THE GEOLOGY OF THE
OLD CABIN CREEK MASSIF,
SELWYN BASIN, YUKON TERRITORY

THE GEOLOGY OF THE
OLD CABIN CREEK MASSIF
SEWYN BASIN, YUKON TERRITORY

By

Craig Joseph Ronald Hart

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AUTHOR: Craig Joseph Ronald Hart

SUPERVISOR: Dr. P. M. Clifford

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ABSTRACT

The Old Cabin Creek Massif is underlain by Hadrynian to Silurian basin facies strata intruded and altered by Cretaceous plutonic rocks. Exposures are typical of Selwyn Basin and Misty Creek Embayment lithologies.

A 500 m package of upper Cambrian to lowermost Silurian submarine volcanics occur in the stratigraphy. Such volcanics are not uncommon in the Selwyn Basin, but thicknesses such as those exposed at the Old Cabin Creek Massif are unusual. The volcanic rocks are typically hyaloclastic breccias with lesser amounts of massive flows, pillowed flows, lapilli tuffs, epiclastics, sills and dikes. These rocks show evidence of intense low-temperature hydrothermal alteration. Olivine and pyroxene are pseudomorphed by hydrated phyllosilicates, quartz and carbonate. Unaltered amphiboles (hornblende?) were seen in one sample.

Chemical analysis and petrologic examination suggest they are tholeiitic basalts.

Correlation of upper Proterozoic and lower Paleozoic strata is enhanced by the use of trace fossils. The "Grit Unit" is divided into a Hadrynian "Lower" member and a lower Cambrian "Upper" member. Oldhamia is recognized only in Cambrian strata.

A late Mesozoic tectonic event emplaced northwest-trending overturned and upright isoclinal folds, open folds and thrust faults in all stratigraphy. In addition a klippe derived from the west repeats Cambro-Ordovician lithologies on "Wenchless Ridge".

Most of the study area has been hornfelsed and block faulted

by the intrusion of more than one Cretaceous granodiorite pluton.

Gold values up to 9650 ppb were found in thin arsenopyrite veins at the lower contact of the volcanics. They are thought to have been derived from the intrusive and not the volcanics. The potential for other mineralization to be hosted at the Old Cabin Creek Massif is high.

ACKNOWLEDGMENTS

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CHAPTER 1

1.0 INTRODUCTION

The Old Cabin Creek Massif extends over approximately 120 square kilometers of mountainous rock whose resistant features give rise to an extremely rugged sub-arctic terrain (Figure 1). Glaciation has left a series of large cirque amphitheatres separated by long narrow serrated aretes and isolated horn peaks.

The study area ranges in elevation from valley bottoms at 900 m to a mountain peak at 2260 metres. Exposure above tree line at 1200 m is good but icefields, rock glaciers, scree slopes and extremely steep terrain prevent visual inspection in some areas. The cirque floors are covered in alpine vegetation and are frequented by grizzly bears.

Freeze/thaw mechanisms are rapidly breaking down the ridges and rock falls are a constant menace.

1.1 LOCATION AND ACCESS

The Old Cabin Creek Massif is located just east of the junction of Old Cabin Creek with the Rogue River in the Hess

Figure 1: Looking southeast towards "Aho Peak" one can see the typical resistant nature of the Massif.

Mountains which are part of the Selwyn Mountain range in east-central Yukon Territory, (63° 42"N, 131° 25"W) (Figure 2).

Access is only by helicopter. Charters are available from the nearest settlement, Ross River, 210 km to the southwest, or from a seasonal base located at MacMillan Pass, 90 km to the southeast which exists if there is enough exploration in the area to sustain such an operation. Such was the case during the summer of 1984 when the author completed the field portion of this thesis.

1.2 PREVIOUS WORK

Geological studies of areas fringing the Old Cabin Creek Massif have been undertaken by a few early investigators.

In 1902, R. G. McConnell and Joseph Keele explored the upper reaches of the North and South MacMillan Rivers by canoe, as well as Husky Dog Creek 60 km south-southwest, (Bostock 1954). Subsequently, in 1907-08, Keele travelled from Ross River, across the Selwyn Mountains to Christie Pass, then into the N.W.T.. He recognized abrupt lithological changes in this area which were later recognized as the carbonate-shale facies boundary (Keele, 1910).

A similar transect of the Selwyn Mountains was undertaken by E. D. Kindle in 1945, as he made a geological reconnaissance along the then newly built Canol Road, as far as MacMillan Pass.

All these authors described the regional rock types as well

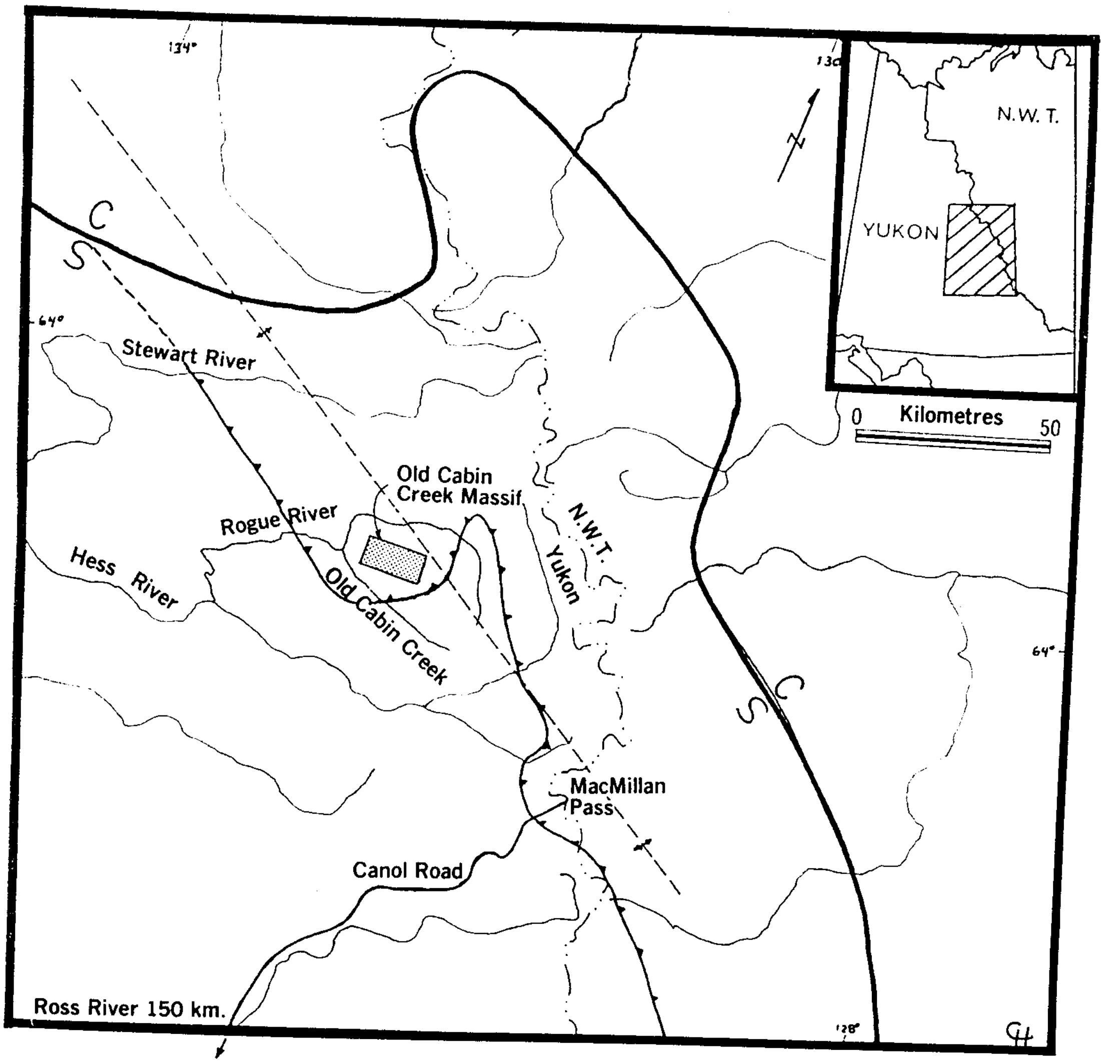


Figure 2: Location of the Old Cabin Creek Massif.

as topographic and structural trends in the Selwyn Mountains, but it was not until 1952 that J. O. Wheeler (1954) first examined the rocks of Old Cabin Creek. Wheeler spent a portion of the summer of 1952 working out of camps based at Arrowhead Lake, 10 km west of The Old Cabin Creek Massif. He was the first person to recognize the presence of volcanic rocks in this part of the Selwyn Basin and at Old Cabin Creek. He included them on the map accompanying the report, (Wheeler, 1954).

H. S. Bostock included the volcanics of Old Cabin Creek on his geological compilation map of the Yukon Territory in the late fifties. The most recent geological maps which include the study area (Cecile 1982, GSC 1983), however, fail to identify or differentiate these volcanics.

With the upgrading and maintenance of the North Canol Road in the early seventies, MacMillan Pass became an important base for mineral exploration in the east and central Yukon. This led to extensive exploration of the region by the mineral industry and the discovery of four significant mineral deposits in the area.

During the decade before 1983, the Old Cabin Creek area was explored for mineral wealth by at least four companies, two of whom saw fit to take claims, (Union Carbide, Canadian Industrial Oil and Gas). Confidential assessment reports were produced by Union Carbide in 1982 and 1983 as a result of summer exploration work. P. Sarjeant (Queen's University, 1983) produced a bachelor's thesis while employed by Union Carbide. He studied the textures and petrology of the volcanics on "Wenchless Ridge".

The heightened economic significance of the MacMillan Pass area has attracted many government geologists to the area, and the stratigraphy of the Selwyn Basin, especially the MacMillan Pass area has received much attention of late, (Abbott, 1983; Anderson, 1983; Dawson, 1979; Cecile, 1982; Gordey 1979, 1980).

Most recently, the author spent 16 days in the area while employed by the Geological Survey of Canada, during July 1983. The project was suggested by Dr. Mike Cecile while undertaking 1:50,000 scale mapping of NTS sheet 105/O. A preliminary map produced from this study has since become part of a Geological Survey of Canada Open File Report 1118.

1.3 PURPOSE

The purpose of this thesis is to produce a geological map of the rocks exposed at the Old Cabin Creek Massif, and to describe the complex structure and stratigraphy which exists there.

Well defined contacts amongst upper Proterozoic/lower Paleozoic strata allow a sub-division of the "Grit Unit" into upper and lower members.

A Lower Paleozoic volcanic package occurs in the stratigraphy, and is exposed in other locations nearby (Cecile, 1982). Its contacts are well exposed at Old Cabin Creek. Upper and lower age limits can be determined stratigraphically for this volcanic package.

A thin Devonian volcanic unit is exposed in the Selwyn Basin and a comparison of compositions with the Old Cabin Creek volcanics may suggest a possible genetic relationship.

The Old Cabin Creek Massif hosts anomalous base and precious metal values. Their economic potential and relationships with other mineral deposits in the Selwyn Basin will be discussed.

CHAPTER 2

2.0 SELWYN BASIN

The Selwyn Basin is a large, essentially east-west trending depositional feature defined by a Cambro-Ordovician facies change from platform carbonates to deeper water shale, chert and argillite (Figure 3).

The geometry of the basin evolved with changes in paleogeography (Gabrielse, 1967; Cecile, 1982), but continued accumulating sediments into the Mississippian.

Total thickness of all platform, transition and basin facies strata is in excess of 5000 metres.

2.1 STRUCTURAL SETTING

The Old Cabin Creek Massif is located in the Selwyn Basin tectonic province, just southwest of the Niddery High which separates the Selwyn Basin from the Misty Creek Embayment (Figure 4). Lying on the southwest limb of the Selwyn Anticlinorium, the rocks of Old Cabin Creek Massif are within the Selwyn Fold and Thrust Belt.

All pre-Mesozoic Selwyn Basin lithologies show moderate to extensive northeasterly directed shortening resulting in northwest trending upright and overturned isoclinal folds, open folds and

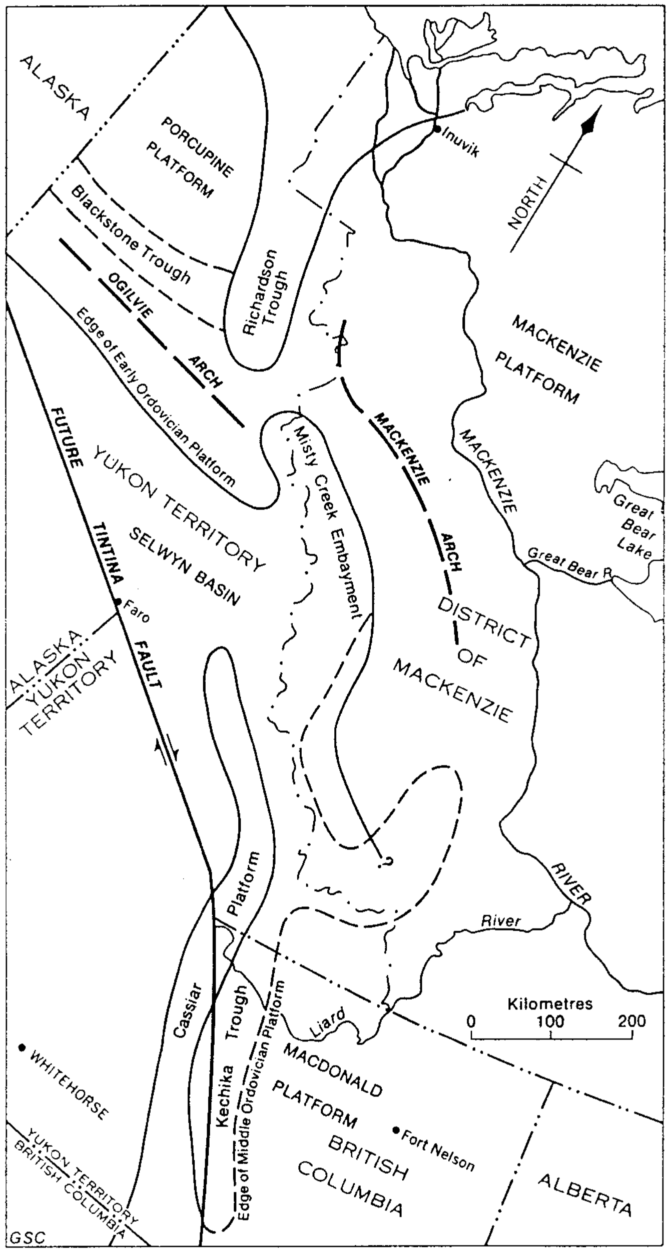


Figure 3: Persistent tectonic elements controlling lower Paleozoic facies distribution define boundaries of Selwyn Basin and Misty Creek Embayment (Cecile, 1983).

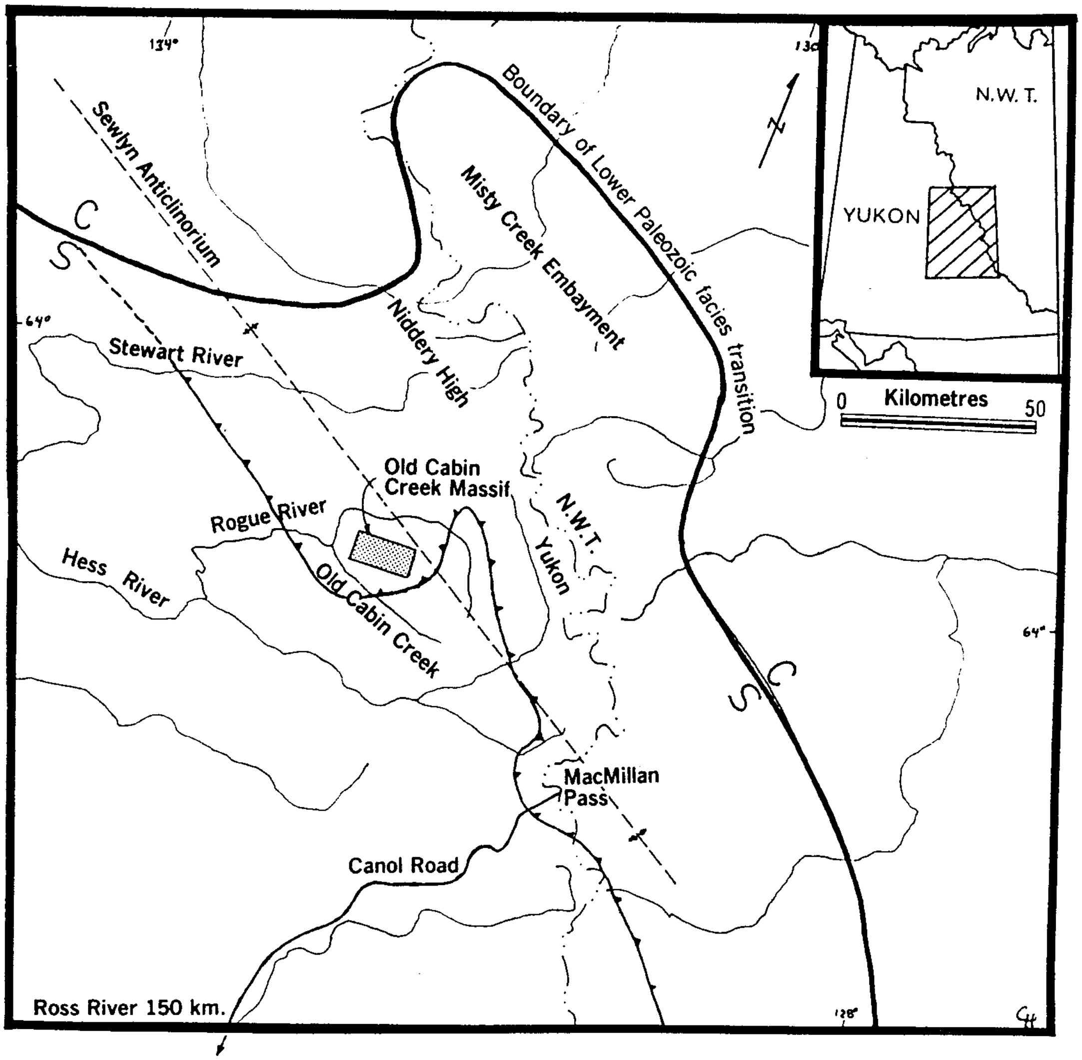


Figure 4: Structural and geographical setting of the Old Cabin Creek Massif in the northeastern Selwyn Basin. Thrust fault line represents contact between Paleozoic and Proterozoic lithologies. C - carbonate; S - shale.

thrust faults. Some rock units locally remain horizontal and may be preserved in low angle thrust slices or related to horizontal detachment surfaces.

This Late Mesozoic-Tertiary compressional event has resulted in the tectonic thickening of many units to several times their original thickness.

Locally the largest influence on geology at Old Cabin Creek is a large east-west concave thrust fault which brings up lithologies as old as Proterozoic (Figure 4). In addition, the proximity of the Selwyn Anticlinorium causes local deviations on fold axes and fault directions in Old Cabin Creek lithologies.

2.2 REGIONAL STRATIGRAPHY

Selwyn Basin stratigraphy is well described by Cecile (1980, 1982) and by Gordey (1979, 1980, 1981) as part of their respective mapping projects in the Niddery Lake (105-0) and Nahanni (105-I) map-areas. Earlier descriptions by Wheeler (1954) and Blusson (1974) may be useful, although formation names have changed considerably.

Abbott (1982) gives a detailed description of rocks found in the MacMillan Pass area, while Gordey et al (1982) give attention to Devono-Mississipian strata.

