will be assigned a high potential. Such considerations are particularly critical when map data is fed into a computer-based evaluation program. There may be many other similar examples in the northern Shield that are an inevitable consequence of the reconnaissance nature of existing maps. We suggest that reconnaissance geochemical surveys provides one means of focussing attention on particular areas for more detailed geological mapping.

TABLE 1

Zn, Cu, Pb, Ag and As (as ppm) in soil samples from Soil Traverse 641 (see Fig. 2). Sample 641 is easternmost sample; 658 is westernmost sample.

SOIL SAMPLE	Zn	Cu	Pb	Ag	As
641	37	25	15	0.2	44
642	67	44	10	0.2	309
643	31	31	20	0.2	239
644	14	10	15	0.7	92
645	26	20	10	0.2	72
646	79	297	83	3.4	317
647	112	206	271	3.1	92
648	47	116	2	0.2	7
650	136	856	1,370	23.0	145
651	26	56	206	4.7	13
653	141	163	189	0.2	28
654	42	450	12,600	41.0	890
656	126	189	259	3.1	7
657	93	158	644	11.0	22
658	75	38	25	1.0	12

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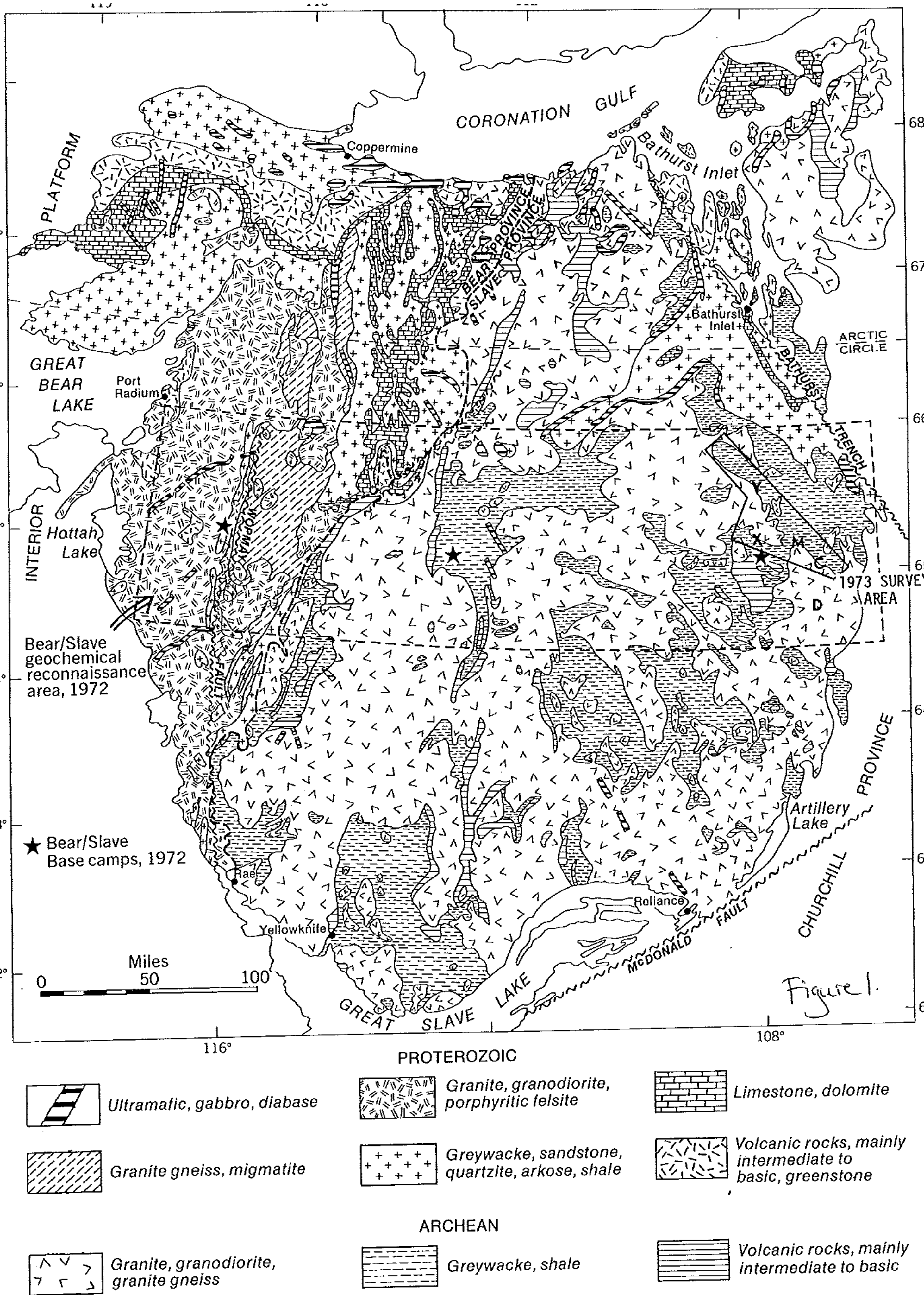
FIGURES

Figure 1. Geological map showing the location of the Bear-Slave Geochemical Operation, 1972 and the follow-up area, 1973. Letters X, Y, M, C and D refer to specific geochemical anomalies studies in 1973.