The regional stratigraphy (Figure 5) contains five packages of sedimentary rocks and possibly two smaller localized volcanic packages.

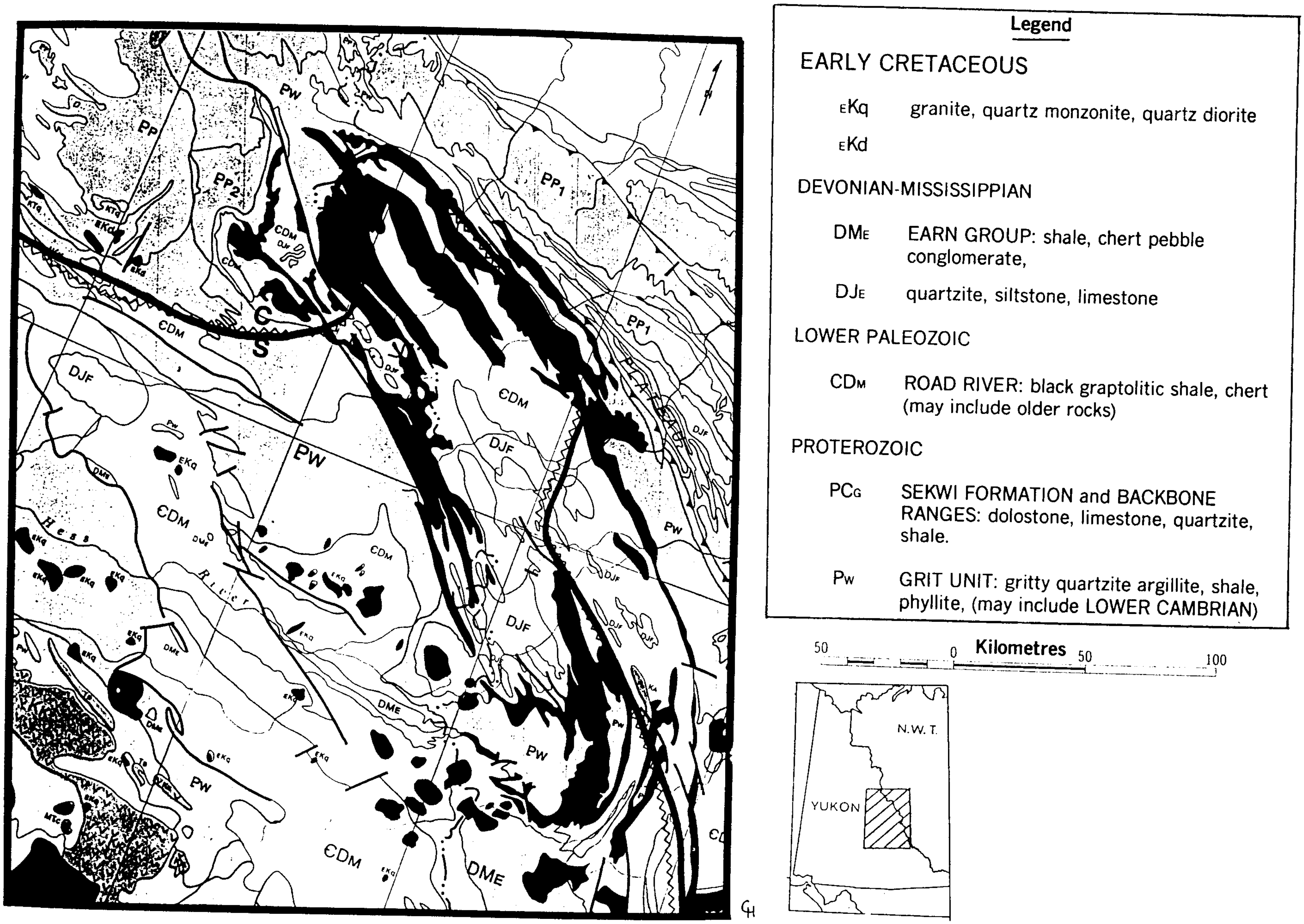


Figure 5: Regional Geology of northeastern Selwyn Basin (GSC 1983).

The sedimentary rocks represent deep marine accumulations of several thousands of meters of shale, chert, carbonate and clastic rocks ranging in age from late Proterozoic through Triassic. Rocks older than Ordovician include the "Grit Unit" and their shaley equivalents in surrounding platform carbonates. Ordovician through Devonian Shale, chert and limestone of the Road River 'Group' compose most of the basinal fill.

Sea-level changes and local extensional faulting in the late Devonian caused an influx of Earn Group clastics, characterized by quartz sandstones and chert pebble conglomerate, probably derived from older Selwyn Basin lithologies. The Earn Group commonly has an unconformable lower contact with the Road River 'Group'.

The north and east boundaries of the basin are marked by sharp lithological transitions with early Cambrian through Mid-Devonian shallow water carbonates of the MacKenzie Platform. The Cassiar Platform accumulated shallow water dolostones and quartz arenites during Siluro-Devonian time to form the Selwyn Basin's southwest boundary. The Lower Cambrian Sekwi Formation and Cambro-Ordovician Rabbitkettle Formations make up the greatest portion of the platform carbonate sequences.

2.3 VOLCANICS

The occurrence of Lower Paleozoic volcanic rocks among Selwyn Basin sediments is not infrequent and has been reported by many authors (Blusson and Tempelman-Kluit, 1970; Cecile, 1982, 1983; Gabrielse, 1965, 1973; Goodfellow et al, 1980; Gordey, 1979; Green and Roddick, 1963).

Typically they are found as thin discontinuous beds of altered submarine volcaniclastics and less commonly as pillowed flows.

The distribution of Lower Paleozoic volcanics at the present weathering surface in the northeastern Selwyn Basin shows a roughly north-south trend, (Figure 6). These volcanics are divided into two groups on the basis of age.

Volumetrically the most important are Cambro-Ordovician rocks, which outside of the Misty Creek Embayment sit on either lower Cambrian maroon argillites (lCma) or Cambrian argillites (Ca). These most often appear as breccias, tuffs or agglomerates and are commonly less than 100 m thick. Flows may be interbedded with volcaniclastics, or flows may be the only lithology present. These volcanics are most often found as caps or "skifs" on high mountain peaks and only very rarely show an upper contact. Three cases noted in the Niddery Lake map-area (105-O).
The overlying rocks are recognized as middle-upper Ordovician cherts (muOc). In the other case, at Old Cabin Creek, Silurian shales (Sa) overlie the uppermost volcanic flows.

In the Misty Creek Embayment, the Marmot Formation (Cecile, 1982) contains lithologically similar volcanic rocks which range in age from middle Ordovician to middle Devonian. Accumulations of volcanics up to 500 m have been interpreted as volcanic centres.

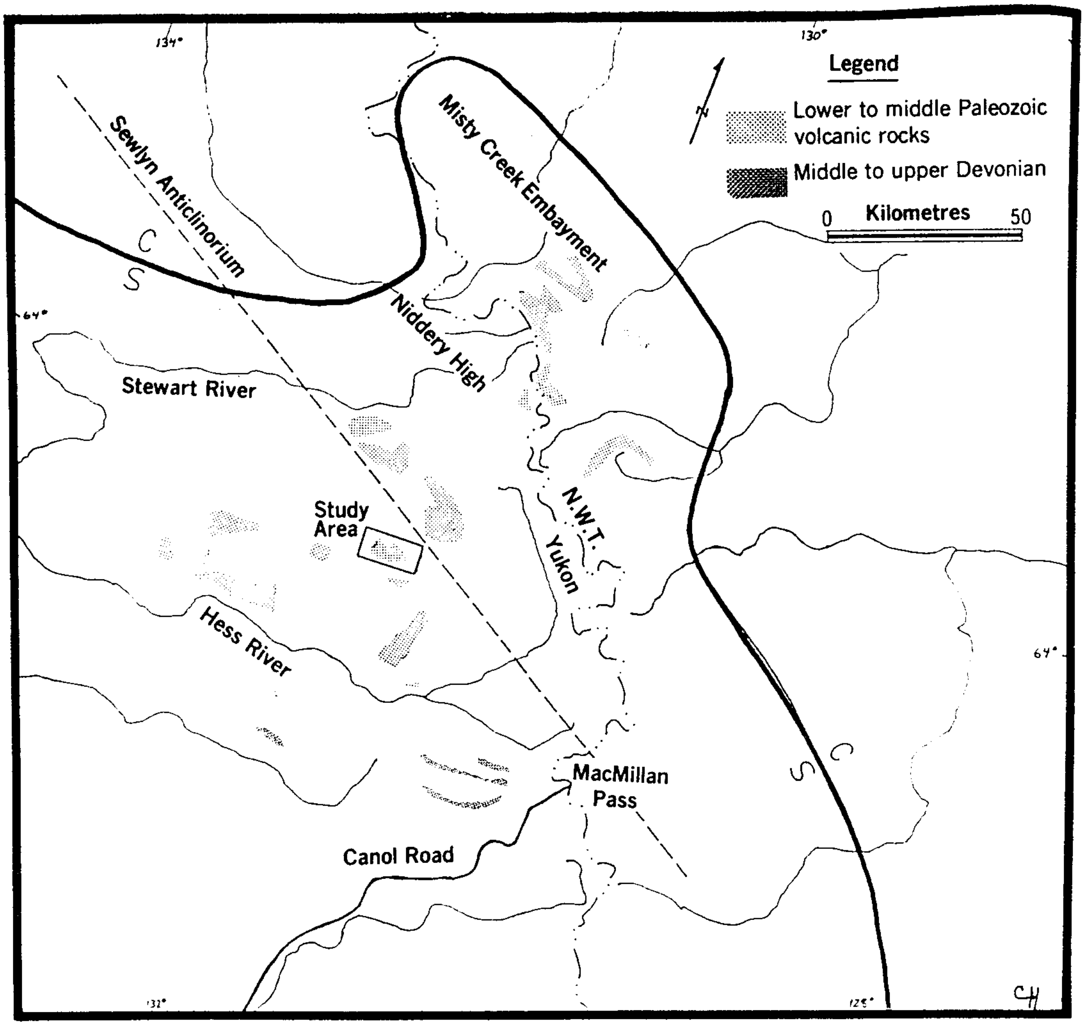


Figure 6: Distribution of volcanic rocks.

Further south at MacMillan Pass, Walker (1982) studied flows and minor clastics which have been placed at mid-upper Devonian by Abbott (pers. comm., 1985). These flows reach only 15 m in thickness and are areally restricted to the MacMillan Pass area.

All Lower Paleozoic volcanics found in the Selwyn Basin and surrounding area are recognized as submarine and have undergone extensive hydrothermal alteration.

2.4 SELWYN PLUTONIC SUITE

Two belts of northeast-trending , post-tectonic, early-mid-Cretaceous (77-96 Ma) plutons have been recognized in the Selwyn Mountains by Anderson (1983). These plutons are part of the Selwyn Plutonic Suite, characterized by granite or quartz-monzonite intrusions which lie west of a major tectonic hinge line defined by the westerly shaling-out of Lower Paleozoic carbonate rocks (Figure 7).

Surface exposure of these plutons is variable with exposed areas up to 270 square kilometers (O'Grady Batholith). Most range from 2 to 10 km^2. These intrusives are typically composite with a large massive equigranular phase.

Their contacts with the country rock are steeply-dipping with well developed alteration halos of width from quarter to equal their diameters and are characterized by fine-grained, often silicified, hornfels. Where carbonates are in contact with the

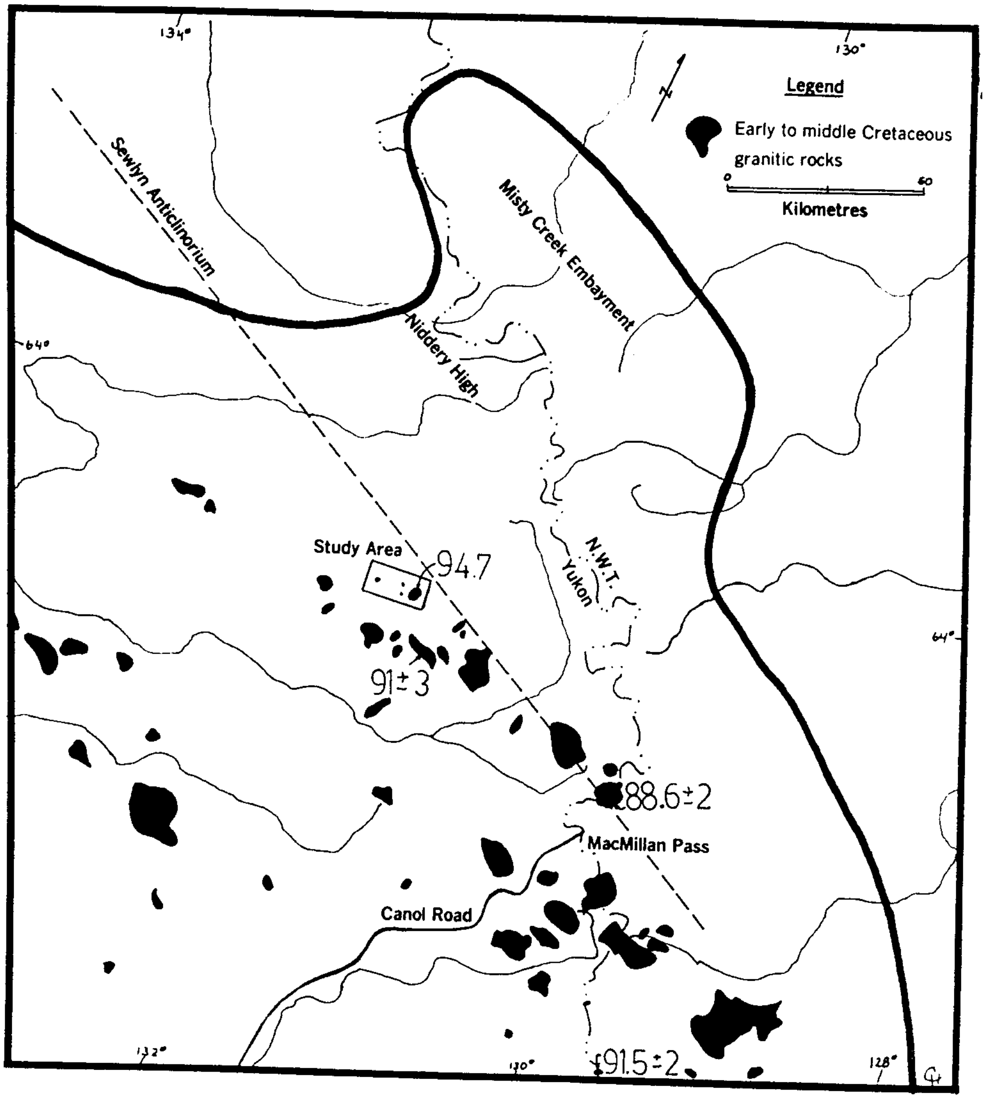


Figure 7: Distribution and ages of plutonic rocks. All ages from K-Ar biotite dates (Anderson, 1983).

plutons, skarn mineralization is common.

Economic tungsten skarns are typically associated with granite plutons not containing hornblende as a major mafic constituent.

CHAPTER 3

3.0 OLD CABIN CREEK

The Old Cabin Creek Massif is underlain by Hadrynian to Silurian basin facies rocks which have been intruded and altered by Cretaceous plutonic rocks (Figure 8).

In the stratigraphy, a package of Cambro-Ordovician shallow water volcanic flows, breccias and tuffs of variable thickness are recognized. These rocks show evidence of intense low-temperature hydrothermal alteration. Such an occurrence disrupts local deposition making stratigraphic correlations difficult. Late Mesozoic deformation adds further to this complexity.

The overprinting recrystallization during contact metamorphism makes lithological interpretations difficult. The pervasive nature of this hornfelsing at Old Cabin Creek suggests that the sedimentary/plutonic contact is not far beneath the present day erosional surface. Aeromagnetic maps support this inference.

3.1 STRATIGRAPHY

Eight mappable units are recognized at Old Cabin Creek. For the most part they can be correlated with similar units in the Selwyn Basin.

The oldest strata exposed at the Massif are two units of

Geology of the Old Cabin Creek Massif, Yukon Territory

105-O/13 105-O/14
105-O/12 105-O/11

ELEVATIONS IN METRES ABOVE MEAN SEA LEVEL
CONTOUR INTERVAL .... 20 METRES

Scale 1:50 000 Échelle

Metres 1000 0 1000 2000 3000 4000 Mètres
Yards 1000 0 1000 2000 3000 4000 Verges

Geology by Craig Hart, 1983.

Schematic cross-section showing stratigraphic relationships

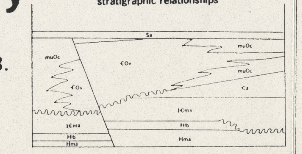


Figure 8

LEGEND

- Geological contact (defined, approximate)
- Normal Fault (downside indicated)
- Thrust Fault (teeth on hanging wall)
- Vein network

CRETACEOUS

Kgr	Granodiorite and granite: b-with biotite, h-with hornblende
Kal	Alaskite sills and dikes

SILURIAN

Sa	Silver weathering, thin-bedded, black, siliceous graptolitic shales

ORDOVICIAN

muOc	Grey, green, blue, black and white, thin- to medium-banded, chert and siliceous shales

CAMBIAN to ORDOVICIAN

COv	Dark brown to green basic volcanic and volcanisclastic rocks interbedded with chert, argillite and black shale. Volcanic sequence includes coarse flow breccias, pillow breccias, lapilli tuff, fine-grained breccia, massive amygdaloidal flows, pillow lavas, epiclastics, agglomerate, sills and dikes.
tCO	Thrust package containing various Cambro-Ordovician lithologies.
Ca	Creamy-buff to rusty orange weathering blue, tawny and pale-green, thin-bedded argillite and shale, interbedded with chert and black shale
1Cma	Maroon and green, thin-bedded argillites, with interbeds of black and brown shale, quartz grit, greywacke and quartzite

HADRYNIAN

H1b	Grey-white weathering, dark grey to black, thick-bedded limestone and limestone conglomerate with interbeds of orange weathering, calcareous quartz sandstone
Hma	Thin-bedded maroon argillite, brown and black shale with interbeds of medium- to thin-bedded grit, pebbly sandstone and quartzite.

upper Proterozoic/lower Paleozoic maroon and green argillites and shales. These two lithologically similar units are separated into upper (€ma) and lower (Hma) members by a limestone unit (Hlb). Collectively, these rocks are known informally as the "Grit Unit" (H€ma). This is characterized by interbeds of gritty quartzo-feldspathic sandstones and turbiditic sandstones.

These rocks are overlain by a Cambrian argillite unit (€a) which, at Old Cabin Creek grades upwards to chert (eOc and muOc). These in turn become interbedded with volcaniclastics and flows (€Ov). The upper contact of this volcanic unit is seen only once at Old Cabin Creek, where it is conformably overlain by black graptolitic Silurian shales.

The youngest rocks exposed in the study area are Cretaceous granodioritic and granitic (Kgr) intrusives with varying mafic content.

3.1.1 Hma

Thin-bedded maroon argillite, brown and black shale with members of medium- to thin-bedded grit, dirty pebbly sandstone and quartzite make up the lower "Grit Unit" at Old Cabin Creek. Only the top 200 m of this 3000 m thick (Gordey, 1979) is exposed in the study area.

The lower portion of this unit is mainly dark maroon argillites, shales and slates with sandy interbeds. The top 100 m of this unit is predominantly thin-bedded, light brown shale, sandstone and grit with an extensive network of quartz stringers. The grit typically has a dark grey muddy matrix with milky quartz clasts and up to 15% chert clasts which tend to be larger than the quartz. In some places these beds occasionally contain cross-bedding. Some weathered surfaces are orange, resulting from either the hydration of iron sulphides in the matrix or weathering of the typically calcareous cement. The coarser clastics also tend to be the more calcareous.

AGE AND INTERPRETATION

The trace fossil Gordia has been found in the upper portion of this unit at Gull Lake, Yukon (Fritz et al, 1983). In the absence of additional fossil evidence this unit is placed in the upper Precambrian, (Vendian).

Coarse clastics of this unit are interpreted as turbidites with Bouma A and AC sequences; they have been derived from the west (Gordey, 1979).

3.1.2 Hlb

Grey-white weathering, dark grey to black, thick-bedded limestone with interbeds of sandstone are the predominant lithologies in this unit. At Old Cabin Creek there are two distinct limestone horizons (Figure 9).

The lower horizon has a thickness of approximately 15 metres and contains thin interbeds of medium grained, light brown

Figure 9: Looking north towards limestone unit Hlb. Dips steepen towards vertical just right of photograph.

Figure 10: Typical intraclast limestone conglomerate.

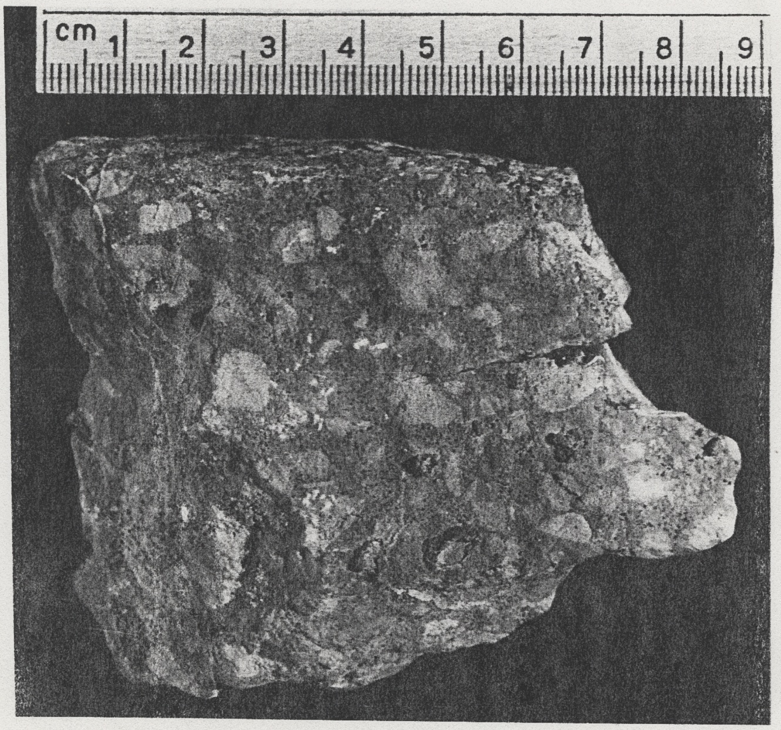
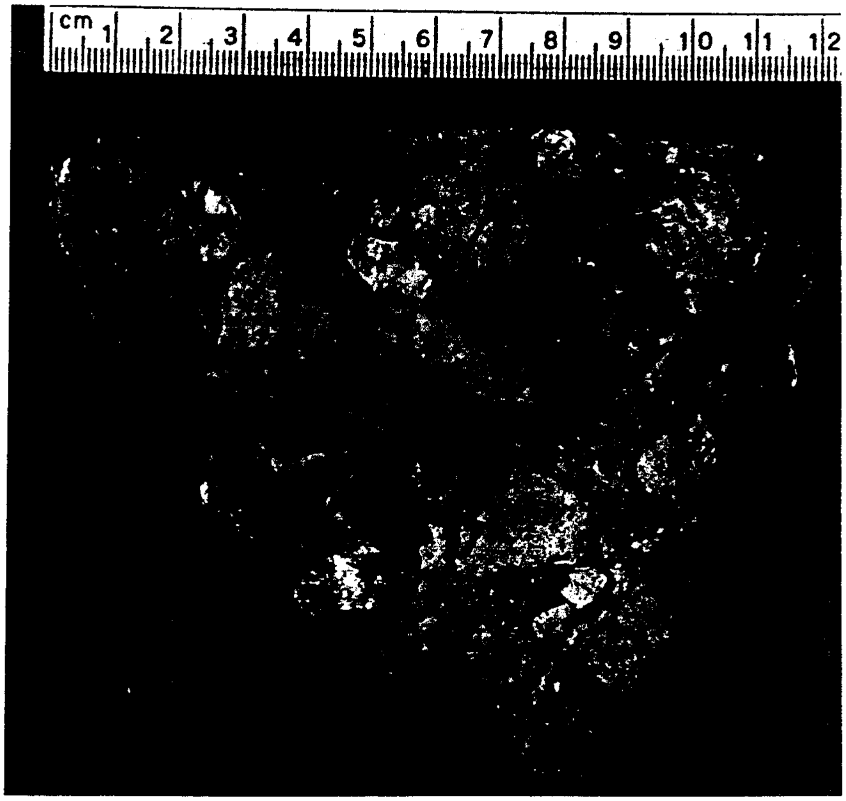

cm 1 2 3 4 5 6 7 8 9

Figure 11: Polymitic limestone conglomerate containing fragments of sandstone, shale and oncolithic "grapestone".

Figure 12: Aggregates of silicified oncoliths in limestone.


cm 1 2 3 4 5 6 7 8 9 10 11 12

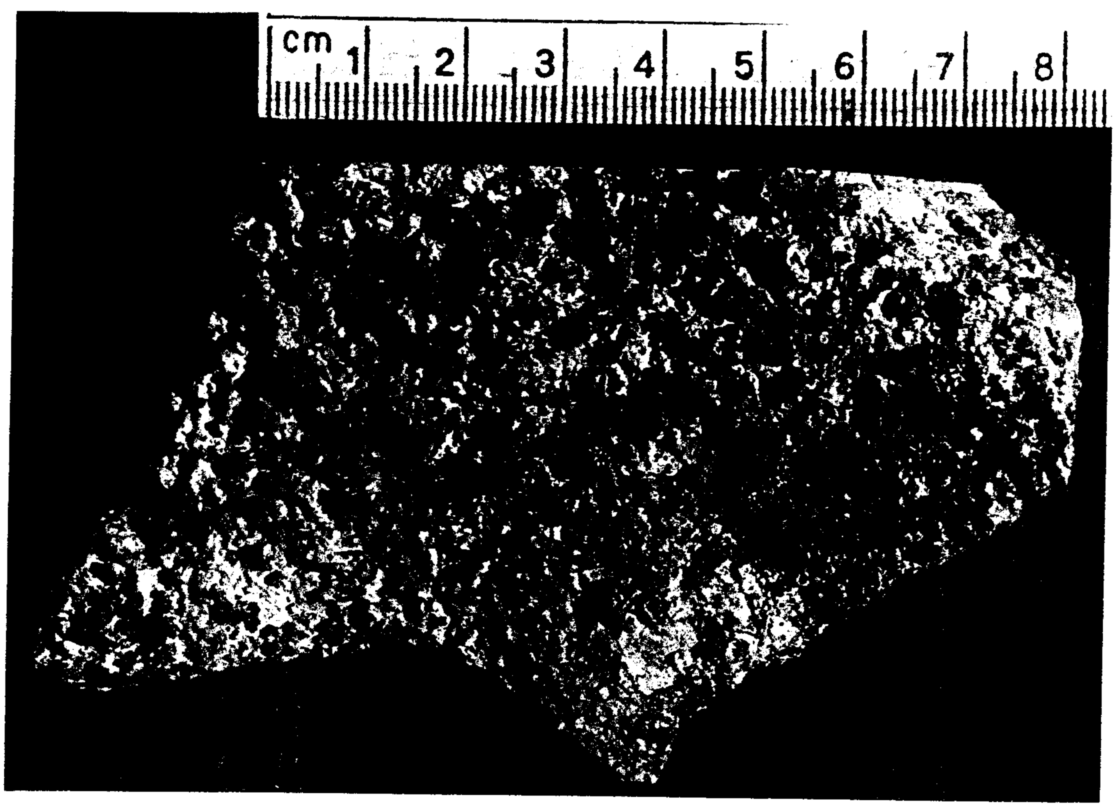
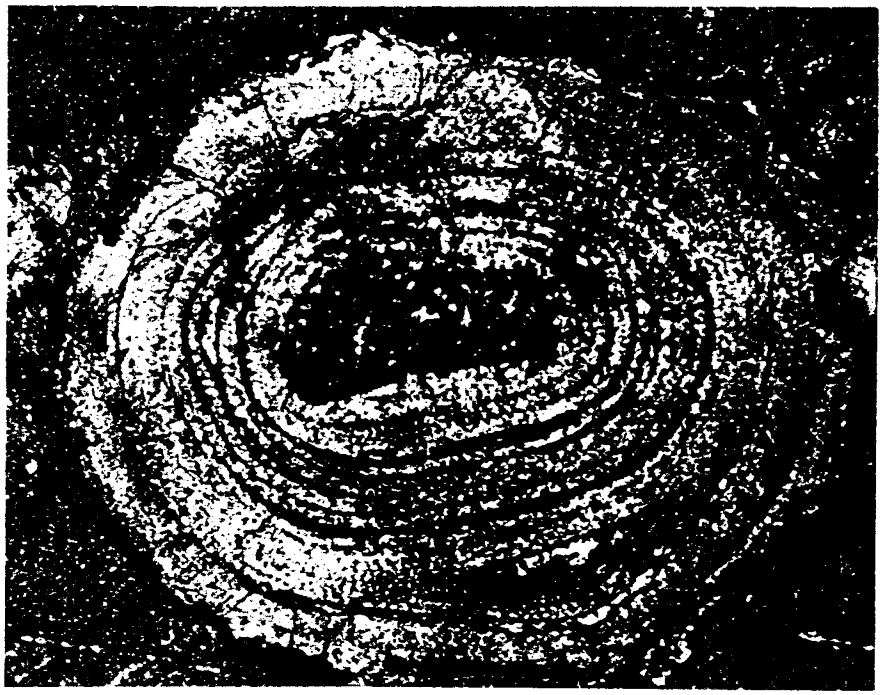
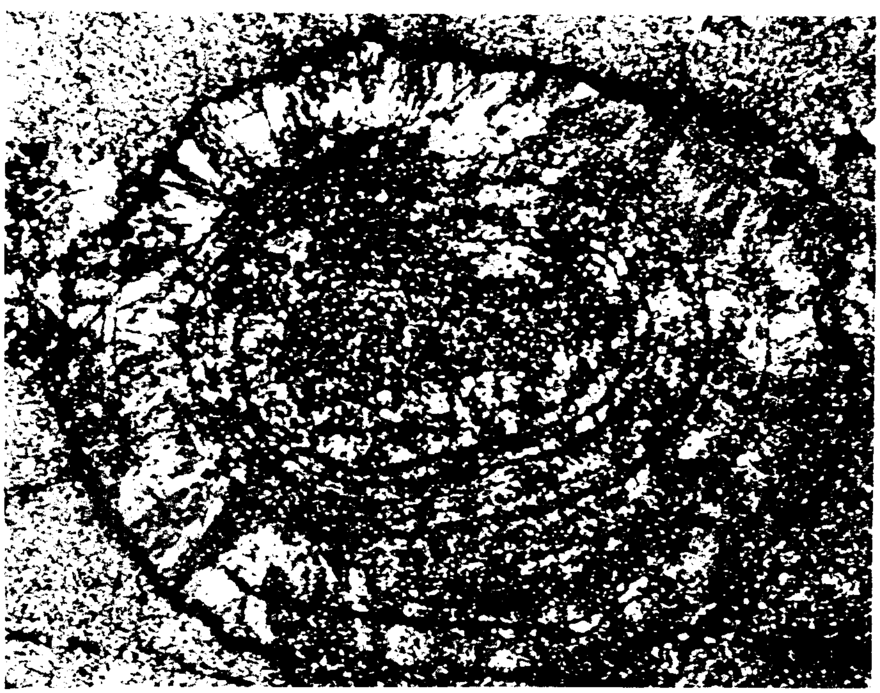

cm 1 2 3 4 5 6 7 8

Figure 13: Silicified oncolith in limestone unit, Hlb. Top photo is in plane light and botton is under cross-polars.





calcareous substrate.

The upper contact of the limestone unit is locally marked by the presence of a discontinuous, well-sorted, cross-bedded, orange sand body of about 4 m in thickness. This, in turn is overlain by two 1 m sequences of grey-brown grits, each overlain by cobble-sized clasts of chert, limestone, dolostone, and rip-up clasts of shale, all in a calcareous sandstone matrix.

The only exposure of this unit and Hma in the study area is in the eastern portion where strata are brought up by Cretaceous faults and incised by present day erosion.

AGE AND INTERPRETATION

This unit seems not to contain either trace or small shelly fossils, yet is above units containing Gordia. The recognition of oncoliths in the limestone is not useful in age determinations. This unit is regarded as having been deposited in the uppermost Precambrian.

The transition from fine to coarse clastics, then to massive limestone, to mono and polymictic conglomeratic limestone suggests deposition in increasingly shallower environments. It seems that proximal turbidites gave way to shallow water carbonates, portions of which became unstable and formed slump breccias. As sea levels fell, emergent terrestrial masses acted as a source for large lithic fragments which were deposited on the shallow carbonate shelf. The formation of oncoliths probably required wave action, suggesting a shallow, nearshore environment.

The overlaying cross-bedded sandstone body is probably representative of a small offshore bar capped by thin beach deposits.

3.1.3 €ma

Approximately 300 m of mainly thin-bedded, maroon and green argillite with interbeds of black and brown shale, quartz grit, greywacke and less often clean, white quartzite make up the upper "Grit Unit".

Thin beds of limestone conglomerate and grits associated with flute casts occur in the lower 100 m of exposed section.

The upper portion of this unit often loses its distinctive maroon and green nature as the argillites are replaced by tawny, medium-bedded shales (Figure 14).

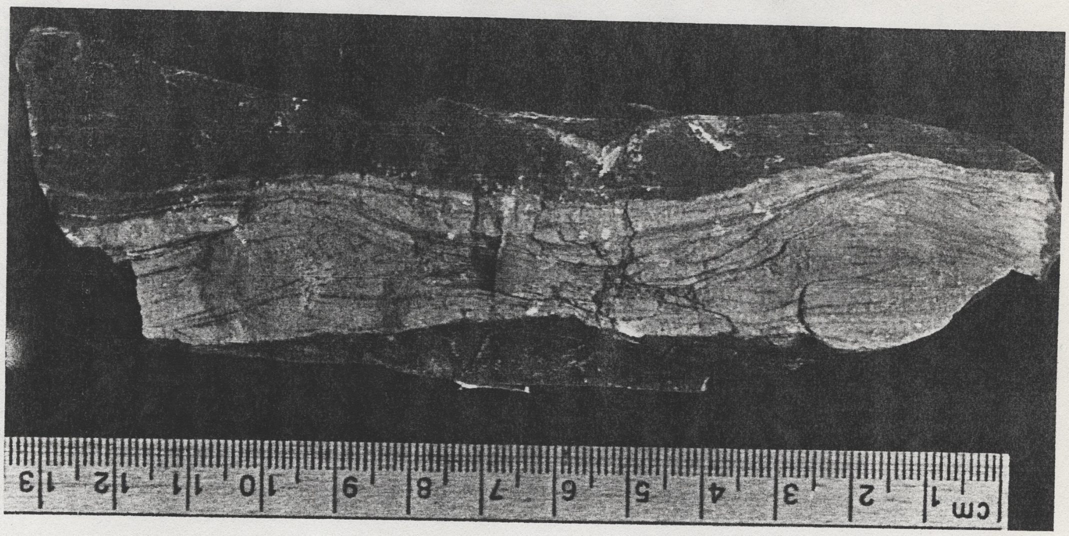
In the western portion of the study area, 10-15 cm thick beds of maroon argillites are monotonously interbedded with 5 cm beds of cross-ripple laminated white sandstones for at least 200 vertical metres (Figures 15,16). Where hornfelsed, the argillites become more siliceous and slate-like, while the sandstones become pale-green quartzites. The coloration is thought to come from clays in the sandstone which have been altered to chlorite.

Trace fossils become abundant in sandy horizons of the upper portion of this unit.

Figure 14: Well bedded tawny shales typical of the upper forty metres of 1€ma.

Figure 15: Monotonously interbedded ripple-cross laminated white quartzose sandstone with maroon argillites of lCma on "Scary Ridge".

Figure 16: Close-up of Figure 15.



AGE AND INTERPRETATIONS

The sudden proliferation of trace fossils in the sandy argillite layers represents the Cambrian/ Precambrian transition, (see Ch. 4). This upper member of the "Grit Unit" is conformably overlain by shales described by Gordey (1980), as hosting an archeocyathid-bearing limestone conglomerate debris flows. The maroon and green argillites are partially correlative with the Backbone Formation. This evidence, and that given in Chapter 4, suggest that this unit represents the lowermost Cambrian.

The rapid change from coarse to fine clastics in this unit is interpreted as a relative rise in sea level.

3.1.4 ₠a

Creamy-buff to rusty orange weathering, blue, tawny and pale-green, thin-bedded argillite and shale make up the unit recognized as the Cambrian argillite (Figure 17). Interstratified blue, green and brown chert and less often black shale give this unit a total thickness of 400 metres. In the Selwyn Basin this argillite contains volcanic fragments and is equivalent to volcaniclastic units recognized by Cecile (1982).

In the field this unit is very difficult to recognize. The brown shales weather very similarly to the brown shales of the underlying l₠ma and the cherts are often indistinguishable from the overlaying chert units.

Figure 17: Rusty weathering blue siliceous shales typical of unit €a.

At Old Cabin Creek the lower boundary is set immediately above the last maroon shale of l€ma. The upper boundary is gradational with chert and volcanic rocks.

This unit is highly variable in thickness. Often, where overlain by volcanics, this unit can reach thicknesses of 400 m or be totally absent.

AGE AND INTERPRETATION

The lower portion of this unit is correlative with cream coloured, archeocyathid-bearing shales (Gordey, 1979) and probably with the Sekwi Formation. Spicules from the lower Paleozoic Protospongia have been recognized by G. Narbonne (Sarjeant, 1983) from cream coloured shales at Old Cabin Creek. Originally this unit was assigned to the lower Cambrian only. It now seems likely that this unit extends from the latest lower Cambrian to the upper Cambrian.

The upward trend to black shale and the increasing silica content of the shales and eventual chert deposition indicate a continually deepening or restricted basin. The wide variation in the thickness of this unit over short distances (1000 m) may be due to Cambrian faulting.

3.1.5 Oc

Grey, green, blue, black and white, thin- to medium-bedded, chert and siliceous shale make up the Ordovician chert unit at Old Cabin Creek. Elsewhere in the Basin two distinct chert units are recognized (eOc and muOc, Cecile and Hart, 1983), but at Old Cabin Creek the penecontemporaneous deposition of the volcanics makes such a lithological distinction difficult. Chert found at the Massif is therefore divided into two units based solely on their position in the stratigraphy.

The older chert (eOc) is found interbedded with stratigraphically lower argillites and higher volcanics.
It tends to be a massive green to dark grey resistant chert with buff coloured limestone nodules in some horizons. Thicknesses for this unit are variable to zero and difficult to measure due to the gradational nature of the lithologies. At the Massif, it is rarely seen thicker than 25 m while in the Basin its thickness has been estimated at 80-130 meters.