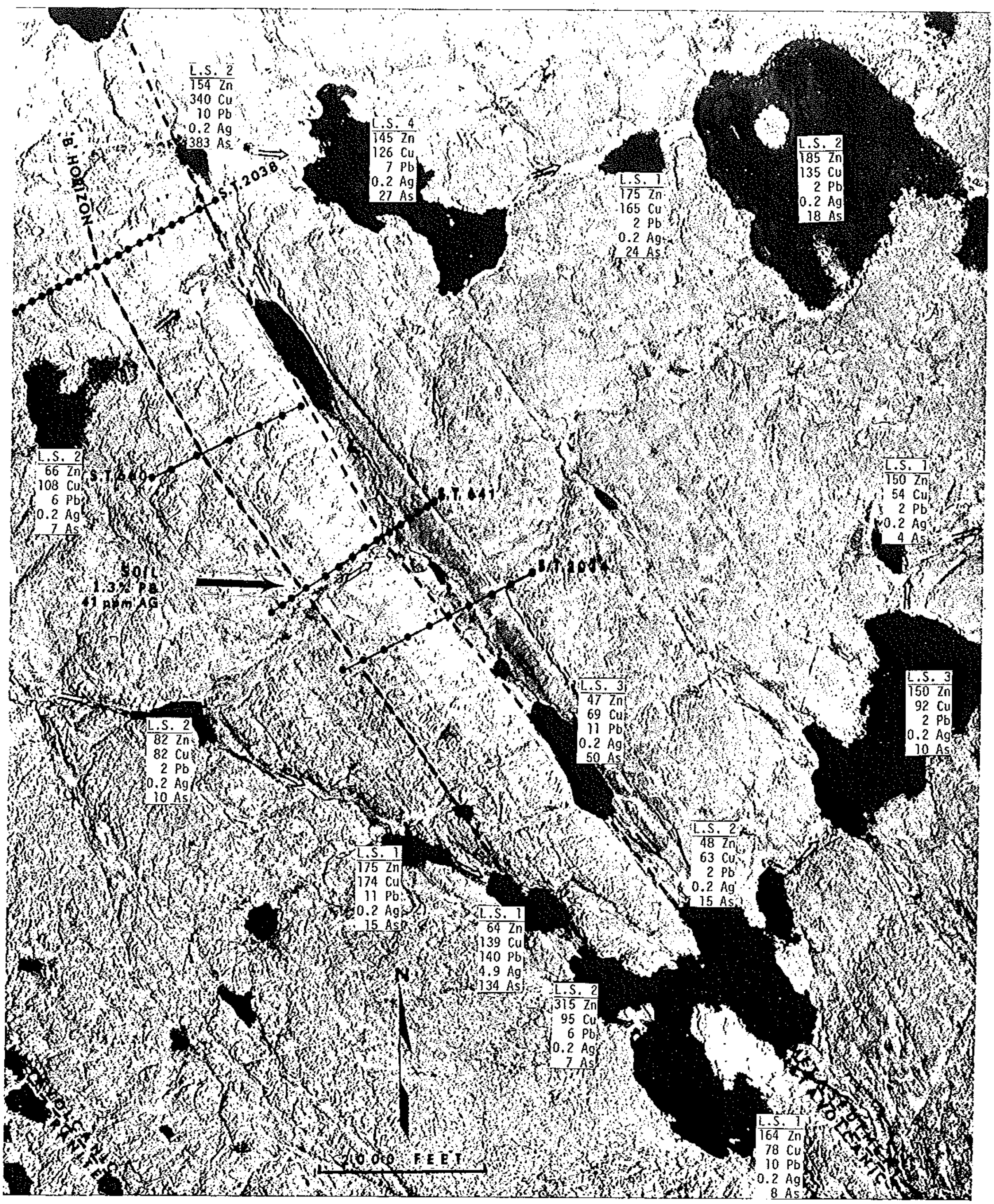
Figure 2. Geochemical data for the area of Anomaly Y. The numeral following lake sediment (L.S.) is the number of samples from that lake that were averaged to provide the analyses given below. Soil sampling traverses identified as S.T. Rock sampling traverses not shown. Drainage directions given by small arrows. Note that no lake sediments were found in the lake at the eastern end of traverse S.T. 660.

Figure 3. Diagram showing the suggested approach to geochemical exploration for massive sulphide deposits in the Northern Canadian Shield. Based on studies at Anomalies X and Y (see text).

Figure 4. Anomaly Y, photographed facing north from the centre of the area shown in Figure 2. Light coloured ridge of upper siliceous volcanics runs diagonally from right centre of photograph; metasedimentary rocks beyond. Light coloured outcrops in left centre are thickest portion of "B" zone gossans and the underlying altered volcanic rocks.

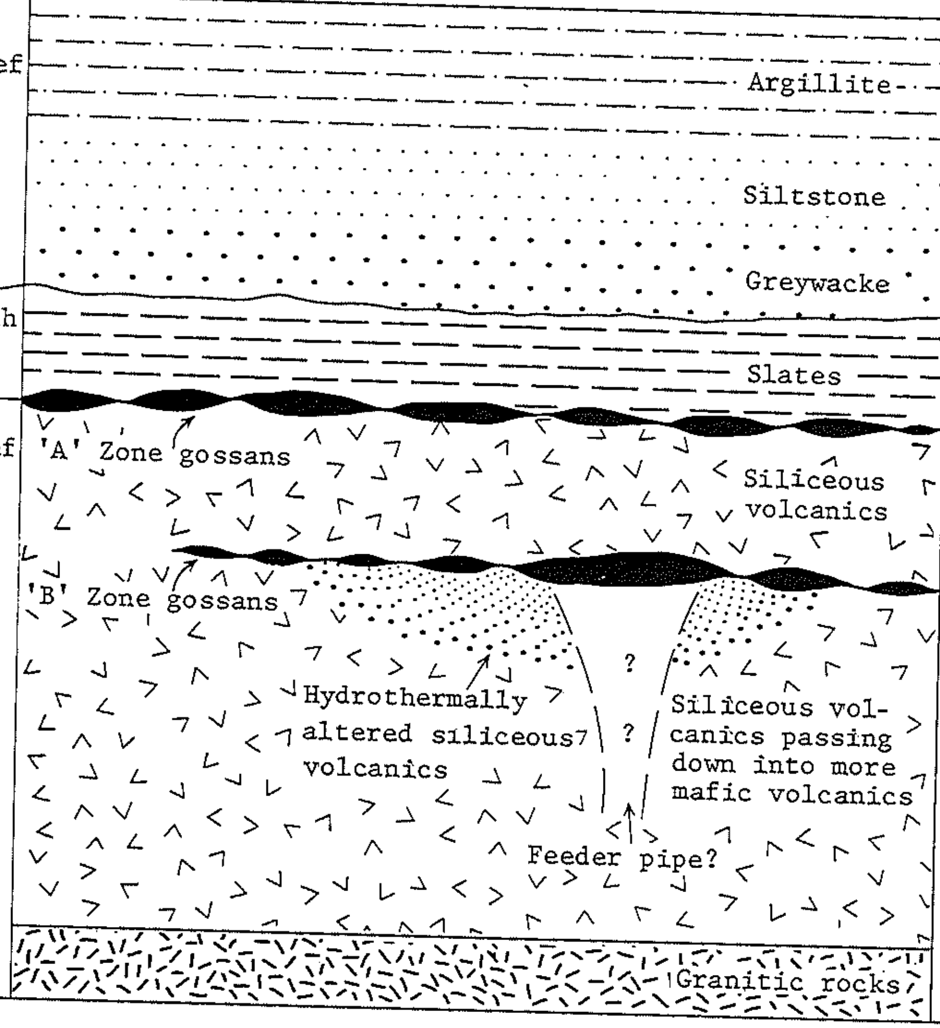


CORONATION GULF
Coppermine
Bathurst Inlet
Bathurst Inlet
ARCTIC CIRCLE
BATHURST TRENCH
PLATFORM
GREAT BEAR LAKE
Port Radium
INTERIOR
Hottah Lake
WOPMAY FAULT
BEAR PROVINCE
SLAVE PROVINCE
Bear/Slave geochemical reconnaissance area, 1972
1973 SURVEY AREA
Bear/Slave Base camps, 1972
Rae
Yellowknife
Reliance
Artillery Lake
GREAT SLAVE LAKE
McDONALD FAULT
CHURCHILL PROVINCE
Miles
0 50 100
68°
67°
66°
65°
64°
63°
62°
116°
108°
Figure 1.
PROTEROZOIC
Ultramafic, gabbro, diabase
Granite, granodiorite, porphyritic felsite
Limestone, dolomite
Granite gneiss, migmatite
Greywacke, sandstone, quartzite, arkose, shale
Volcanic rocks, mainly intermediate to basic, greenstone
ARCHEAN
Granite, granodiorite, granite gneiss
Greywacke, shale
Volcanic rocks, mainly intermediate to basic