The younger unit (muOc) is white-blue weathering, black to blue chert with partings of black shale. Occurrences of these cherts and shales within the volcanics is common. They are often seen in beds up to 40 m thick within the volcanic pile. In fact, at some locations ("Black Poll Peak"), they represent almost 50% of the volcanic package, while at others ("Aho Peak") thin beds appear to be capping the volcanics.

AGE AND INTERPRETATION

Chert is not uncommon in Selwyn Basin and Misty Creek

Embayment stratigraphy. Early Ordovician and middle-upper Ordovician chert units are recognized elsewhere in the basin by the presence of representative graptolite assemblages found in interbedded shales (Cecile, 1982; Cecile and Hart, 1983). An age correlation with chert beds at Old Cabin Creek is inferred by the relative position in the stratigraphy and similar lithologies.

The variability of chert lithologies at the Old Cabin Creek Massif is a result of coeval deposition with volcanic rocks. Chert deposition may in fact be directly associated with submarine volcanic activity.

3.1.6 ЄOv

Dark brown to green basic volcanic and volcaniclastic rocks comprising this unit include, in order of abundance: coarse flow breccias and pillow flow breccias (hyaloclastite); lapilli tuff and fine-grained breccias; massive amygduloidal flows and pillow lavas; epiclastics; agglomerate; sills and dikes. Extreme textural and lithological variation over short distances in stratigraphic horizons is common. In addition, thicknesses of up to 40 m of cherts and argillites may be within the volcanic package.

Locally, thin beds of orange weathering dolostone can be found among volcaniclastic horizons. Calcite filled amygdules and thin calcite stringers are pervasive in most volcanic lithologies.

The total thickness of the volcanic unit is estimated by the author to be 500 m thick. A measured section at "Wenchless Ridge" (Sarjeant, 1983), gave a thickness of 330 m, but neither an upper or bottom contact could be recognized.

In most parts of the Selwyn Basin and Misty Creek Embayment these volcanics occur as a single thin unit of tuff, hyaloclastite or pillowed flows, usually not greater than a few tens of metres thick. Local accumulations of hundreds of metres of volcanics probably represent volcanic centres.

Chemically, these rocks contain between 41 and 47% SiO_2 and thus are tentatively classified as basalts.

Petrologically and texturally these rocks are similar to those on "Wenchless Ridge" as discussed by Sarjeant (1983).

Volcaniclastics

Hyaloclastics of varying characteristics, are the most extensive volcanic deposits at the Old Cabin Creek Massif. The variation in fragment size and lithic proportions is large and stratigraphic continuity is almost non-existent.

Fragment sizes are most often 0.5 to 5.0 cm, but extend an order of magnitude in either direction. Fragment lithologies among flows are most often similar to those of the flow themselves - fine-grained basic volcanics. They are usually either angular, elongate, glassy, lapilli-sized fragments of pillow crusts or larger, rounded, calcite-filled amygduloidal clasts derived from scoria (Figure 18).

Varying amounts of light grey chert, limestone, shale and

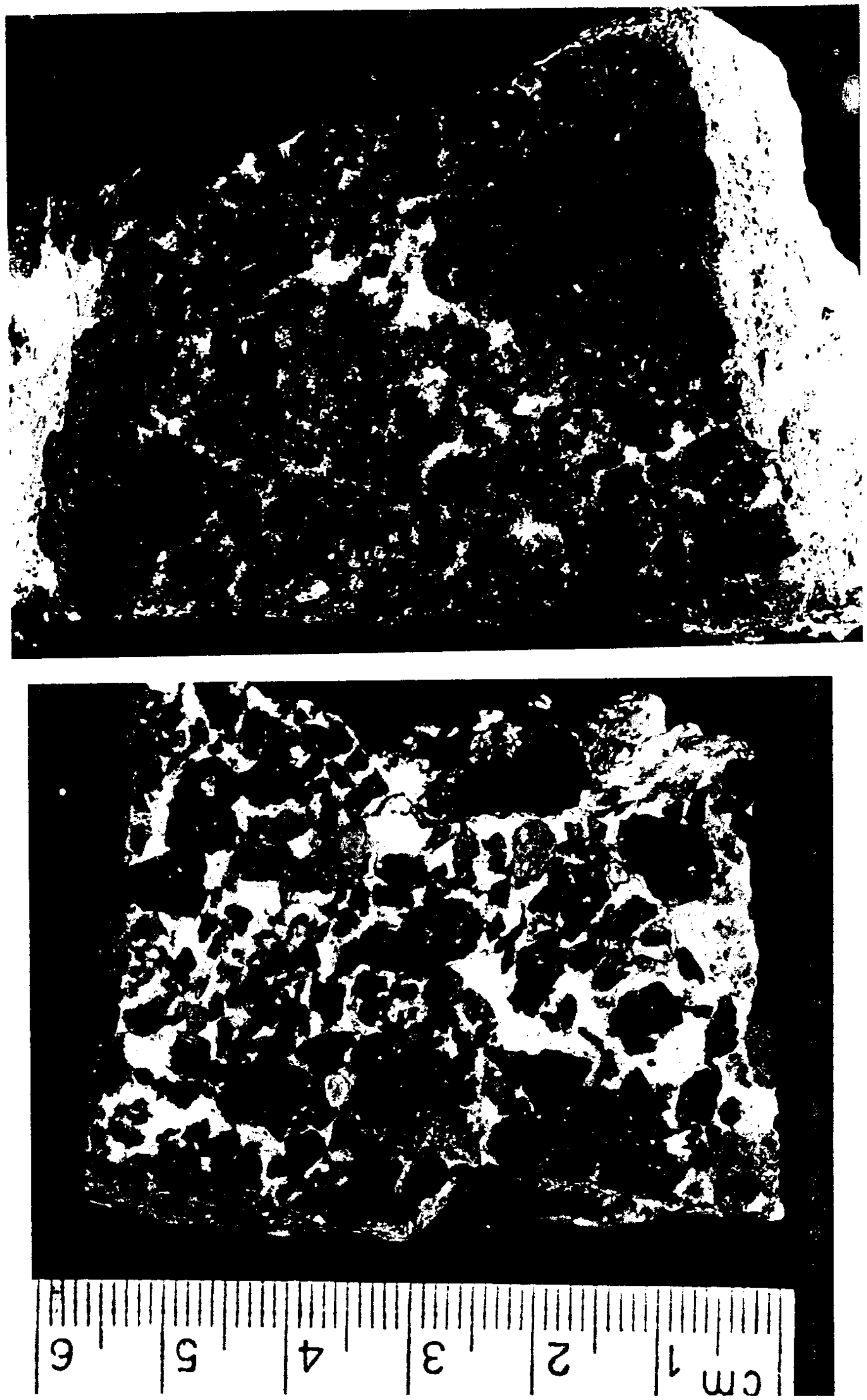
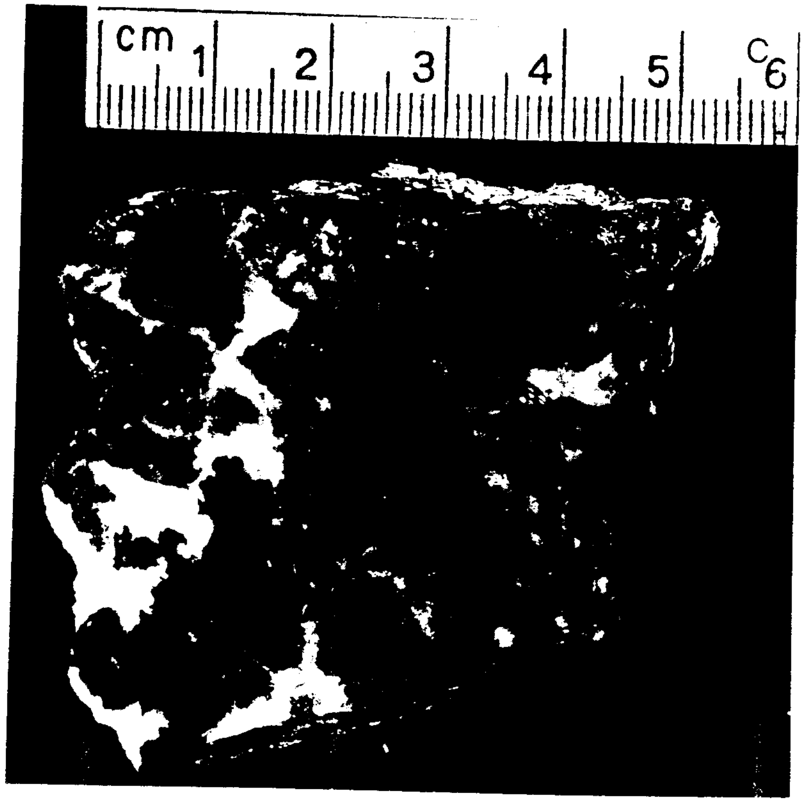


Figure 18: Hyaloclastic breccias composed of fine-grained pillow crusts and amygduloidal scoraceous fragments cemented by varying amounts of calcite spar. Note fabric in sample D.



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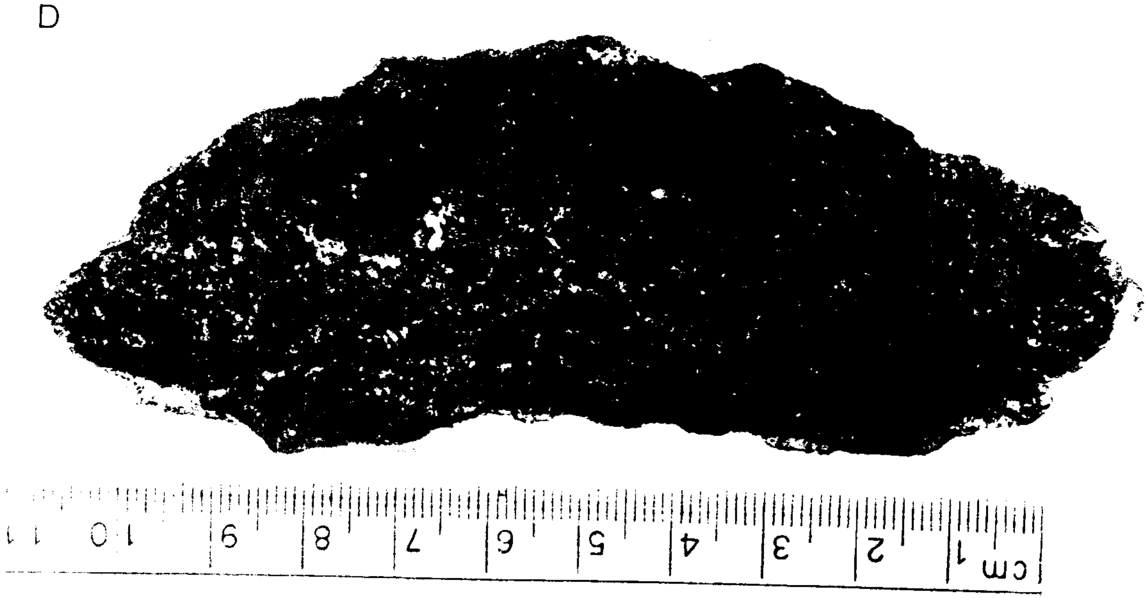

epiclastic fragments are locally common as brecciated clasts (Figure 19). Rare hornblende granite fragments can also be found. Clasts are set in a fine-grained volcanic matrix, often with well developed flow textures and up to 20% vesicles.

Many accumulations of volcanic fragments have not been "ingested" by the advancing volcanic flow. In these cases a sparry calcite cement binds the fragments together. As a result, many volcaniclastics contain up to 50% calcite.

Flow breccias are found interbedded with massive and pillowed flows. Isolated pillows within the breccia are not uncommon.

Lapilli Tuff

Fragments composing lapilli tuffs and fine-grained breccias are typically lighter in colour (intermediate in composition), than flows or other volcaniclastics. In addition they almost always clast supported. Up to 20% of the fragments are lapilli-sized chert and less often shale. Lapilli fragments are composed of minute crystallites, glass shards, fine-grained opaques and vesicles set in a very fine-grained matrix of devitrified glass and either hematite or limonite (Figure 20).

In outcrops, these lithologies weather pink or orange respectively. They show little to no welding or reworking by sediments. Bedding planes are not common. The greatest accumulations of tuffs at the Massif are found locally at the base of the volcanic pile.

Figure 19: Chert and argillite fragments in pillowed flow.

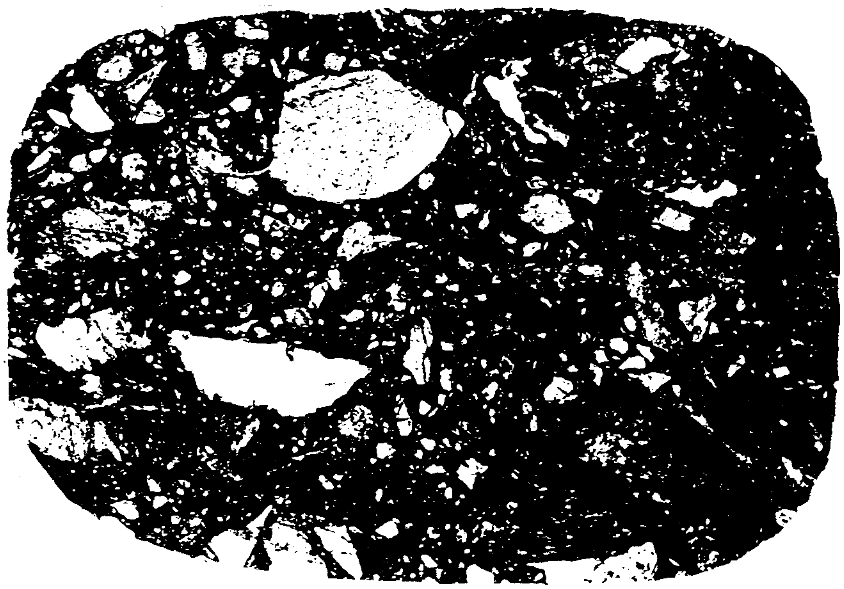

Figure 20: Angular polymictic lapilli tuff set in a hematitic matrix. Clasts are 60% intermediate volcanics, 20% chert and 20% argillite.

The variable thickness and lack of stratigraphic continuity indicate that this unit was deposited as a localized flow.

Epiclastics

Well-bedded, fine-grained tuffs and epiclatics are not volumetrically important at Old Cabin Creek except on "Wenchless Ridge" and "Aho Peak" ridges. Here they occur as fine laminae of alternating buff, red or cream coloured calcareous fine-grained clastics. Bed thicknesses are up to 3 metres, but most often average 40 cm in thickness. They are commonly found overlaying tuffs.

Darker beds of well stratified, fine-grained volcanics and ash are found less often. These "volcanowackes" are calcareous in nature and typically interbedded with breccias. Disseminated pyrrhotite and chalcopyrite are not uncommon features of this unit. As well, 1 cm long crystals of actinolite were recognized in small vugs.

Flows and Pillow Lavas

Massive amygdaloidal flows and pillow lavas make up 50% of the volcanic pile on "Aho Peak". They are common, but less abundant throughout the rest of the study area.

Beds of massive amygduloidal flows range from 5 to approximately 100 m in thickness. The amygdules range from a few millimetres to greater than a centimetre in size, and are almost always filled with calcite spar. Ten metre thick flows low in the volcanic pile were found locally to contain approximately 50% amygdules by volume. According to Moore (1970), this degree of vesiculation indicates emplacement at depths less than 500 metres. Sarjeant (1983), using Jones' (1969) relationship between vesicle size and depth, suggests that the basaltic flows of ""Wenchless Ridge" were extruded in water approximately 400 m deep or less.".

By contrast, a very thick (100 m) massive flow high in the stratigraphy and therefore late in the volcanic sequence on "Aho Peak", contains only a few percentage of amygdules by volume. This unit does however show excellent flow textures and contains up to 30% pyrrhotite in the upper portion of the flow (Figure 21).

Pillow lavas are the most extensively distributed volcanic lithology at Old Cabin Creek, but not the most abundant. They occur in beds 1-20 m thick, interbedded with volcaniclastics and massive flows. Low in the section, flows of pillows form beds 1-5 m with interbedded cherts of similar thickness (Figure 22).

Pillows are 20-50 cm in diameter but occasionally reach a maximum of 3 metres. Chilled margins are about 2-3 cm (Figure 23) thick beneath scoraceous rims of up to 10 centimetres. Together they form reactionary selvages having intense alteration; they commonly are yellow in colour.

Although most often found interbedded with coarse breccias, they are found between beds of basinal sediments in areas thought to be distal from the source.

Figure 21: Massive volcanic rock containing up to 30% pyrrhotite.

Figure 22: Lower contact of volcanic unit on top of Cambrian argillites with thin bed of chert in between.

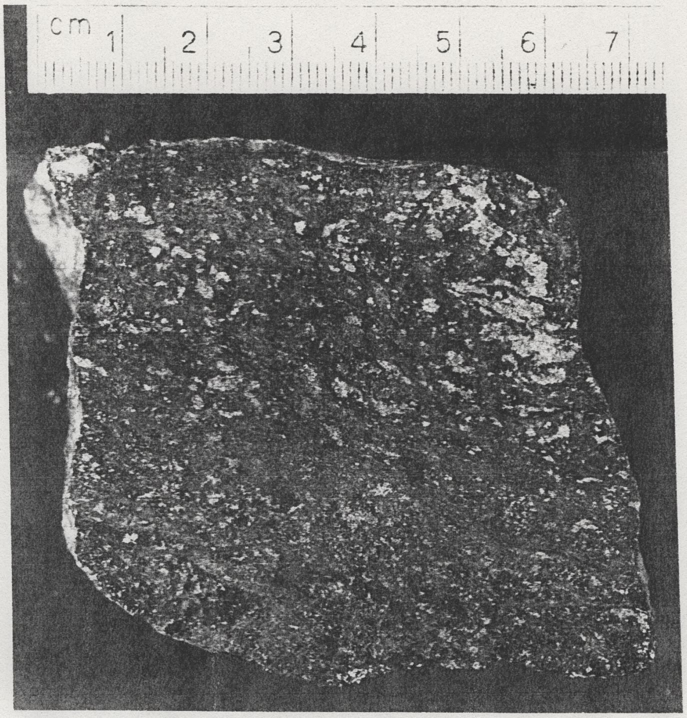
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Figure 23: Vesicular pillow with scoraceous crust.

Sills and Dikes

In the study area, sills and dikes are neither abundant or extensive. They are typically less than 2 m thick, although a few larger dikes (10 m) exist. They are dark green, fine-grained and massive. Sills are dominant within the volcanic lithologies but three thick dikes are found cross-cutting unit €a in the valley floor south of "Blackpoll Peak".

AGE AND INTERPRETATION

The lower contact of this unit is not well defined. Volcanics predominate where the Cambrian argillite becomes cherty (eOc). Initial volcanism probably began in the latest Cambrian/earliest Ordovician. In the Misty Creek Embayment, strata of the lowest Marmot Formation overlie graptolitic shales with an early Middle Ordovician fauna (Cecile, 1982).

On "Wenchless Ridge" the uppermost volcanic flow is directly overlain by black shales. These contain Monograptus spiralis and are therefore latest Llandoverian in age. Thus, the youngest volcanic rocks at Old Cabin Creek are Llandoverian.

Volcanics in the study area are interpreted as representing many small submarine volcanic edifices from a partially zoned magma chamber. The localized basal accumulations of intermediate tuff and ash resulted from explosive submarine degassing of the silica-rich magma near the top of the magma chamber. This eventually gave way to massive flows, pillow lavas and associated volcaniclastics.

A hiatus in volcanic activity allowed the accumulation of epiclastics and eventual deposition of chert and argillite.

As lower portions of the magma chamber were tapped, a degassed, sulphur-rich magma of low viscosity erupted as a thick, massive, pyrrhotite-rich flow with few vesicles.

Subsidence or faulting of the volcanic pile into the emptying magma chamber dropped much of the accumulated lithologies to a stratigraphically lower level and pushed residual basic magma into the newly formed fractures.

Minor block faulting is thought to have occurred during most of the volcanic event.

3.1.7 Sa

The uppermost strata at Old Cabin Creek are silver weathering, thin-bedded, black siliceous, graptolitic shales. Less than 5 m of section is exposed at only one location throughout the study area on "Wenchless Ridge".

Silurian strata recognized elsewhere in the basin are predominately rusty to buff weathering, dark green argillites with orange dolostone. This unit is easily correlated with other lithologies by the distinctive graptolite assemblage it bears.

AGE AND INTERPRETATION

A collected graptolite assemblage suggests the host rocks are latest Llandoverian in age. The presence of black shales indicates a return to either a deep and/or restricted basinal environment.

This unit is correlative with RRl (Cecile, 1978), which is a grey limestone unit found in the uppermost Road River in the rocks of the Misty Creek Embayment.

3.1.8 Kgr

Intrusive rocks at the Old Cabin Creek Massif are most often granodiorites and less often granites. They are medium-grained and equigranular and contain rounded, fine-grained mafic xenoliths Figures 24,25). The mafic constituent in the largest and easternmost exposure is predominantly crystals of hornblende up to 3 mm long. Rarely, biotite may be found composing up to 30% of the mafic portion.

The small exposures of granodiorite in the west contain mainly biotite as the mafic constituent and is slightly coarser grained and contains mare quartz. Other exposures host varying percentages of both hornblende and biotite.

Well zoned euhedral plagioclase crystals probably indicate a trend from Ca-rich to Na-rich (Figure 26).

FIGURE 24: Typical sample of hornblende granodiorite (Kgr-h).

Figure 25: Fine-grained mafic xenoliths in Kgr-h.

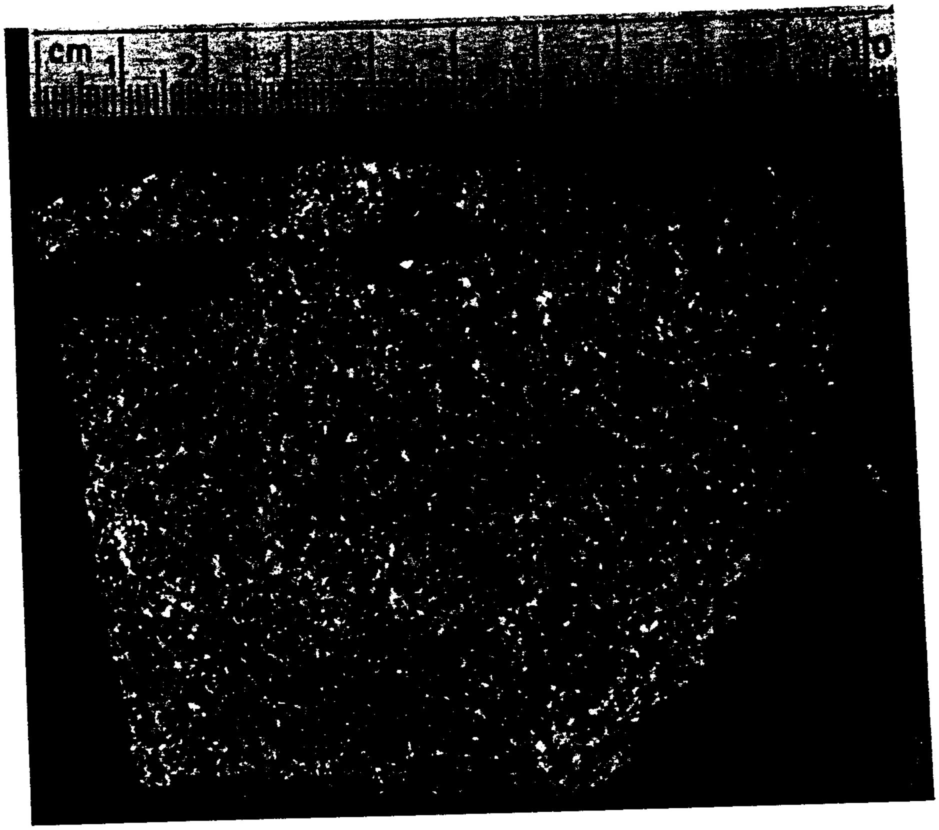
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Figure 26: Well-zoned euhedral plagioclase crystal next to hornblende. Zoning probably represents trend from Ca-rich to Na-rich magma.

Thermal contact aureoles in the country rocks range from several metres to several kilometres. Fine-grained clastics, chert and volcanic rocks are recrystallized to dark, fine-grained pyrrhotite-bearing hornfels.

Thin (<1 cm), sub-parallel quartz and K-feldspar veins cross-cut the granodiorite and less often the hornfelsed country rock. A second generation of pyrite- and molybdenum-bearing quartz veins are responsible for localized sericitic alteration.

AGE AND INTERPRETATION

A K-Ar date from biotite in the granodiorite yielded an age of 94.9 +/- 1.7 Ma. It is part of the Selwyn Plutonic Suite (Anderson, 1983).

The variable extent of the contact metamorphism is probably a result of the variable inclination of the contact between the intrusion and the country rock. A steeply dipping contact would result in a small contact aureole while shallow dips would give rise to extensive aureole formation.

The variable mafic composition is thought to arise from either the emplacement of composite plutons or the gradual contamination of the intrusive from ingestion of the wall rock. Either method might explain the Ca/Na zonation in plagioclase.

3.2 UNCONFORMITIES

At least three major unconformities interrupt the stratigraphic record in the Selwyn Basin - two are Devono-Mississippian and the third is Cambro-Ordovician. Evidence of the older hiatus at Old Cabin Creek is inconclusive.

The variable thicknesses of all Cambro-Ordovician units (€a, eOc) suggest a possible partial removal by erosional processes. This truncation of units result in the contact of COv with the maroon and green argillites of the Proterozoic "Grit Unit" as seen in many places throughout the Basin.

However, neither basal conglomerates or accumulations of coarse clastics are recognized in the Ordovician.

Block faults associated with volcanic deposition during the Cambro-Ordovician, may account for the variable thicknesses and unusual contacts seen in Cambro-Ordovician stratigraphy.

Evidence of a Late Proterozoic unconformity has been presented earlier in this thesis.

3.3 SUMMARY

All units older than middle Cambrian at Old Cabin Creek are easily correlated with other units in the Selwyn Basin. During the period from middle Cambrian to Middle Ordovician, episodic volcanism caused local perturbations in the depositional environment making regional correlations problematic.

Chert beds in the lower portion of the volcanics do not correlate well with the regional stratigraphy.

Accumulations of volcanogenic epiclastics are localized.

The thickening volcanic pile compressed sediments beneath it and caused soft sediment deformation in the unlithified portions.

Silica formation thought to be associated with volcanic activity may have been responsible for the formation of thicker chert beds in the vicinity where shale or argillite might otherwise have been present. In addition, this silica rich water certainly found its way as pore fluid since most shales and argillites of the Massif show varying degrees of silicification.

As the volcanic pile thickened the waters became shallower and coarse clastics and carbonates deposited in the upper portions. In addition, the volcanic centre became its own sediment source as epiclastic sedimentation predominated in the waning stages of volcanism.

Deposition of units younger than early Silurian formed thin veneers on the new submarine topographic high while accumulating greater thicknesses throughout the rest of the basin.

CHAPTER 4

4.0 PALEONTOLOGY AND STRATIGRAPHIC AGE DETERMINATIONS

Basin facies strata at Old Cabin Creek contain graptolites and sponge spicules as well as abundant and diverse trace fossils. These help in correlating units of varying lithologies; they may also help to identify anomalous juxtapositions caused by thrusts or overturned folds.

4.1 GRAPTOLITES

Graptolites are especially important in the correlation and identification of so many shale units which have identical lithological characteristics. Good multi-species collections of graptolites have been made throughout the Selwyn Basin in strata ranging from Cambrian through Triassic in age. At Old Cabin Creek only one unit has preserved graptolites in recognizable condition. Other units probably contained graptolites but the recrystallization of most rocks by the nearby intrusion obliterates any evidence of their existence. As a result, the correlation of shale units at Old Cabin Creek with units elsewhere in the basin is problematic.

Two collections of graptolites were made at Old Cabin Creek. Both were made in the uppermost black shales on "Wenchless Ridge". The assemblage is characterized by the limonitic remnants of Monograptus spiralis and Retiolites sp. This assemblage corresponds to a minimum age of latest Llandoverian (Figure 27).

This unit is therefore the Silurian argillite (Sa) unit as recognized elsewhere in the basin. The upper contact of the volcanic unit at Old Cabin Creek is comformably overlain by this Silurian argillite. This suggests that the youngest possible age for volcanic rocks exposed at Old Cabin Creek is Llandoverian.

The chert and argillite which often forms interbeds with the volcanics are those of the middle Ordovician chert series (mOc).

4.2 SPONGE SPICULES

Sponge spicules have been recognized in a buff-weathering green argillite directly overlying the "Grit Unit". Identified as Protospongia sp by G. Narbonne (pers. comm.), these spicules occur in rocks ranging from Lower Cambrian to Ordovician in age the Yukon. At Old Cabin Creek and in recent mapping by Cecile and Hart (1983), this unit is recognized as Cambrian argillite, (€a).

4.3 TRACE FOSSILS

Diverse and abundant trace fossils are easily found in the upper "Grit Unit" maroon and green shales and argillites at Old Cabin Creek. Planolites montanus, Planolites tabularis and Paleophycus sp are commonly found in the same beds.

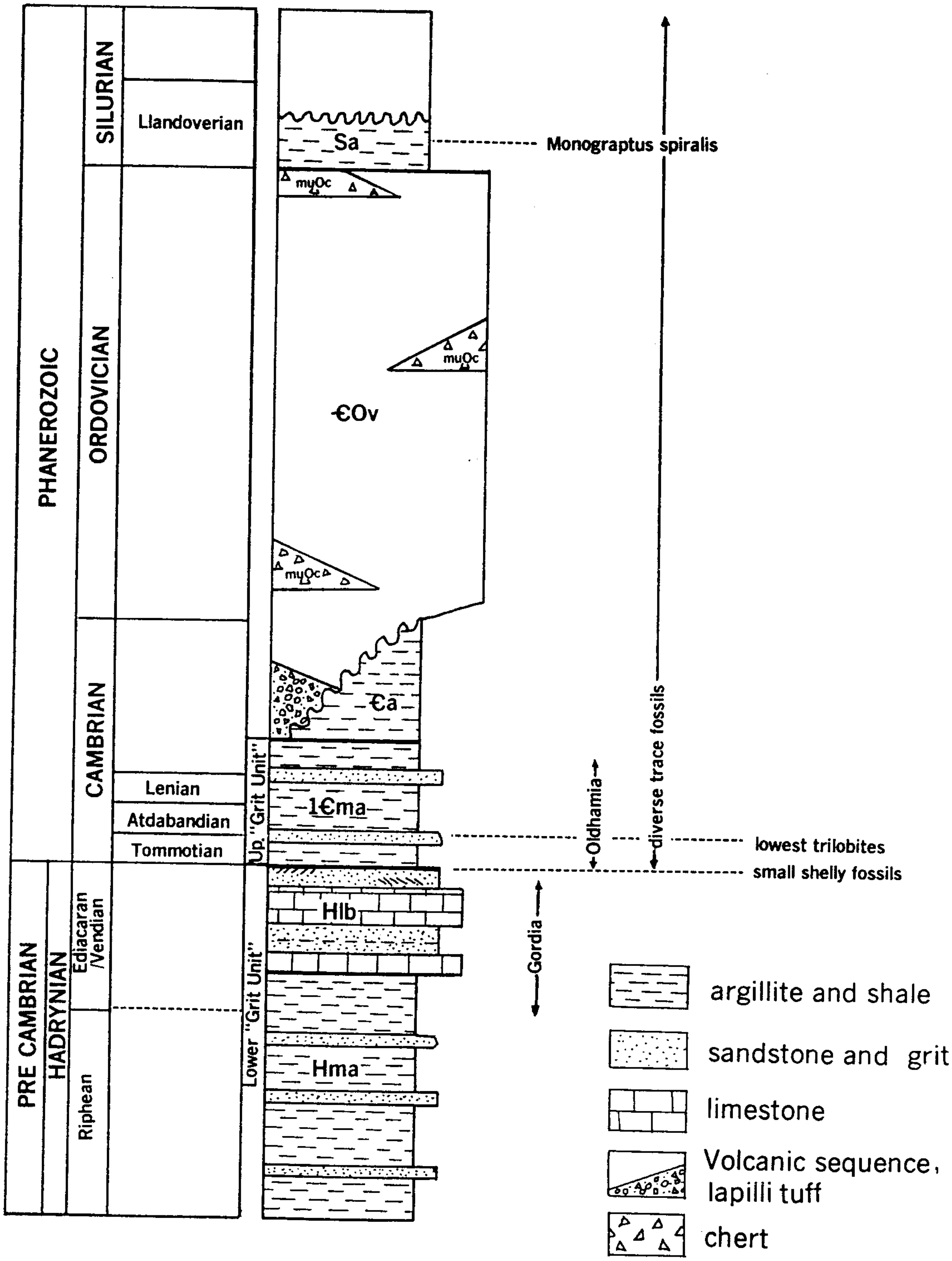


Figure 27: Paleontological age determinations of lithologies at the Old Cabin Creek Massif. Vertical axis is not to scale. Trilobites and small shelly fossils are not found in the study area.

Planolites montanus is the most common of all traces found among Old Cabin Creek lithologies. These can be seen extending in arcuate lengths up to 12 cm. Diameters of the traces are variable, but occasionally they reach 0.7mm (Figure 28).

Planolites tabularis is much less common. Traces are straight and often up to 15 cm in length. Trace diameter is consistently between 5 and 10 mm (Figure 29).

Paleophycus sp forms large bulbous elongate traces of various forms up to 20 cm in length. Diameters are sand-filled and extremely large, commonly reaching 20 mm (Figure 30).

Preservation is good to excellent in the non-hornfelsed portion of the upper "Grit Unit". Local abundances are best seen at contacts in sandy horizons with green argillites.

These trace fossils are known to occur in rocks ranging in age from Vendian to Recent.

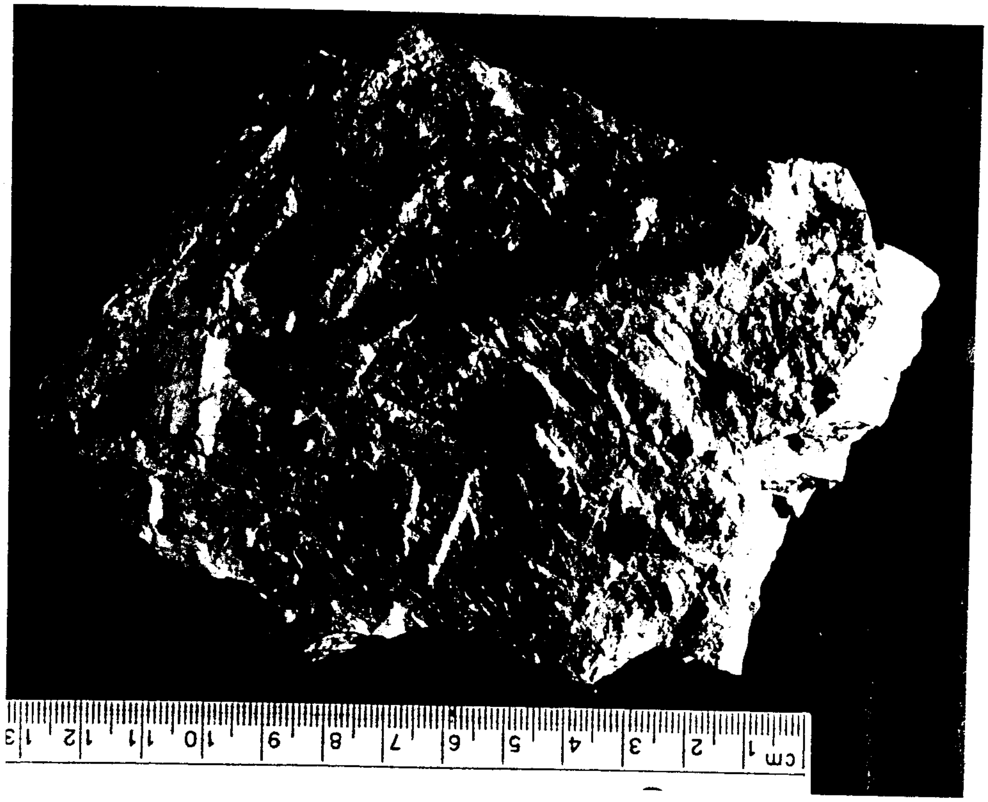
Further descriptions are beyond the range of this thesis and the reader is referred to Fritz et al (1983) and Hoffman and Cecile (1983) for more information.

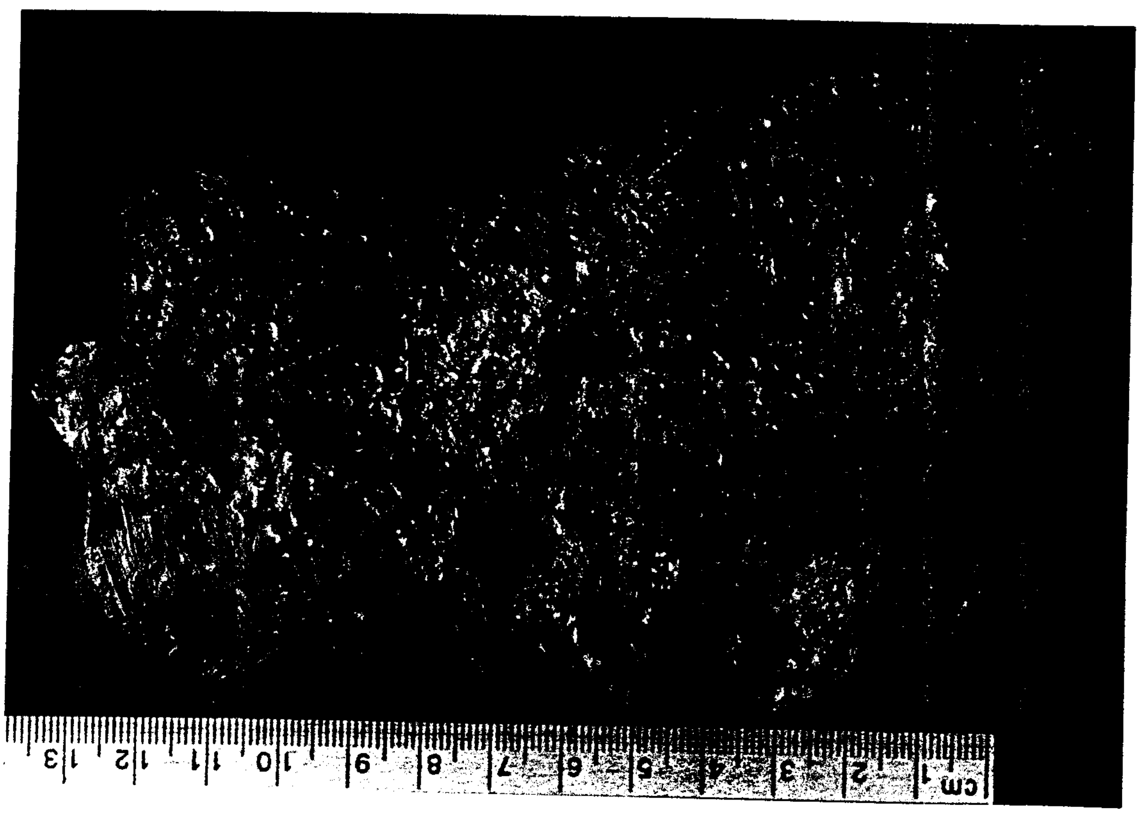
The occurrence of Gordia has been noted by Hoffman and Cecile, (1981) in the Lower Cambrian upper "Grit Unit" elsewhere in the Selwyn Basin. They suggests however that the structures "cannot be assigned with any confidence" and that Gordia in this case may result from impressions from now removed overlying Planolites burrows.