B' HORIZON
S.T. 2038
L.S. 2
154 Zn
340 Cu
10 Pb
0.2 Ag
383 As
L.S. 4
145 Zn
126 Cu
7 Pb
0.2 Ag
27 As
L.S. 1
175 Zn
165 Cu
2 Pb
0.2 Ag
24 As
L.S. 2
185 Zn
135 Cu
2 Pb
0.2 Ag
18 As
L.S. 2
66 Zn
108 Cu
6 Pb
0.2 Ag
7 As
S.T. 641
L.S. 1
150 Zn
54 Cu
2 Pb
0.2 Ag
4 As
SOIL
L.S. 3
47 Zn
69 Cu
11 Pb
0.2 Ag
50 As
L.S. 3
150 Zn
92 Cu
2 Pb
0.2 Ag
10 As
L.S. 2
82 Zn
82 Cu
2 Pb
0.2 Ag
10 As
L.S. 2
48 Zn
63 Cu
2 Pb
0.2 Ag
15 As
L.S. 1
175 Zn
174 Cu
11 Pb
0.2 Ag
15 As
L.S. 1
64 Zn
139 Cu
140 Pb
4.9 Ag
134 As
L.S. 2
315 Zn
95 Cu
6 Pb
0.2 Ag
7 As
N
L.S. 1
164 Zn
78 Cu
10 Pb
0.2 Ag
8 As
1000 FEET

figure 2

GEOMORPHIC FEATURES	GEOLOGICAL SECTION (Strata near vertical)	GEOCHEMICAL FEATURES
Very low relief Large lakes		Zinc and copper from mineralization in volcanics dispersed several miles in solution through lakes in sedimentary area. Arsenic less widely dispersed, lead and silver no dispersion. Use zinc and copper in lake sediments to outline mineralized areas in adjacent volcanics.
Depression with chain of long narrow lakes		
Moderate relief generally has highest elevation in region Small lakes		Zinc and copper leached from soils and gossans; arsenic partially leached; lead and silver fixed. Use lead, silver and arsenic in soil and gossan samples to define exploration targets.

Drainage

Figure 3.

figure 4.

GEOLOGICAL RECONNAISSANCE OF NORTHERN MELVILLE PENINSULA, DISTRICT OF KEEWATIN, (PARTS OF 47A,B,C,D)

W.W. Heywood

The reconnaissance geological mapping of northern Melville Peninsula was commenced and completed in the 1973 field season using a Bell 47 G4A helicopter from a base camp at Hall Beach. W.L. Davison and D.N. Proudfoot assisted with the Precambrian mapping. T.E. Bolton of the Geological Survey of Canada, Ottawa, B.V. Sanford of the Atlantic Geoscience Centre, Dartmouth, and H.P. Trettin of the Institute of Sedimentary and Petroleum Geology, Calgary, spent about two weeks in August investigating problems of Paleozoic stratigraphy and structure.

Gneisses, migmatities and foliated to massive granitoid rocks underlie most of the map-area. These include some areas of metasedimentary rocks that consist of biotite-rich paragneiss, small amounts of amphibolite, and minor thin marble bands. Granulites are present in an irregular zone along the western side of Melville Peninsula. Small ultrabasic bodies occur locally but are not common.

Folded and metamorphosed sedimentary and volcanic rocks of the Prince Albert Group are the oldest recognized in the area. They outcrop at the southwest end of Hall Lake, and in a belt about 30 miles long and as much as 10 miles wide trending north to northwesterly from the mouth of Hall River. Granitic stocks and sills are common in the Hall Lake area. The Prince Albert Group is bounded by intrusive granitic rocks at the south end, and is apparently conformable with gneissic and granitoid rocks north of Hall River. Along the eastern boundary they are in fault contact with Paleozoic strata. The sedimentary rocks are mainly derived from greywacke and are metamorphosed to varying degrees. Mafic rocks derived from andesite and basalt form most of the volcanic suite. As much as 2000 feet of rhyolitic to dacitic rocks are interlayered. Altered ultrabasic sills were observed in scattered localities associated with the metavolcanic rocks. A similar sequence of rocks outcrop on the peninsulas and islands north and south of Richards Bay and probably represent a northern extension of the Prince Albert Group.

Discontinuous remnants of metavolcanic rock and amphibolite occur in a north to northeasterly trending zone from the Kingora river at 83°30'W.

Iron formation was observed in many places in the Prince Albert Group and probably forms more or less continuous layers. The maximum observed thickness of iron formation is about 1,500 feet, however there may be some repetition due to folding. Layers composed predominantly of magnetite are as much as 2 feet thick, and some sections contain up to 30 per cent magnetite. Iron formation has been reported from the Garry Bay area but was not examined.

Helikian strata, gently folded and metamorphosed, outcrop in several localities on the south side of Fury and Hecla Strait from Alfred Island in the west, to the Bouviere Islands in the east. The Fury and Hecla Formation, consisting of pink and white quartzite with minor amounts of conglomerate and shale, rests unconformably on granitic and gneissic rocks. Siltstone, shale and dolomite of the Autridge Formation outcrop on islands in Fury and Hecla Strait.

Unaltered northwesterly trending diabase dykes and sills occur throughout the area. They are most abundant in the south central region and along the north coast where they intrude the Fury and Hecla Formation.

Rusty weathering zones, some containing disseminated sulfide minerals were observed in many localities. Most are associated with metavolcanic rocks of the Prince Albert Group. A rusty zone, containing minor amounts of pyrite and pyrrhotite, extends about 15 miles north and south of the east end of Blacks Inlet. Pyrite, pyrrhotite, and minor chalcopyrite are present in metavolcanic and associated rocks north of the Kingora River. Disseminated chalcopyrite occurs in peridotite plugs about 45 miles northwest of Hall Beach.