Gordia is known to occur only in the Vendian (Hadrynian). Fritz et al (1983) have recognized Gordia in upper Hadrynian

Figure 28: *Planolites montanus*.

Figure 29: *Planolites tabularis*.





siltstones correlative with the lower "Grit Unit". Thus, rocks containing Gordia are assigned to the lower "Grit Unit" which are Vendian and older.

The absence of this trace in rocks at Old Cabin Creek leads the author to infer that this assemblage is therefore younger than Vendian. Stratigraphically younger rocks containing the assemblage of traces mentioned above, but without Gordia, are considered Tommotian in age and are part of the upper "Grit Unit" (Figure 27).

4.4 OLDHAMIA

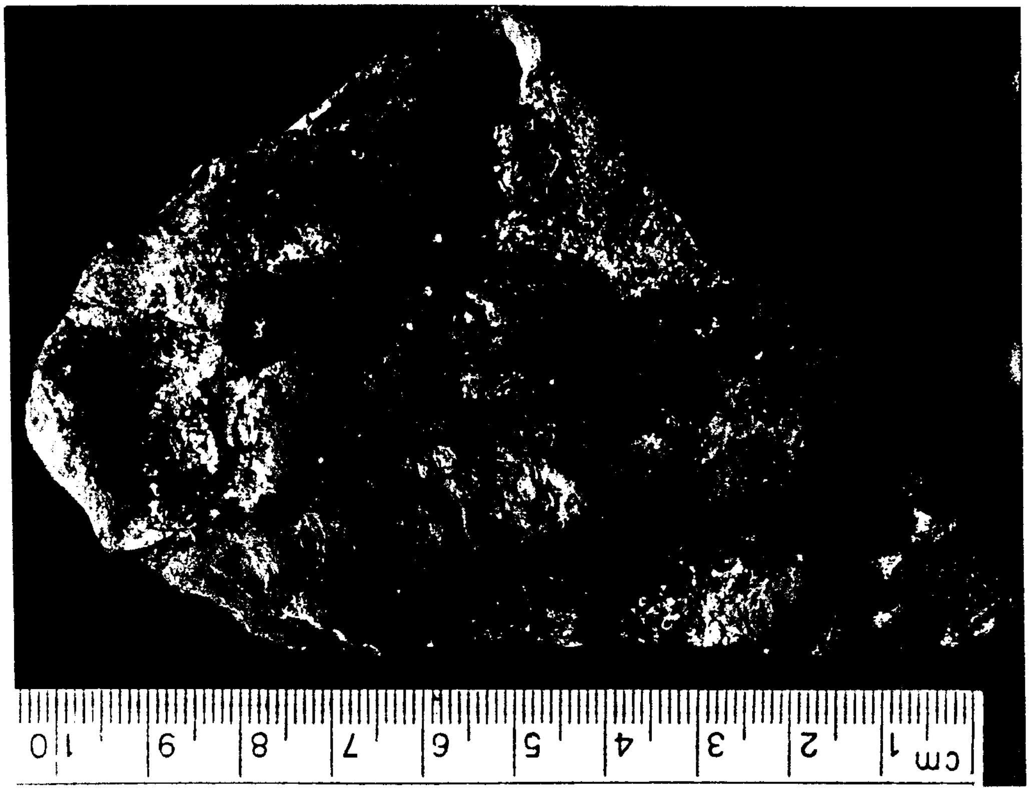
The informal "Grit Unit" is divided into upper and lower members by a bed of limestone (Hlb). The uppermost portion of this unit has been correlated with a Lower Cambrian archaeocyathid-bearing buff-weathering shale by Gordy (1981). This would allow a possible youngest age of the lower "Grit Unit" to reach middle Cambrian.

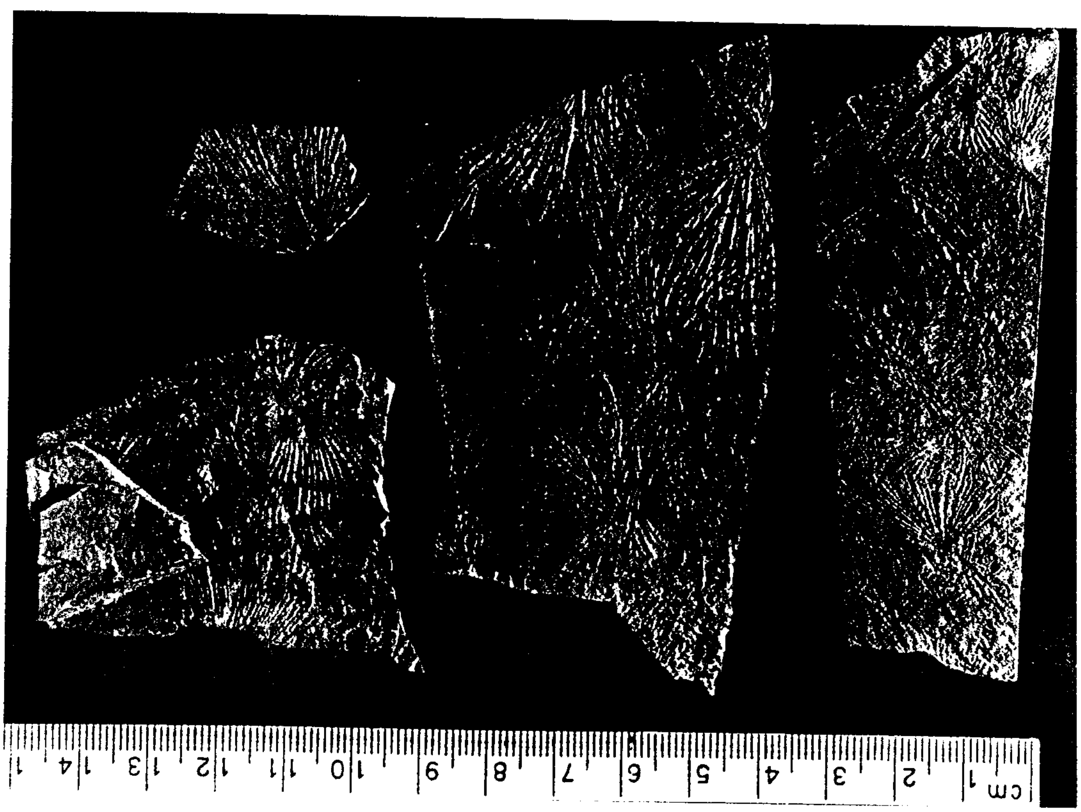
The occurrence of abundant Oldhamia in the upper "Grit Unit" has been recognized by Hoffman and Cecile (1981). Several collections have been made by the author at Old Cabin Creek. They were taken from upper maroon and green argillites approximately 30 m above the limestone unit (Hlb). Collections contained exclusively Oldhamia radiata, similar to those described by Hoffman and Cecile (1981) (Figure 31).

Oldhamia was not found in the maroon and green argillites of

Figure 30: <u>Paleophycus</u>.

Figure 31: Oldhamia radiata.





the lower "Grit Unit" beneath the limestone.

Some rocks containing Oldhamia are thought to be Hadrynian in age (Hoffman and Cecile, 1981). However, these suggestions may have been based on the presence of Oldhamia beneath the lowermost trilobites. Recent data (G. Narbonne, pers. comm.) suggest that the Cambrian/Pre-Cambrian boundary may now be defined by the abundance of small shelly fossils and diverse traces found beneath the lowest trilobites in the Tommotian (Figure 27).

4.5 INTERPRETATION

All "Grit Unit" strata above the limestone (Hlb) are to be recognized as the "Upper Grit Unit".

On the basis of lithology and the evidence presented here, I propose that the "Upper Grit Unit" containing Oldhamia and other traces was deposited almost entirely within the Tommotion.

All recognizable "Grit Unit" lithologies beneath and including the limestone units are Vendian and older (Hadrynian) in age and are here termed the "Lower Grit Unit".

The occurrence of traces in thin-bedded maroon and green fine-grained lithologies indicate a deep oceanic environment with oxidizing conditions. The appearance of these lithologies between a conglomeratic limestone at their lower contact and cherts at their upper contact give evidence of a regression in the early Cambrian.

CHAPTER 5

5.0 EXAMINATION OF VOLCANICS ROCKS

To obtain greater information about the nature and origin of the volcanic rocks at Old Cabin Creek, and indeed the Selwyn Basin, petrological and geochemical studies of representative rocks were undertaken. Similar studies ventures have been completed on the Earn Group volcanics (Walker, 1982) and the rocks of "Wenchless Ridge"(Sarjeant, 1983). The combination of information gathered through these studies, with evidence presented earlier in this thesis, will allow a comparison of the volcanic rocks at Old Cabin Creek with those of the Marmot Formation (Cecile, 1983) and Earn Group.

5.1 PETROLOGY

Samples of coarse breccias, flow breccias, massive flows and pillow lavas were all examined petrologically.

Preliminary observation of all samples indicated that the volcanic rocks have been subjected to pervasive alteration. The original mineralogy has been altered such that replacement of primary minerals is almost complete. Mineral identification is naturally difficult, but textural evidence is well preserved. Essentially all rocks observed are variolitic and consist of a few recognizable pseudomorphed phenocrysts in a pervasively altered very fine-grained matrix (Figure 32).

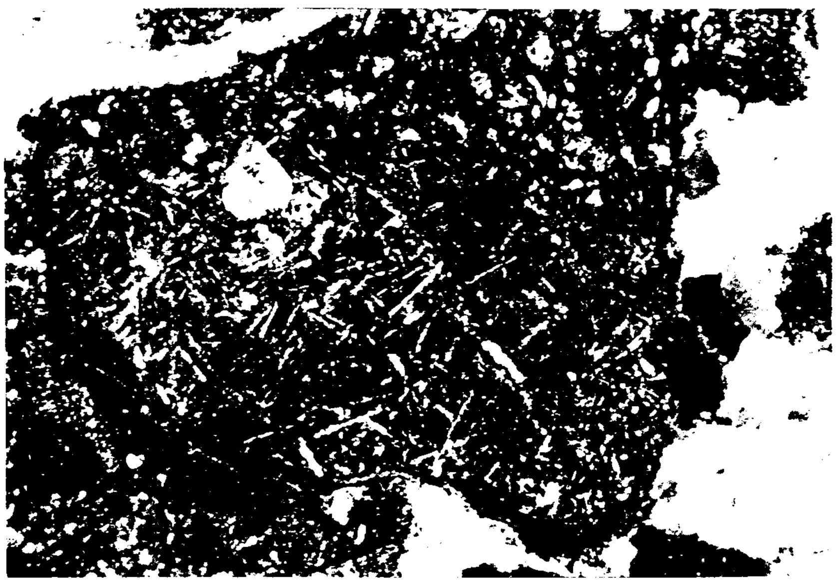


Figure 32: Devitrified and hydrothermally altered, fine-grained volcanic fragment set in sparry calcite matrix. Laths are chlorite.

Pseudomorphs of olivine are rimmed with opaques and filled with calcite spar. In one sample replacement is incomplete and remnant olivine, partially altered to talc, can be seen in fractured fragments of the crystal (Figure 33).

Pyroxene crystals are pseudomorphed by very fine-grained talc, serpentinite and fibrous chlorite with quartz and calcite

Accumulations of feldspar crystallites are easily recognized in plane light by the characteristic outline of their laths by fine-grained opaques (Figure 34). Plagioclase feldspars are now recognized as fine-grained albite. Potassium feldspars were not recognized although some samples contain sericite which is their typical alteration mineral in hydrating environments. In one sample, epidote/clinozoisite with calcite appears to be replacing plagioclase.

Opaques, as identified by Sarjeant (1983) typically take two forms:

i) subhedral crystals, usually of pyrite but occasionally of pyrrhotite;

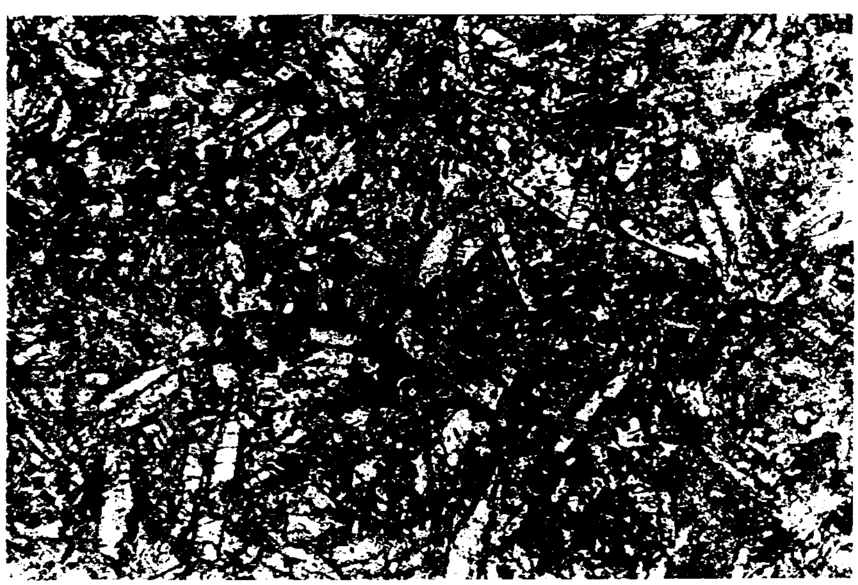
ii) anhedral "blebs" of leucoxene, which are likely Ti-rich magnetite or ilmenite.

A third, more common type occurs as very fine-grained particles, probably sphene, in the groundmass. They were produced during the alteration of the mafic constituents (Figure 35).

Amygdules are common in some samples. In volcaniclastics, they are seen to occupy 50% of the volume of the clast, but are typically small (1 mm). In flows and pillows they are typically

Figure 33: Olivine crystal pseudomorphed by talc then calcite (left-plane light; right crossed polars).

Figure 34: Laths of feldspars outlined by fine-grained opaques.



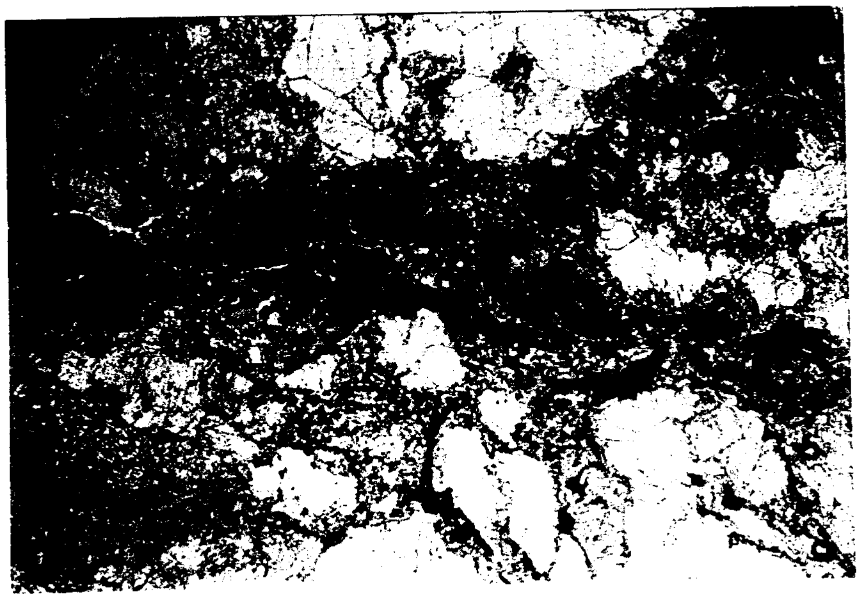


Figure 35: Alignment of fine-grained opaques in strewn-out volcanic fragment in sparry calcite cement. This photomicrograph is taken from sample D in Figure 37.

larger (up to 5 mm), but in most cases are filled with calcite spar(Figure 36). Less often a ring of chalcedony can be seen to outline an amygdule. In many cases, epidote or a fine-grained unidentifiable zeolite (saponite?, phillipsite?) occurs in the calcite filling (Figure 37).

In the least altered sample, taken from a massive flow, approximately 5% of the sample is unaltered hornblende (Figure 38) phenocrysts, some of which are overgrown by an unidentified lath-like mineral (Figure 39).

The pervasive nature of the alteration shown in these rocks makes identification difficult. Potentially they have undergone up to six periods of alteration:

i) Initial reaction with sea water at low temperature and pressure causing enrichment in Ca^{2+}, Na^{+}, H_2O and CO_2. Overall hydration and initial alteration of minerals has taken place;

ii) Deuteric alteration and spilitization with residual fluids in the groundmass;

iii) Burial metamorphism at slightly higher temperatures and pressures causes initial devirification and formation of zeolites;

iv) Mesozoic deformation increased pressure regimes;

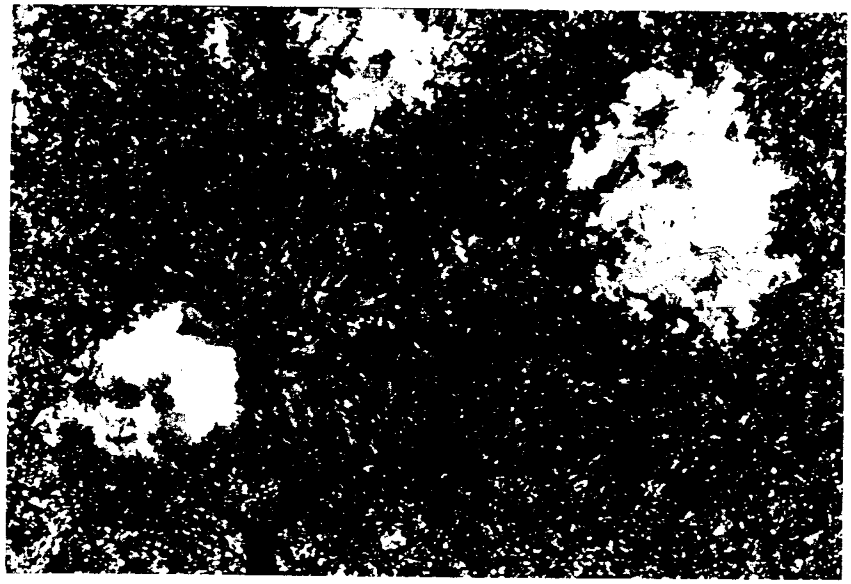
v) Contact metamorphism at high temperature and low pressure caused depletion of volatiles and oxidation of sulphides as well as recrystallization of low temperature minerals;

vi) Ground water leaching and frost/thaw mechanisms cause preferential elemental depletion.

From the petrological evidence presented here, the volcanic rocks at the Old Cabin Creek Massif may be identified as olivine-pyroxene basalts. Further classification would be unreliable due

Figure 36: Calcite spar filling amygdules of fine-grained volcanic flow.

Figure 37: Zeolites rimming amygdules.



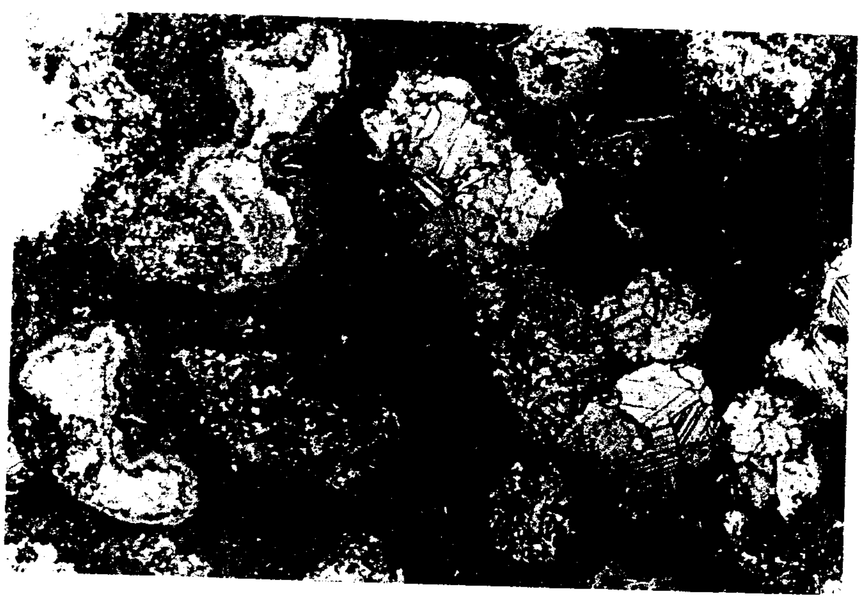
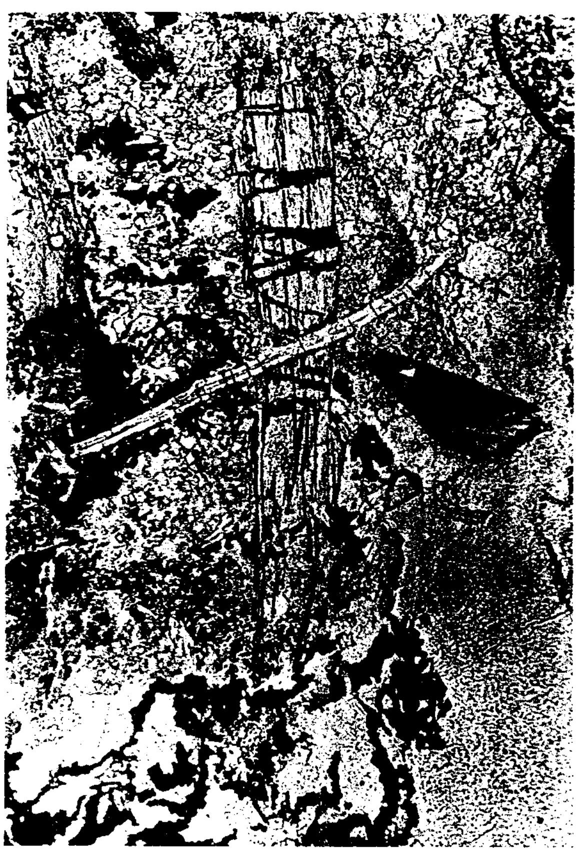


Figure 38: Unaltered euhedral hornblende crystals in sample 52A.

Figure 39: Hornblende overgrown by unidentified lath-like crystal. Left photo, plane light; right photo, cross-polars.



to the intense and ubiquitous nature of the alteration.

7.2 CHEMISTRY

In an effort to compensate for the lack of primary mineralogic evidence in the volcanics, three representative samples were chemically analyzed at McMaster University.

Whole rock x-ray fluorescence analysis was performed for major element oxides. Neither CO_2 or H_2O content of the rocks were analyzed. Loss of volatiles on ignition of the fused bead is considerable, thus decreasing the reliability of the analysis. Spectrochemical analysis was applied to detect quantities of Ba, Zn and Cu (Table 1).

The samples chosen are from both massive and pillowed flows. An effort was made to choose those samples visually less affected by alteration processes, and containing the least amount of observable calcite as either amygdules or cement.

Visually and petrologically, sample 52A is the least altered and contained phenocrysts of unaltered amphibole and laths of recognizable albite. Sample 1R3 shows total replacement of primary minerals while in 52B even primary textures are hard to identify. These samples are progressively lighter in colour and contained a greater percentage of calcite-filled amygdules.

Petrologically , the volcanics are interpreted as having been olivine and pyroxene-bearing basalts. Chemical variability between samples at Old Cabin Creek results from varying degrees

	Old Cabin Creek, Selwyn Basin, Yukon			Earn Group, MacMillan Pass (Walker 1982)			Marmot Formation, Misty Creek Embayment (Goodfellow et al, 1980)		Ocean Ridge Basalts (Engel et al, 1965)	
Per cent	52A	1R3	52B	3-4	2-14	5-7	S	D	Tholeiitic	Alkalic
SiO_2	42.79	47.13	41.00	35.42	41.90	41.58	41.8	50.0	49.34	47.41
Al_2O_3	14.96	16.19	8.30	14.58	10.74	13.55	11.6	15.0	17.04	18.02
TiO_2	5.71	3.75	4.44	2.58	2.66	3.65	3.59	2.0	1.49	2.87
FeO_T	16.84	6.82	16.67	11.29	15.15	13.45	9.3	9.3	8.62	8.65
CaO	6.87	16.46	15.37	13.78	11.86	10.65	7.5	1.0	11.72	4.79
MgO	8.39	7.14	13.09	17.16	17.47	10.08	7.5	8.0	7.19	1.66
K_2O	0.23	0.30	0.16	3.11	0.04	3.35	3.01	3.0	0.16	3.99
Na_2O	3.07	0.70	0.17	0.23	0.14	0.14	0.0	0.0	2.73	0.92
P_2O_5	0.96	1.41	0.67	1.40	0.66	0.56	0.76	0.6	0.16	0.16
MnO	0.19	0.09	0.13	0.16	0.22	0.22	0.03	0.1	0.17	1.40
ppm										
Ba	498	385	480	4720	1130	16200	17400	40000	14	498
Zn	166	29	96				142	103	-	-
Cu	25	23	27				98	45	77	36

Table 1: Comparison of Chemical Analysis of volcanic rocks from the Old Cabin Creek Massif with those from MacMillan Pass and Misty Creek Embayment.

and types of alteration.

During spilitization there are net losses of ferrous Fe, Ca, Mg and Na, while there are net gains of ferric Fe, K, H_2O and CO_2 (Andrews, 1977; Baragar et al, 1977). Sea water metasomatism however enriches basalts in Na while later stage amygdule and vein filling causes a net gain in calcium.

Such conflicting chemical exchanges make interpretation of chemical proportions difficult if a standard, unaltered sample is not available. Examination of submarine basalts of Leg 37 of the DSDP (Andrews, 1977) reveals general chemical trends between oxidized and unoxidized basalts (Table 2). Comparison of unoxidized basalt samples with data from Old Cabin Creek show grossly similar trends.

For direct comparison between samples from different locations, abundances of immobile elements such as Ti or Zr should be used.

Titanium

Within the Old Cabin Creek suite there are very high values of titanium. Although high TiO_2 values are common among oceanic basalts (Chayes, 1965), since alteration has little effect on either enrichment or depletion, the titanium is thought to come from high amounts of primary sphene or ilmenite. In comparison with the volcanics at MacMillan Pass or the Misty Creek Embayment, Old Cabin Creek rocks contain significantly higher Ti values.

TABLE 5. Whole-rock analyses of oxidized and adjacent unoxidized basalt

	1		2		3		4		5	
Weight %	O	U	O	U	O	U	O	U	O	U
SiO_2	46.88	49.67	48.94	49.58	47.64	48.30	50.25	50.45	47.25	48.34
Al_2O_3	16.96	18.44	15.89	16.96	18.62	18.17	15.23	16.42	16.17	15.02
Fe_2O_3	11.02	7.51	12.78	9.42	9.63	7.94	11.29	9.64	12.46	10.27
MgO	7.20	8.01	6.00	6.94	7.08	8.83	6.84	6.63	6.76	9.00
CaO	14.96	13.80	11.98	12.80	13.96	13.80	12.72	13.09	13.54	11.70
Na_2O	2.18	1.83	2.48	2.83	2.02	2.25	2.73	2.46	2.59	2.45
K_2O	0.25	0.11	0.61	0.26	0.35	0.09	0.37	0.14	0.27	0.14
TiO_2	0.52	0.59	1.16	1.18	0.51	0.57	1.05	1.06	0.83	3.01
P_2O_5	0.03	0.02	0.10	0.07	0.01	0.01	0.01	0.05	0.14	0.00
SO_3	0.00	0.02	0.04	0.00	0.15	0.00	0.01	0.04	0.00	0.01
ppm										
Mn	1437	927	1300	1083	993	922	1637	1119	982	1038
Ni	116	75	235	160	146	125	27	63	189	254
Co	30	31	40	40	41	41	68	73	64	126
Cu	42	67	70	59	58	78	84	90	89	105
Zn	47	30	85	69	55	53	78	106	81	124
Sr	52	38	110	48	78	75	—	—	—	—

TABLE 5. (*Continued*)

	6		7		8		U.S. Geological Survey international standards			
							BCR-1		JB-1	
Weight %	O	U	O	U	O	U	This study	*Recommended values	This study	*Recommended values
SiO_2	51.05	51.20	48.09	49.79	50.69	51.03				
Al_2O_3	14.96	15.86	18.29	17.83	15.08	16.02				
Fe_2O_3	10.71	9.17	8.81	7.91	11.22	9.75				
MgO	7.18	7.21	5.82	7.02	7.22	7.12				
CaO	12.60	12.91	15.07	14.52	12.38	12.70				
Na_2O	2.30	2.27	2.75	2.22	2.02	2.18				
K_2O	0.17	0.07	0.47	0.12	0.33	0.14				
TiO_2	1.04	0.99	0.61	0.59	1.04	1.04				
P_2O_5	0.00	0.00	0.05	0.02	0.00	0.01				
SO_3	0.00	0.31	0.00	0.00	0.00	0.06				
ppm										
Mn	1384	1168	1293	1173	1285	1303	1490	1406	1300	1238
Ni	76	72	293	104	292	297	18	16	140	139
Co	74	66	143	75	102	74	41	38	42	39
Cu	96	95	159	107	114	123	17	18	56	52
Zn	62	87	114	75	80	78	105	120	84	83
Sr	—	—	—	—	—	—	307	330	—	—

O = oxidized rock, and U = adjacent unoxidized rock; (—) = not analyzed. *Flanagan (1973).
Trace-element analyses 1–3 and BCR-1 by spark source mass spectrophotometry; analyses 4–8 and JB-1 by atomic absorption.
All Mn analyses by atomic absorption. Total iron calculated as Fe_2O_3. Major-element analyses recalculated on a water-free basis.

Table 2: Chemical analysis of oxidized and adjacent unoxidized submarine basalts. (Andrews, 1977).

Calcium

The CaO value for Sample 52A is low, possibly indicating a value near the original calcium content of the rock, relatively unaffected by later calcite formation (calcium metasomatism). Other samples in the study area show considerable higher CaO values, as do those from MacMillan Pass. Since Ca depletion occurs during hydrothermal alteration, additional Ca emplaced as calcite vein and amygdule filling is thought to cause enrichment in calcium.

In the case of the Marmot Formation in the Misty Creek Embayment, CaO values in the sill and dike samples are average (7.5) and very low (1.0) respectively, for oceanic basalts. Possibly hydrothermal Ca-depletion was not compensated by subsequent sea water calcium metasomatism. Cecile (1983) provides very little in the way of petrological description, but each of the two samples is intrusive in nature and sea water reaction was probably negligible.

Sodium

The value of Na_2O in Sample 52A is very high with respect to all other samples listed, although in comparison with typical ocean ridge basalts (Engel et al, 1965), the Old Cabin Creek samples are not high at all. The overall deficiency of other samples in Na is unusual since basalts reacting with sea water should give elevated Na_2O values. Depleted Na_2O values indicates leaching during late stage hydrothermal alteration by saline-poor fluids.

Sample 52A may be retaining its primary Na values. Because it was derived from a massive flow, its permeability is less than that of a pillowed or brecciated flow and therefore, is less susceptible to fluid and oxygenation alteration processes.

Potassium

The low K_2O values among Old Cabin Creek samples contrast with concentrations found in other samples listed from the Selwyn Basin as well as typical Ocean ridge samples. Notably, the samples from MacMillan Pass are recognized as chlorite- and clay-rich, containing zeolites which host potassium cations. Alteration minerals from volcanic rocks at the study area are typically K-poor minerals such as serpentine, talc, quartz and calcite indicating either low original values in K^+ or extensive ground water leaching.

Magnesium

Examination of MgO values indicate that samples 52A, 1R3 and those from the Misty Creek Embayment are close to those given by Engel et al (1965) and Andrews (1977). Sample 52B and those from MacMillan Pass contain elevated Mg^{2+} values. Although sea water may have contributed to the formation of a Mg-rich chlorite (Walker, 1982), remobilized Mg^{2+} from olivine may precipitate as Mg-rich saponite (Scarfe and Smith, 1977).

Barium

The samples were specifically analyzed for barium to provide a comparison with Ba-rich basalts at both MacMillan Pass (Walker, 1982) and the Misty Creek Embayment (Goodfellow et al, 1980).

Barium values among volcanic rocks at the Old Cabin Creek Massif are not anomalously high. They correspond well with that of Alkalic Ocean Ridge basalts (Engel et al, 1965).

The volcanics at MacMillan Pass are stratigraphically correlative with Devonian strata containing metal-rich barite deposits associated with known submarine exhalitives.

In the Marmot Formation of the Misty Creek Embayment, barium is found as celsian. No barite or witherite has been recognized, but may have reacted to form celsian. The relationship between some sedimentary barite an volcanic processes is known in the Selwyn Basin.

In the rocks at Old Cabin Creek either barium was not abundant as a primary constituent or it has since been leached out by fluid alteration processes.

5.3 INTERPRETATION AND COMPARISON

Information obtained from chemical analysis is displayed on an AFM diagram (Figure 40).

Examination of points indicates a cluster of sample 52A with the sill (S) and dike (D) samples from the Misty Creek Embayment, in the tholeiite field. Samples 52B and 1R3 are visibly and

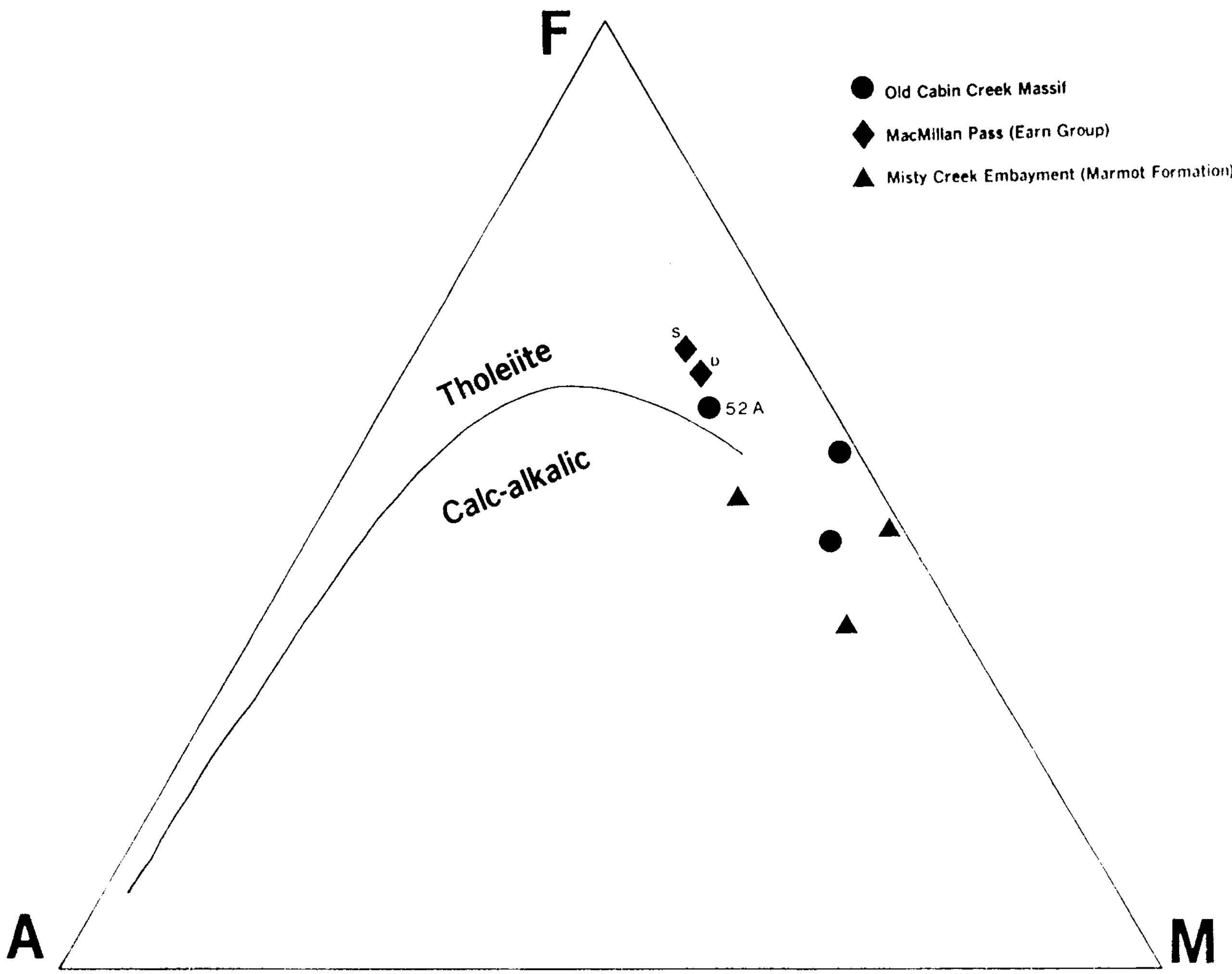


Figure 40: AFM plot for volcanic rocks found in the Selwyn Basin. The trend with increasing alteration seems to be towards MgO, as seen in Old Cabin Creek samples.

petrologically more altered versions of sample 52A. They, along with samples from the MacMillan Pass volcanics, contain more MgO and less alkalis than the previous mentioned samples. Such a trend is characteristic of sea water alteration of basalts (Andrews, 1977; Baragar et al, 1977).

The high MgO and low SiO_2 values in the MacMillan Pass samples probably represent a near original level. These rocks plot in a field typical of picrites. When plotted on a Jensen diagram, they appear almost entirely within the komatiite field (Figure 41).

Goodfellow et al (1980) suggested that the Misty Creek Embayment analysis are "characteristically alkaline although the alkalis have been changed by metasomatic processes". Indeed this may be true as both samples are totally depleted in sodium and appear to be enriched in potassium. However, the intrusive nature of the samples taken should show significantly less alteration and metasomatism than their submarine extrusive equivalents. Therefore, the Misty Creek Embayment samples and sample 52A from the Old Cabin Creek Massif, are accepted as the least affected by alteration and retain the closest original chemistry.