Soapstone occurs at the southwestern end of Hall Lake and north of the Kingora River at 68°39'N, 84°16'W. Soapstone at the latter locality is derived from an altered peridotite dyke that is more than 125 feet wide and is exposed for at least 2000 feet. It is medium to light grey colored, relatively free of impurities, and could be quarried in large blocks.

GEOLOGY OF THE CALDER RIVER MAP-AREA (86F)
DISTRICT OF MACKENZIE

J.C. McGlynn
Regional and Economic Geology Division

During the first summer of field work for this project a map of the south half of the Calder River area was completed. However, in succeeding summers further work will be required in the area to refine parts of the mapping and to better document some of the relationships established during the past field season. The objectives of the study include the definition of the stratigraphic and relative age relations of Aphebian supercrustal rocks and associated plutonic rocks; the determination of the nature and environment of the volcanogenic-plutonic complex in the western part of the Bear Structural Province; and a more precise definition of the various tectonic environments present in the Bear Structural Province. These aims lead to the ultimate objective of providing a more refined assessment of the resource potential of the area, an improved map and additional data as a basis for further mineral exploration in the region.

The south half of the Calder River map area spans two major tectonic divisions of Stockwell's Wopmay Belt (Stockwell, 1970) which has been also called the Wopmay Orogen by Fraser et al. (1972). These divisions are known as the Great Bear batholith and the Hepburn metamorphic-plutonic belt and their mutual boundary is defined by the Wopmay fault (Fraser et al., 1972).

The oldest rocks in the area (units 1 and 2, Figure 1) occur just east of the Wopmay fault and comprise a conformable sequence of siltstones and shales overlain by dolomite which in turn is overlain by basic volcanic rocks. These rocks were assigned to the Snare Group by Lord and Parsons (1952) and later by McGlynn (1964). This correlation remains a reasonable one. The thickness of the lowest siltstone and shale formation cannot be known as it is everywhere cut by granite but within the area some hundreds of feet are exposed. The dolomite formation where exposed is very thin varying between 5 and 50 feet in thickness. In some sections it is not present but its true distribution is difficult to determine as it outcrops poorly. The top of the volcanic unit is not exposed but as much as two thousand feet are present in the sequence. The bulk of the volcanic sequence consists of massive thick flows of probable basaltic composition. A few thin pillowed flows occur locally near the base of the sequence, and northeast of Wopmay Lake, and facies comprising thin (up to 6 feet) basic flows with scoraceous tops occur. Two small areas of interrelated basic and intermediate to acidic flows and tuffs were found in the upper part of the sequence. The rocks are metamorphosed to low greenschist facies except near granitic intrusions. The sequence is gently folded about axes that trend about northeast. The lower shale unit is intensely cleaved so that in most outcrops bedding is all but destroyed. The Snare rocks appear to be tectonically preserved between the Wopmay fault and the complex fault zone that marks their eastern boundary.

East of the belt of Snare rocks, gneisses (unit 3) of the Hepburn metamorphic-plutonic belt comprise migmatites (with Snare type metasediments), veined gneisses, biotite gneisses and granitic gneisses. The structure of the gneisses is complex and more detailed work is needed to define their structural style but they appear to be doubly folded with first fold axes trending northeast to east. These folds are open to isoclinal and overturned so as to be almost recumbent. They, in turn, are refolded about northerly or west of north-trending axes. The regional grade of metamorphism is amphibolite of low pressure high temperature type.

The granitoid gneisses and less deformed Snare rocks are cut by high level, massive, coarsely porphyritic granodiorites to quartz monzonites. Within the Snare rocks these intrusions are bounded by narrow metamorphic zones in which rocks reach amphibolite grades of metamorphism and they modify pre-existing regional structures.

The transition from moderately to gently deformed and metamorphosed Snare strata to highly deformed gneisses containing highly metamorphosed Snare rocks is sharp but the nature of the transition is obscured by intense faulting that produces wide zones of mylonite and crushed and brecciated rocks. The late massive granodiorites are also affected by this faulting. It seems likely that somewhat deeper level gneisses and higher level moderately deformed Snare strata were brought into juxtaposition along this complex fault zone.

The western boundary of the Snare rocks and granitic rocks that intrude them is the Wopmay fault. Rocks of the Great Bear batholith are found west of this northerly-to northeasterly-striking fault. Supercrustal rocks of the Great Bear batholith include a sequence of sediments (unit 5) just west of the Wopmay fault and volcanic rocks (unit 6) that occur between Ellington and Lever lakes and around Grouard Lake. Granodiorites and quartz monzonites (unit 7) are the other components of the Great Bear batholith. The supercrustal rocks within the area have been assigned to Snare, Cameron Bay and Echo Bay Groups by previous workers (Lord and Parsons, 1952). They are not part of the Snare Group and the nomenclature of the Cameron and Echo Bay Group is so confused that it seems best for the present to consider the rocks as Cameron and Echo Bay type. As work progresses a new nomenclature will have to be devised or the old one refined.

The sedimentary strata along the Wopmay fault comprise a sequence of shales, silty shales with local fine siliceous beds and bands of ash-flow tuffs. The rocks have an intense cleavage that strikes east of north and dips nearly vertically. In all but a few outcrops bedding is destroyed. Where present it strikes about parallel to the cleavage but dips at lower angles. However, too few observations were made to determine the fold pattern of these sedimentary rocks. The cleavage is paralled to the Wopmay fault and may be related to it.

Cameron Bay, Echo Bay type rocks (unit 6) at Wopmay Lake consist of ash-flow tuffs with some red conglomerate lithic sandstones near the top of the sequence. The units here were not sheared, strike northeast to east and dip gently north. Ash-flow tuffs are found resting unconformably on sheared or crushed porphyritic granodiorites that cut the Snare strata. These volcanic rocks, therefore, are younger than the Snare rocks and the granitic rocks of the Hepburn plutonic and metamorphic complex and probably younger than the faulting that affected those rocks and produced in the granitoid rocks extensive mylonite and crush zones. The rocks are older than the Wopmay fault as they are cut by the fault and sheared along the fault zone.

The most extensive areas of volcanic rocks of Echo, Cameron Bay type north of Ellington Lake and around Grouard Lake comprise a thick sequence of massive ash-flow tuffs with interbedded ash-fall and waterlain tuffs, volcanogenic sedimentary rocks, and dykes and sills of intrusive felsitic porphyries. At Grouard Lake the sequence contains a few andesite flows. In various sections in the sequence as much as 15,000 feet of these rocks are exposed but the cumulative thickness is much greater.

Just north of Ellington Lake the sequence consists of at least four cycles composed of a thin unit of delicately, persistently banded rocks that are probably ash-fall and waterlain tuffs and more crudely banded crystal tuffs overlain by massive crystal and less commonly lithic ash-flow tuffs. Within the banded rocks are thin lensy bands of crossbedded coarse-grained lithic sandstones. The grains are of locally derived volcanic rocks. The massive tuff is moderately to densely welded. The composition appears to be dominantly intermediate possibly dacite or quartz latite with some rhyolitic phases. These rocks give way to the north to a succession of massive ash-flow tuffs with no intercalated banded tuffs or sedimentary strata. Felsitic porphyry dykes, sills and stocks occur within the volcanic sequence and are most abundant around Self and Lever lakes. The volcanic rocks strike easterly to southeasterly and have a regional dip or tilt to the north. The amount of dip ranges from horizontal to about forty degrees. Dips are steep and strikes more variable near granitic rocks.

The volcanic rocks are everywhere cut by granitic intrusions (unit 7) of the Great Bear batholith. Narrow metamorphic zones occur around the granitic intrusions and the volcanic rocks tend to be tilted at steeper angles along the margins of the granitic rocks. The felsitic porphyry intrusions cut the volcanic sequence but both intrude and are intruded by granitic rocks. They probably are therefore about the same age as the granitic rocks.

The granitic rocks are massive granodiorite to quartz monzonites with local quartz diorite phases. Of the three units defined (but not shown on Fig. 1) two are porphyritic with phenocrysts ranging, in length, from ½ to 3 inches. These rocks are in sharp contact with the volcanic strata, have chilled or finer grained marginal phases, are bounded by narrow metamorphic zones, have dyke older rocks about their margins, tend to disrupt regional structure only locally and are therefore considered to be very high level intrusions. The volcanic rocks may well be their extrusive equivalents or skins and the felsitic intrusions their somewhat higher level equivalents. The range of composition of the intrusive and extrusive rocks appears to be about the same.

The youngest rocks are diabase dykes most of which strike northeast. All rocks of the Great Bear batholith are cut by northeasterly trending vertically dipping faults along which quartz stockworks or "giant quartz veins" locally occur. These faults seem to die out before reaching the Wopmay fault.

The sequence of events determined in the Calder River area, then, includes deposition and extrusion of the Snare rocks in the Coronation Geosyncline (Hoffman et al., 1970); burial of these rocks; folding, metamorphism and formation of granitic gneisses and migmatites; late-or post-tectonic intrusion of massive porphyritic granodiorites followed by rather deep level faulting that produced broad mylonite zones and brought gneisses containing highly metamorphosed Snare rocks and less deformed and metamorphosed Snare strata into juxtaposition. After erosion exposed at least the high level granitic rocks in the Snare sequence, Cameron - Echo Bay type volcanism occurred and a thick sequence of ash-flow tuffs were deposited while granodiorite and quartz monzonites were being formed at depth and intruding their own extrusive equivalents. Late in this process the Wopmay fault formed along the boundary of the Great Bear batholith. Later northeast-trending faults cut the Great Bear batholith. Some of the volcanic rocks were tectonically preserved along these faults. The last event was intrusion of diabase dykes.

There is little evidence of mineralization in either Snare rocks or the younger ash-flow tuffs. Sparsely disseminated sulphides occur along parts of some northeast trending faults in the Great Bear batholith especially near quartz stockworks.

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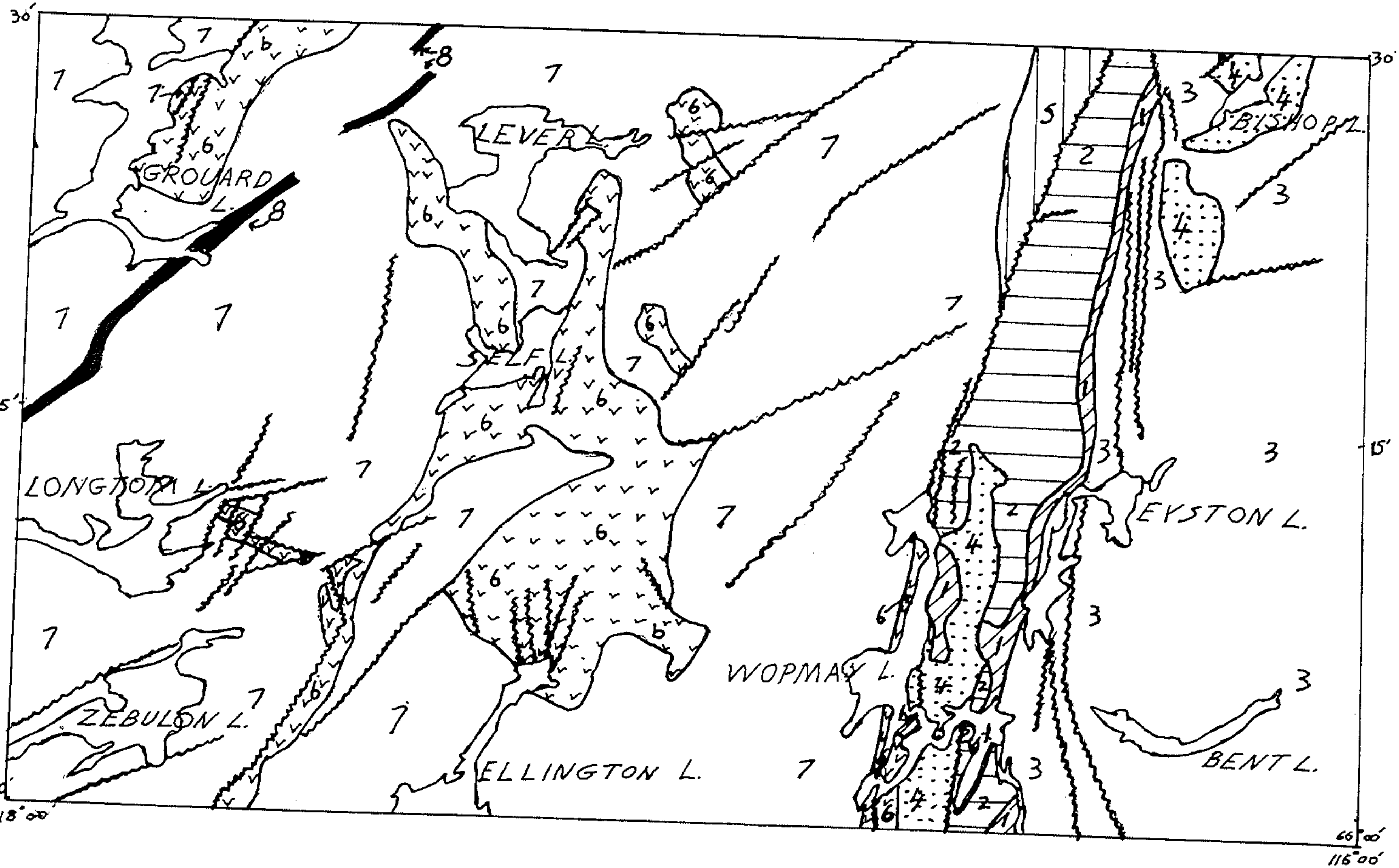
Figure 1: Geological sketch map of the south half of the Calder River map-area. 1, Snare siltstone-shales and dolomite; 2, Snare basic volcanic rocks; 3, migmatities, mixed gneisses, veined gneisses, granitic gneisses; 4, massive porphyritic granodiorite; 5, shales, siltstone, ash-flow tuff; 6, ash-flow tuff, ash-fall tuff, lithic sandstone, felsitic porphyry intrusions; 7, granodiorite and quartz monzonite; 8, diabase dyke.


30'
30'
15'
15'
65°00'
118°00'
66°00'
116°00'
GROUARD L.
LEVER L.
BISHOP L.
SELF L.
LONGTOM L.
EYSTON L.
WOPMAY L.
ZEBULON L.
ELLINGTON L.
BENT L.

PARAGNEISSES OF THE PRINCE ALBERT GROUP

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The rocks of the Prince Albert Group are lithologically subdivided into two sequences:

Greywacke sequence

1) Greywacke - (quartz-plagioclase-biotite/amphibole-magnetite gneiss)
2) Iron-formation - (magnetite -quartz-garnet gneiss)
3) Meta-ultrabasics - (serpentine-talc-magnetite gneiss)

Quartzite sequence

1) Quartzite - (quartz-muscovite/phlogopite/fuchsite gneiss)
2) Knotted Quartzite - (quartzite with sillimanite porphyroblasts)
3) Graywacke (minor) - (quartz-plagioclase-biotite/amphibole-magnetite gneiss)

The quartzite appears to structurally overlie the greywacke sequence, but as no top determinations were possible, it is uncertain which is younger. The base of the greywacke sequence is indefinite, but a conglomerate which is very close to gneissic granodiorite may define the base of the Prince Albert Group. This conglomerate is recognized at only one locality, and thus the evidence is extremely tenuous. Due to the effects of repeated folding of the group, the true thickness is unknown.

The iron-formation in the greywacke sequence occurs at a number of structural/stratigraphic positions but it is uncertain whether or not they are repeated by folding. The increased number of thin iron-formations in the east suggests a primary origin. The thickest iron-formation occurs in the western part of the area, where one unit is approximately 120 m thick; the normal thickness is less than 6 m.

There appear to be two iron-formation associations; the first invariably occurs associated with the meta-ultrabasic rocks, and the second only with metasediments. The association with the ultrabasic rocks is interpreted as a primary rheological control, as there is scant evidence to indicate that the ultrabasics are extrusive.

In both the eastern and western parts of the area an iron-formation is either in contact with, or very close to, granodiorite gneiss. In the east, iron-formation is underlain (?) by a pebble conglomerate. The conglomerate contains much flattened and stretched clasts of quartz and possible gneissic granodiorite. It is adjacent to, but not in contact with, a gneissic granodiorite, which may be remobilized basement, as it appears to be intrusive elsewhere in the vicinity.

Meta-ultrabasic rocks occur as continuous sills up to 70 m thick throughout the western and central parts of Prince Albert Group. They do not occur in the eastern part of the area. They display all phases of deformation recognized in the metasediments, and locally contain inclusions of quartzite and iron-formation. Possible spinifex texture was noted at two localities. An ultrabasic pseudo-breccia is exposed for approximately 4 km in the western part of the area, and is interpreted as blocks of a slightly older sill incorporated in a younger sill. The composition of the "matrix" is sufficiently different from the blocks to produce a breccia-like appearance. Locally, thin veinlets of magnetite are a common alteration product, and fibrous, stiff, asbestiform amphibole up to 30 cm was noted at one location.

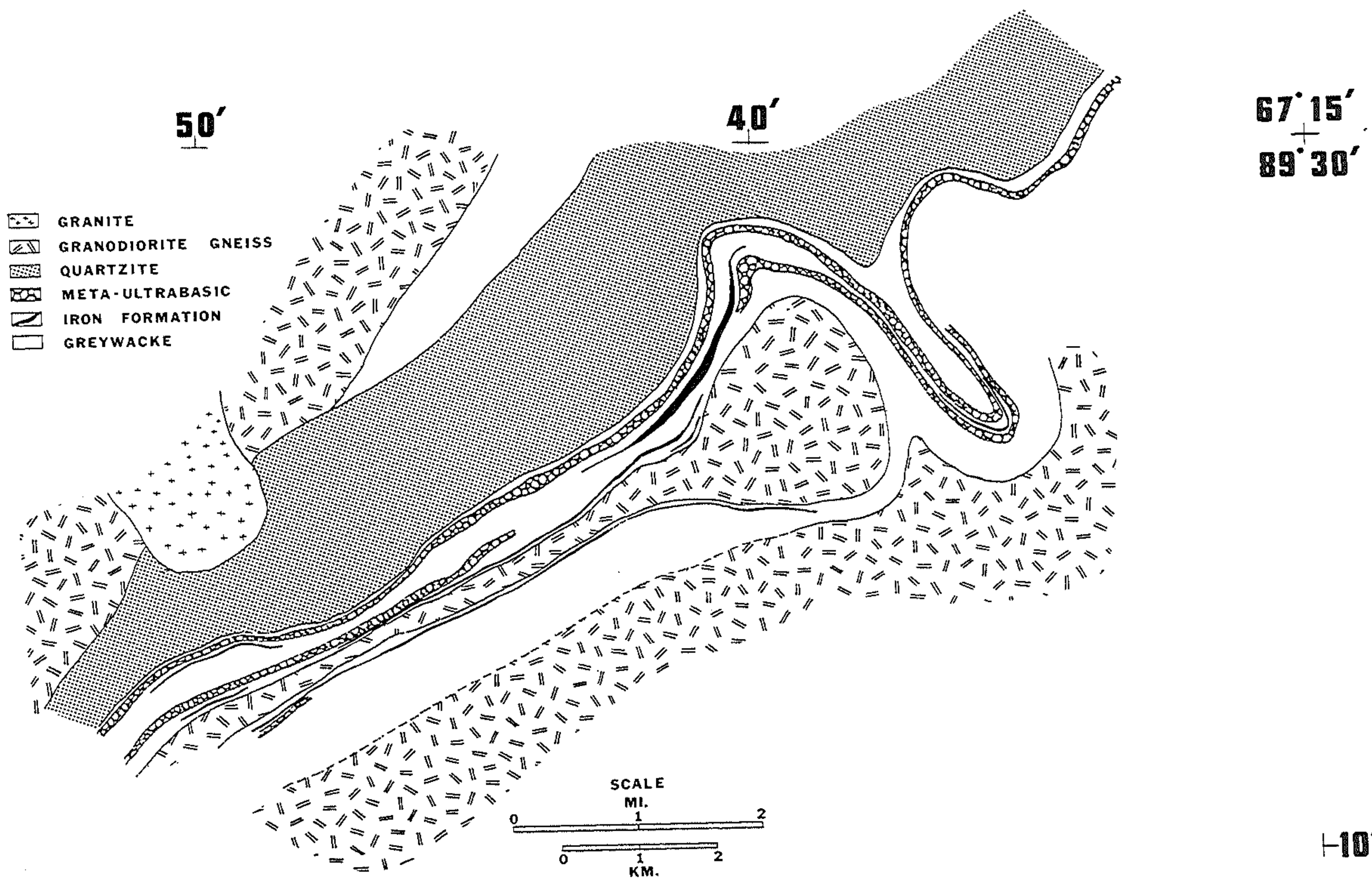
Meta-ultrabasic rocks also occur well outside the main "belt" of Prince Albert Group. Where they are associated with metagreywacke, the rocks are identical to those in the group, except that the iron-formation is sulphide, rather than magnetite variety, and that there is minor greenstone. Elsewhere, the meta-ultrabasic rocks are completely surrounded by well-foliated granodioritic gneiss. The meta-ultrabasics trend north-south, and appear to strike into the main sequence of Prince Albert Group rocks. However, the two are separated by faults, and relations are thus unclear.

The lack of any appreciable amount of quartzite in the eastern part of the area is interpreted as a combination of deformation and facies change. The quartzite sequence is folded between two large masses of granodioritic gneiss, and may completely surround the western-most of the two bodies. The increased number of thin iron-formations in the eastern part of the area suggests a facies change - from quartzite/greywacke in the west to graywacke in the east.

The Prince Albert Group has been affected by at least three phases of deformation. As no top determinations are possible, the form of the resulting fold pattern is unknown. The first recognizable period of folding is represented by tight, overturned, isoclinal folds which plunge shallowly to the southwest, and in some cases, to the southeast. An axial plane foliation is commonly associated with this event, and is defined as the S_2 foliation. However, the S_1 and the S_2 foliations can be distinguished only in the fold noses, and the form of the folds which produced the earliest (S_1) foliation is unknown. The second period of folding produced the tight major and minor, isoclinal, upright to overturned, northwesterly-trending folds. On a minor scale these are best displayed in the iron-formation; on a major scale, they are wll developed in the western part of the area around a granodiorite gneiss core (<u>see</u> Fig. 1). There is no recognizable planar fabric associated with this phase of folding. A fourth period of folding is inferred from the attitude of the minor folds in the fold nose shown in Fig. 1. There, the minor kink folds have divergent plunges, at steep angles, as though the fold was refolded abour northeast-trending axis.

Isolated paragneiss remnants, surrounded by magnetiferous granodioritic gneiss, together with the gradational contacts between the Prince Albert Group and the granodioritic gneiss, suggest that the gneiss has in part been derived from the Prince Albert Group. In the eastern part of the area, the Prince Albert Group rocks are nearly horizontal, and outcrop at the tops of the hills. They are both under- and overlain by sills of granodioritic gneiss. These sills become much thinner in the main part of the belt, where the only intrusive rocks are the ubiquitous pegmatites and younger diabase dykes.

Figure 1 Structure and distribution of the Prince Albert Group in the southwestern part of the area.


50′
40′
67°15′
89°30′
10′
GRANITE
GRANODIORITE GNEISS
QUARTZITE
META-ULTRABASIC
IRON FORMATION
GREYWACKE
SCALE
MI.
0
1
2
KM.
0
1
2

Drift Prospecting in the Ennadai-Rankin Inlet Greenstone Belt; District of Keewatin

W.W. Shilts

Sampling of till from mudboils (Shilts, 1973) on one-mile centres was continued, providing, with samples collected in 1970 and 1971 (Shilts, 1972), a complete grid along a strip approximately 80 miles long by 25 miles wide (Fig. 1) an area of about 2000 square miles. Approximate cost of such a project in this or similar areas is tabulated in appendix I. Costs cited in appendix I were actually exceeded in this project because of the developmental nature of the work and because subsidiary studies were carried out. For a negligible increase in the budget, target areas could be sampled by foot, boat, or all-terrain vehicle on the detailed level. Principal costs are for aircraft support and neither these nor other field costs would increase significantly if close sampling were to be added to the program.

In 1973, several sample plans and spacings were followed around targets discovered during the 1970-71 seasons or around showings that have received serious attention by mining companies. At three sites in the northwest corner of Kaminak Lake, several hundred samples were collected near known Cu-Zn mineralization and over a granite porphyry. In addition to till, samples were collected of stream sediments, marine sediments, and marine or alluvial silty sand underlying frost-cracked peaty terrain. This suite of samples should provide comparisons both among various types of tundra sediment and among a variety of types of mineralization associated with different rock types.

Till (mudboil) sampling on $\frac{1}{4}$ mile centres was carried out in the Spi Lake - Carr Lake area to evaluate the glacial dispersal of known mineralized material. One target, C251, mentioned by Ridler and Shilts (1973) and by Shilts (1973, p.24, 25), was on an island at the south-east end of Spi Lake, about 2 miles southeast of the main showing. Thirty samples were collected on this island and several rounded boulders of massive sphalerite and galena with minor chalcopyrite in chloritized fine-grained rock were found around a gossan-stained mudboil at one site. Analyses of these rocks are included in appendix 2, and a discussion of their significance may be found in Ridler (this volume).

Lake Sediments

R. Klassen, financed by a research agreement between Queen's University and the Geological Survey and under the direction of I. Nichol, E. Hornbrook, and the author, initiated a program to evaluate chemical and physical factors that control geochemical properties of the several sediment facies in eastern Arctic lakes. Five lakes near various types of mineralization and in background areas were studied and an extensive suite of grab and core samples was collected from each. In addition, temperature Eh, pH, and salinity profiles were measured at numerous stations and certain stations were monitored during the summer. Extensive sampling of rocks, glacial sediments, and post-glacial marine and fluvial sediments was carried out around each lake so that the various lake-sediment facies may be compared to their parent materials.

Appendix I

Costs of reconnaissance sampling of 2000 square miles (based on centre of operations 300 miles from railhead and 2-month field season utilizing Bell 206 A,B, or equivalent;

costs of camp equipment and office gear not included;

costs approximate and are thought to represent cost to private sector).

Aircraft Charter:	Bell 206B or equivalent: 180 hrs. @ $200.00/hr.		$36,000.00
	or		or
	Bell 47G4-A or equivalent: 300 hrs. @ $110.00/hr.		33,000.00
Casual Charter:	Gasoline positioning (DC-3 or equivalent) (cost drops significantly if larger a/c can be used)		12,000.00
	Positioning gear and personnel (depending on a/c available	$2700.00	- 3600.00
	Supply, etc.		2000.00
	Depositioning samples to railhead		4000.00
	Depositioning camp and personnel		2500.00
	Air travel personnel to railhead (based on Ottawa to Churchill or equivalent)		2500.00
		Total aircraft costs	$62,600.00
Other:	Gasoline (Jet B or JP-4, based on 25 gal/hr for 200 hrs. @ .45/gal.		2250.00
	at railhead Barrel Deposit (110 bbl @ $12.00/barrel)		1320.00
	Food		3500.00
	Lodging en route to and from field		750.00
	Shipment of gear and samples from railhead		1000.00
	(based on Churchill-Ottawa or equivalent)		
		Total	$ 8820.00

Salaries:	Cook	2500.00
	Geologist in charge	3000.00
	4 samplers	6000.00
	Total	$ 11,500.00
	Total Field Expenses	$ 82,920.00

Analytical Expenses (estimate based on suggestions in Ridler and Shilts, 1973; Shilts, 1973) — $8000 - $10,000 Sample Prep.; 8000 - $10,000 Chemical

Total Analytical $16,000 - $20,000

Grand Total $103,000.00

Appendix II

Analyses of 2 boulders found on gossan-stained mudboil on island at SE end of Spi Lake; at least 4 other similar rounded boulders up to 400 lbs. were observed at same site.

Sample	Cu(ppm)	Pb(ppm)	Zn(ppm)	Ag(ppm)	Au(ppb)
#1	650	22300	102000	120	430
#2	9200	28300	129000	200	290

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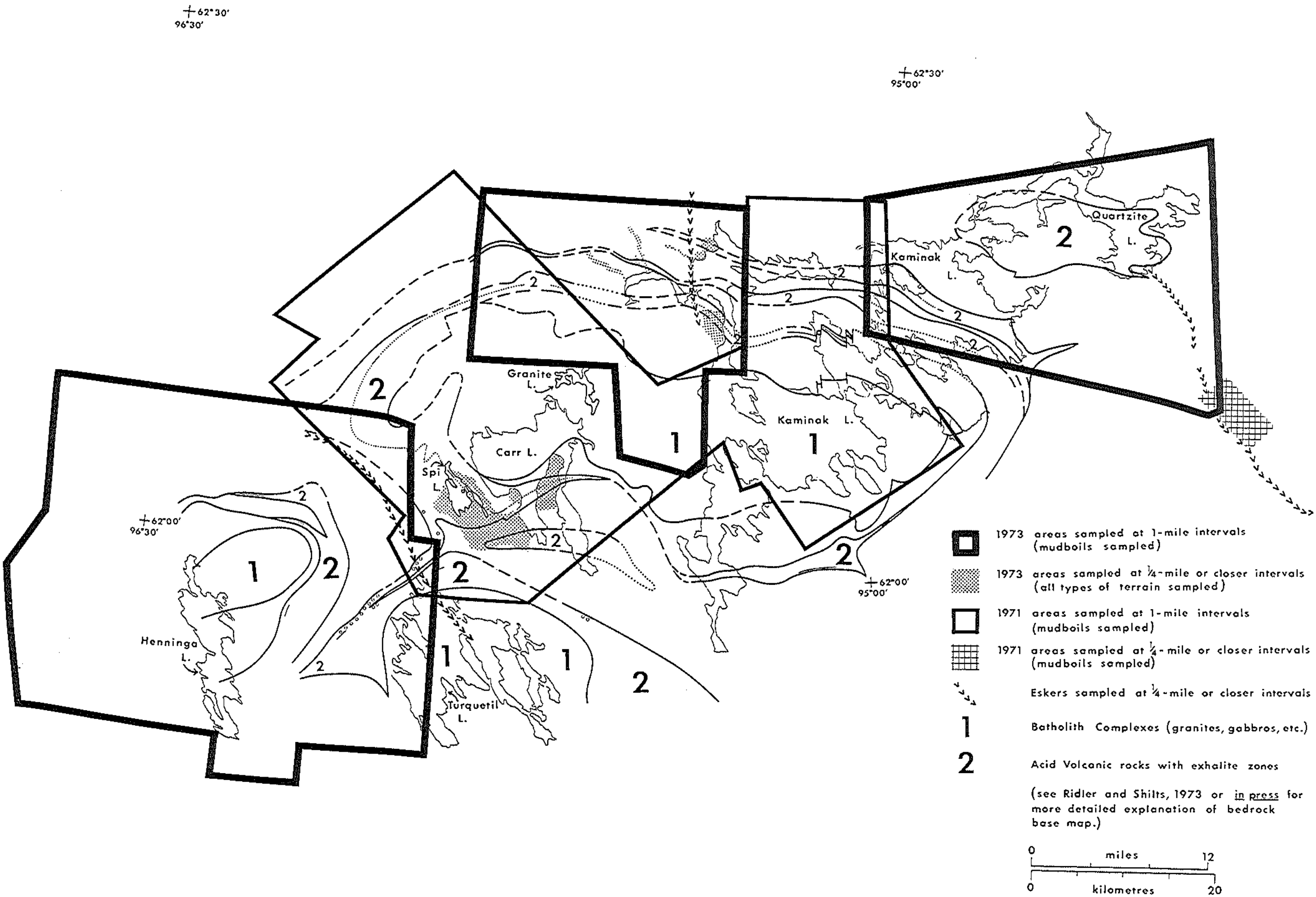
Figure 1 Drift sampling grids in Ennadai-Rankin greenstone belt, 1971-1973. Base map derived from Ridler and Shilts (1973).



62°30'
96°30'
62°30'
95°00'
62°00'
96°30'
62°00'
95°00'
Quartzite L.
Kaminak L.
Granite L.
Carr L.
Spi L.
Henninga L.
Turquetil L.
1973 areas sampled at 1-mile intervals (mudboils sampled)
1973 areas sampled at ¼-mile or closer intervals (all types of terrain sampled)
1971 areas sampled at 1-mile intervals (mudboils sampled)
1971 areas sampled at ¼-mile or closer intervals (mudboils sampled)
Eskers sampled at ¼-mile or closer intervals
1 Batholith Complexes (granites, gabbros, etc.)
2 Acid Volcanic rocks with exhalite zones
(see Ridler and Shilts, 1973 or in press for more detailed explanation of bedrock base map.)
0 miles 12
0 kilometres 20