Evidence of their alkali nature is problematic. Except for the recognition of biotite phenocrysts by Cecile (1983), suggestions that Marmot Formation volcanic rocks are alkaline in nature are inconclusive.

Chemical evidence given by Cecile (1983), and presented here suggests that the basalts of the Misty Creek Embayment, if

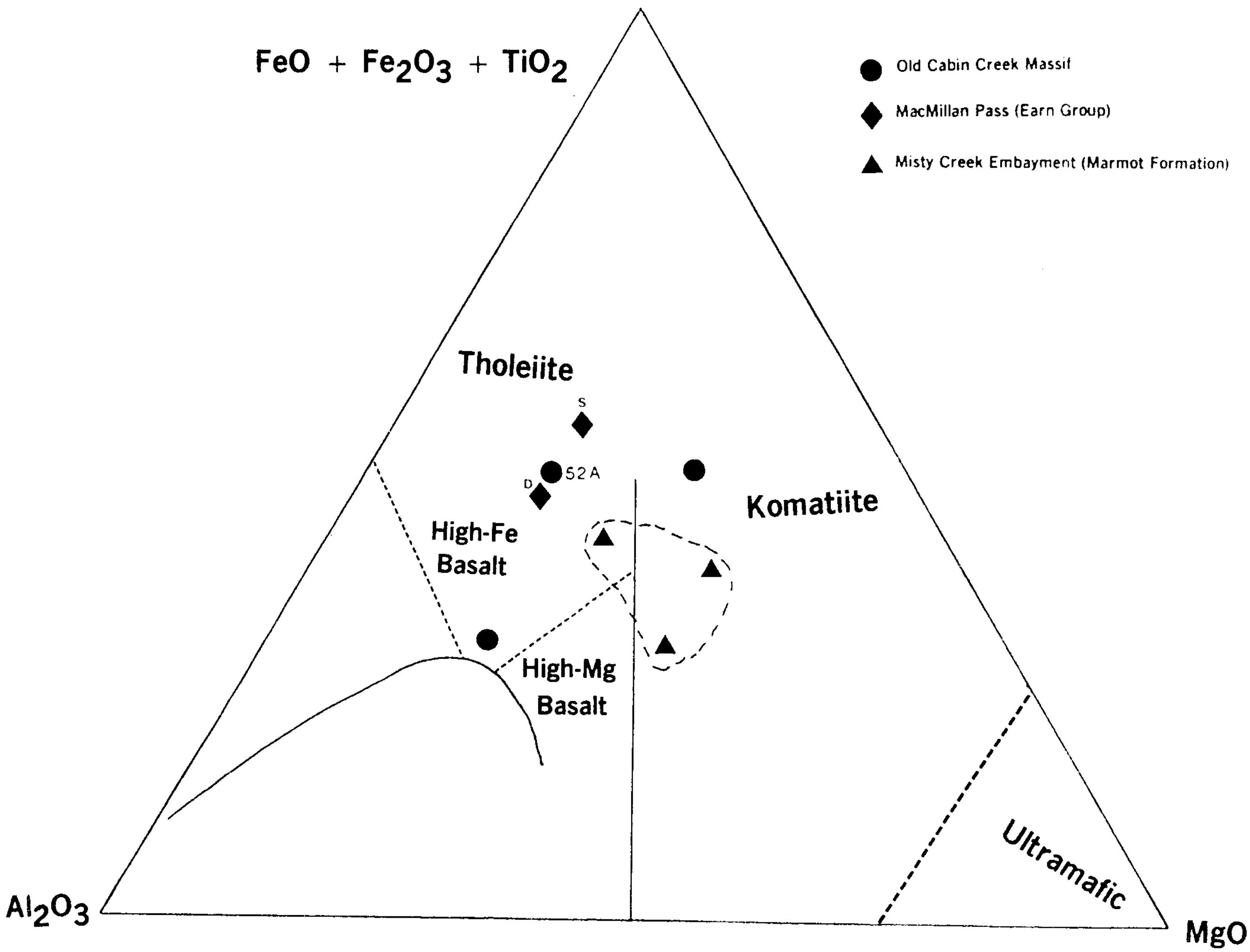


Figure 41: Jensen plot for volcanic rocks found in the Selwyn Basin.

unaltered, are tholeiitic. If the samples are interpreted as metasomatized, then they cannot be confidently used to support a hypothesis of alkalinity.

The volcanic rocks at the Old Cabin Creek Massif are similar in form thickness and chemistry to the Marmot Formation (Cecile, 1983). The lower age of both volcanic sequences is similar but those in the Misty Creek Embayment continue to deposit into the mid-Devonian, while those at Old Cabin Creek terminate in the earliest Silurian.

Mid-upper Devonian volcanic rocks described by Walker (1982) have a different chemistry and may be komatiitic in nature. This may be a result of more extensive alteration of the samples analyzed, but almost certainly they were not originally calc-alkalic.

All volcanics are interpreted as originating from rifting which is correlated with growth faults, basin formation or periods of rapid erosion (Abbott,1982; Cecile, 1983).

CHAPTER 6

6.0 STRUCTURE

A late Mesozoic tectonic event originating in the southwest, caused extensive shortening in Selwyn Basin lithologies, thus forming the Selwyn Fold and Thrust Belt. This structural belt is marked by northwest-trending fold and fault axes developed in pre-Mesozoic stratigraphy in the Selwyn Basin. The style and variability of the deformation is well exposed at the Old Cabin Creek Massif (Figure 42). Subsequent intrusion by early Cretaceous plutons caused extensional and block faulting which offset many of the original structures making stratigraphic and structural correlations difficult.

6.1 LATE MESOZOIC DEFORMATION

All stratigraphic units in the study area are deformed. Northwest-trending tight isoclinal folds, overturned folds, open folds and thrust faults all combine to tectonically thicken units to many times their original thickness. This is most evident among the lower Cambrian maroon argillites (l€ma) where upright and overturned isoclinal folds are recognized as thickening this unit to at least four times its original thickness. The argillaceous, often phyllitic nature of this unit makes it easy to deform ductilely, while thicker, more competent or more brittle

LEGEND

- Geological contact (defined, approximate)
- Normal Fault (downside indicated)
- Thrust Fault (teeth on hanging wall)
- Vein network
- Bedding
- Cleavage
- Anticline (upright, overturned)
- Syncline (upright, overturned)
- Monoclinal bend
- GC 10 Geochemical sample
- F f Fossil Locality; F-collected, f-observed

105-O/13	105-O/14
105-O/12	105-O/11

Structure of Old Cabin Creek Massif, Yukon

ELEVATIONS IN METRES ABOVE MEAN SEA LEVEL

CONTOUR INTERVAL .... 20 METRES

Scale 1:50 000 Échelle

Metres 1000 0 1000 2000 3000 4000 Mètres

Yards 1000 0 1000 2000 3000 4000 Verges

Geology by Craig Hart, 1983.

FIGURE 42

units such as chert or volcanic rocks are more likely to have been affected by faults, thrust faults or open folds.

Folds

Folds at the Old Cabin Creek Massif are best developed in the lower Cambrian maroon argillite (l€ma) (Figure 43). Overturned and upright isoclinal folds have amplitudes up to 500 m although they are more often between 80-200 metres. The isoclinal nature of the folds makes their wavelengths almost immeasurable. Overturned folds dip northeasterly from between zero and 60 with 30 dips occurring most often (Figure 44,45). Open folds maintain similar amplitudes but wavelengths vary up to hundreds of metres (Figure 46).

Synclinal keels of lithologies above l€ma are seen in fold noses. Since portions of the limestone unit (Hlb) are not seen in anticlinal fold noses of l€ma, it is thought that either a detachment surface exists between these two lithologies or that Hlb has been removed by erosion and the Hadrynian maroon argillite (Hma) is undifferentiable from l€ma.

While the argillites show evidence of flexural slip in fold noses, more competent interbedded quartzite beds often fracture brittlely (Figure 47). Fold noses in argillite and shale typically show convergent cleavage; fold noses in quartzite or chert have a notably divergent or axial planar cleavage. Interbedded argillites and quartzites give rise to refracted cleavage patterns. 'S' and 'Z' folds, rods and less commonly mullions are common limb features.

Figure 43: Typical tight fold in lower Cambrian maroon and green argillites (Ꞓma). Light beds are cross-bedded white sandstones.

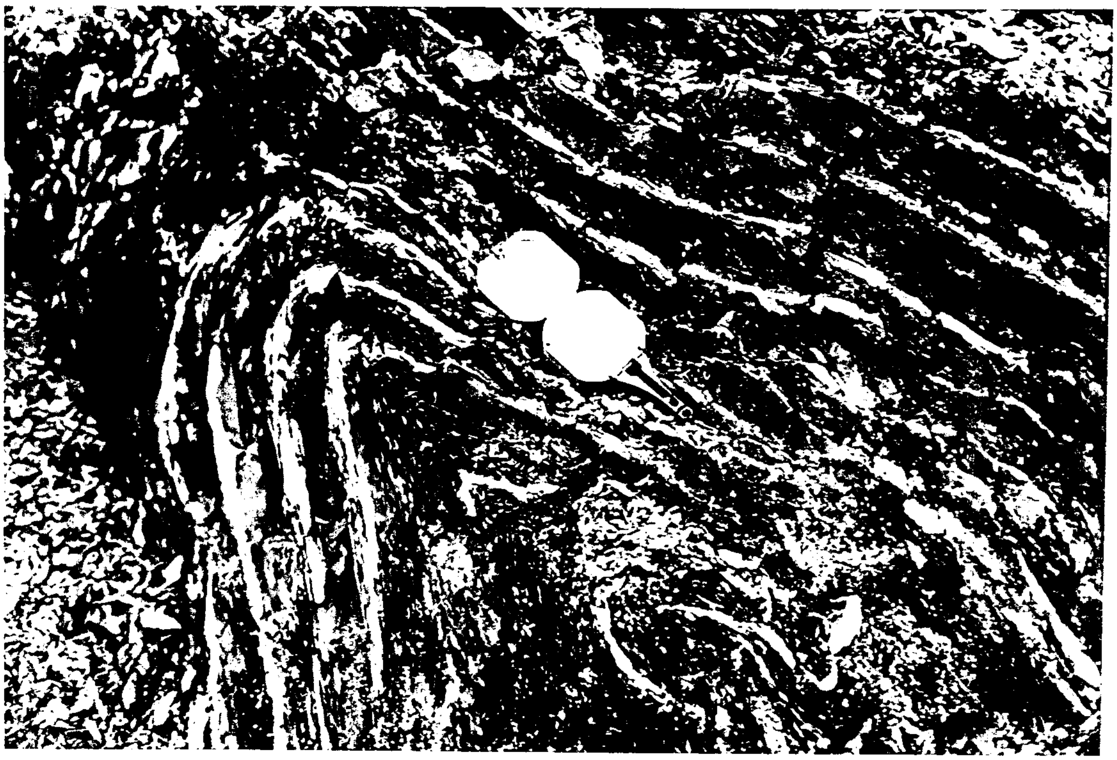


Figure 44: Nose of overturned fold in l€ma. Note the strong induced convergent cleavage.

Figure 45: Nose of overturned fold in argillites with thick sandstone beds. Argillites show evidence of flexural slip while sandstones fracture. Fold is overturned in a south-westerly direction.

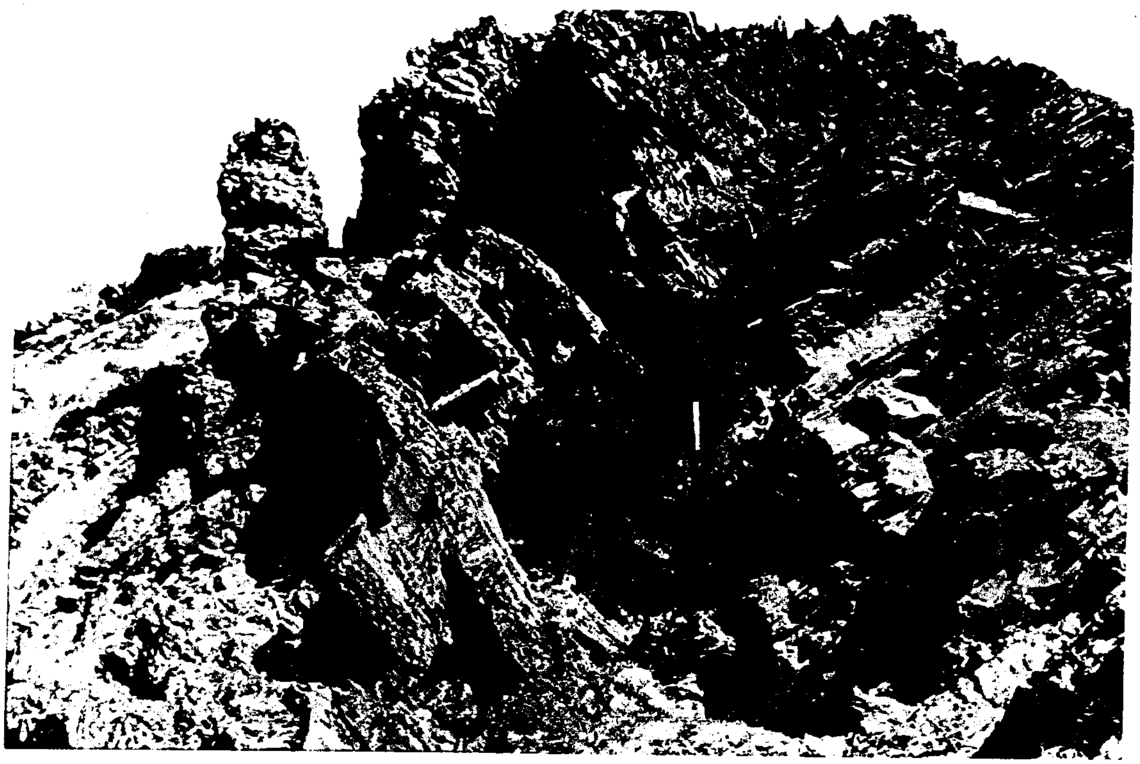


Figure 46: Medium-scale open folds in hornfelsed maroon argillites.

Figure 47: Fractured sandstone bed amongst ductile argillites of
l-€ma.

Thin beds of volcanics among more ductile lithologies are recognized in isoclinal folds. Thick accumulations of volcanics show only moderate dips as fold formation in such a massive block of competent rock is difficult. Lower contacts with argillaceous rocks are typically well sheared or phyllitic.

In the western portion of the study area where volcanic rocks are either absent or in thin beds, many tight overturned isoclinal folds stack up against each other. As chert and volcanic rock become more prominent in the strata, the folds become upright and eventually open up as the thick volcanic pile is abutted. The force of the shortening has inclined the volcanic pile eastward.

East of "Wenchless Ridge" open folds are recognized in Cambro-Ordovician stratigraphy but for the most part bedding has been obscured by recrystallization due to Cretaceous hornfelsing (Figure 48). East of the present day intrusive, the style of deformation seen in the westernmost ridge is repeated in lꞒma with tight isoclinal folds predominating.

On the easternmost ridge system in the study area, strata are for the most part slightly inclined to the east and north with open folds in the lꞒma. At the extreme east of the map area, all units increase their easterly dip angles in a monoclinal fold to become essentially vertical. This is best seen in the Hlb which dips slightly eastward until reaching the end of the ridge where it becomes vertical.

Figure 48: Large tight fold in fine-grain clastic lithologies completely recrystallized due to Cretaceous hornfelsing.

Klippe

At "Wenchless Ridge" a 2 km long klippe derived from the west is all but eroded away (Figure 49). The thrust sheet shows evidence of a detachment in the l€ma and contains strata through to Silurian. Younger strata have been removed by erosion. The thrust package contains all Cambro-Ordovician lithologies including a thin (distal) volcanic sequence. The result is a repetition of Cambro-Ordovician rocks on top of the thick volcanic pile. The klippe is easily recognized by the presence of maroon and green lithologies above unit €Ov. Maroon shales have been recognized high in Cambrian stratigraphy elsewhere in the Yukon (G. Narbonne, pers. comm., 1986), but never in the Selwyn Basin. The klippe is essentially horizontal except for a moderate east-trending syncline and some minor inclinations resulting from fault displacement. East of the klippe small tight isoclinal folds are seen in siliceous shales of muOc above the volcanics.

The klippe appears to have "bulldozed" the muOc which was on top of the €Ov into very tight isoclinal folds. The resistance put up by the bulldozed chert load caused folding in the thrust slice to occur with the underlying strata. An anticline has developed such that it is recognized in the klippe and another appears to have failed, thus bringing up l€ma to a topographically higher position at the westernmost "Wenchless Ridge".

A small portion of this klippe may be exposed on "Blackpoll Peak" where lCma is recognized among volcanic lithologies.

Figure 49: Looking southwest towards the klippe as exposed on "Wenchless Ridge" shows good evidence of Lower Cambrian maroon argillites, Cambro-Ordovician volcanics and chert and Silurian argillite on top of Cambro-Ordovician volcanics. The package has been subjected to later stage block faulting. 'Aho Peak' (top right (west)) is easily recognized by its gossanous pyrrhotite-rich volcanics.

6.2 EARLY CRETACEOUS DEFORMATION

Structures imposed by late Mesozoic shortening are cross-cut by extensional faults formed during the emplacement of Early Cretaceous intrusions. These faults are most often northwest-trending. Fault blocks faults throughout the study area have undergone vertical displacements in the strata up to several hundred metres, but displacements on the scale of tens of metres are most common.

The largest fault occurs west of "Aho Peak" where HCma is juxtaposed against Cambro-Ordovician volcanics. This fault is clearly expressed in the topography as a recessive valley. The valley floor is often floored by breccia and parallel quartz veins cross-cut this breccia. Higher up on the ridge, the fault plane is easily weathered as breccia, clay gouge and limonite lie along the fault contact.

The evidence presented here suggests that this fault may be an older reactivated late Mesozoic fault.

Block faults on "Wenchless Ridge" are recognized as bringing up lЄma to a stratigraphic position held by Sa.

The emplacement of the intrusives is responsible for raising the strata at Old Cabin Creek to a higher topographic level. This sudden raise may be responsible for the formation of the monoclinal fold seen in the extreme east of the study area.

Approaching the pluton from the west dips becomes vertical units appears to be "wrapped around" the southern end of the intrusion.

Many sub-parallel sets of extensional fractures filled with quartz are associated with late-stage plutonic activity. The veins are typically vertical, very close to exposed intrusive rocks and strike either northwest-southeast or east-west.

CHAPTER 7

7.0 ECONOMIC POTENTIAL IN THE SELWYN BASIN

The rocks of the Selwyn Basin and surrounding platforms host several economic mineral deposits (Figure 50).

The discovery of Lower Paleozoic carbonate-hosted base-metal deposits in the late sixties near the carbonate-shale facies transition in the Yukon and N.W.T. created much exploration activity in these transition zones. Subsequent discoveries of shale-hosted base-metal and barite deposits moved the focus of attention basinward as the exhalitive strataform nature of these deposits was understood.

Further exploration activity focussed on tungsten skarn mineralization in contact metamorphic aureoles in calcareous sediments surrounding Cretaceous plutons in the basin. Soon the interest shifted again, as exploration companies examined the plutons themselves as potential hosts of Au, Mo and W mineralization.

Although silver mineralization is not commonly found in the eastern Selwyn Basin, an anomalous deposit of extremely rich silver veins found in the early seventies is being mined at the present.

The presence of volcanic rocks, quartz veining and extensive gossans, faulted and hornfelsed by a siliceous intrusive, makes the Old Cabin Creek Massif an interesting prospecting target.

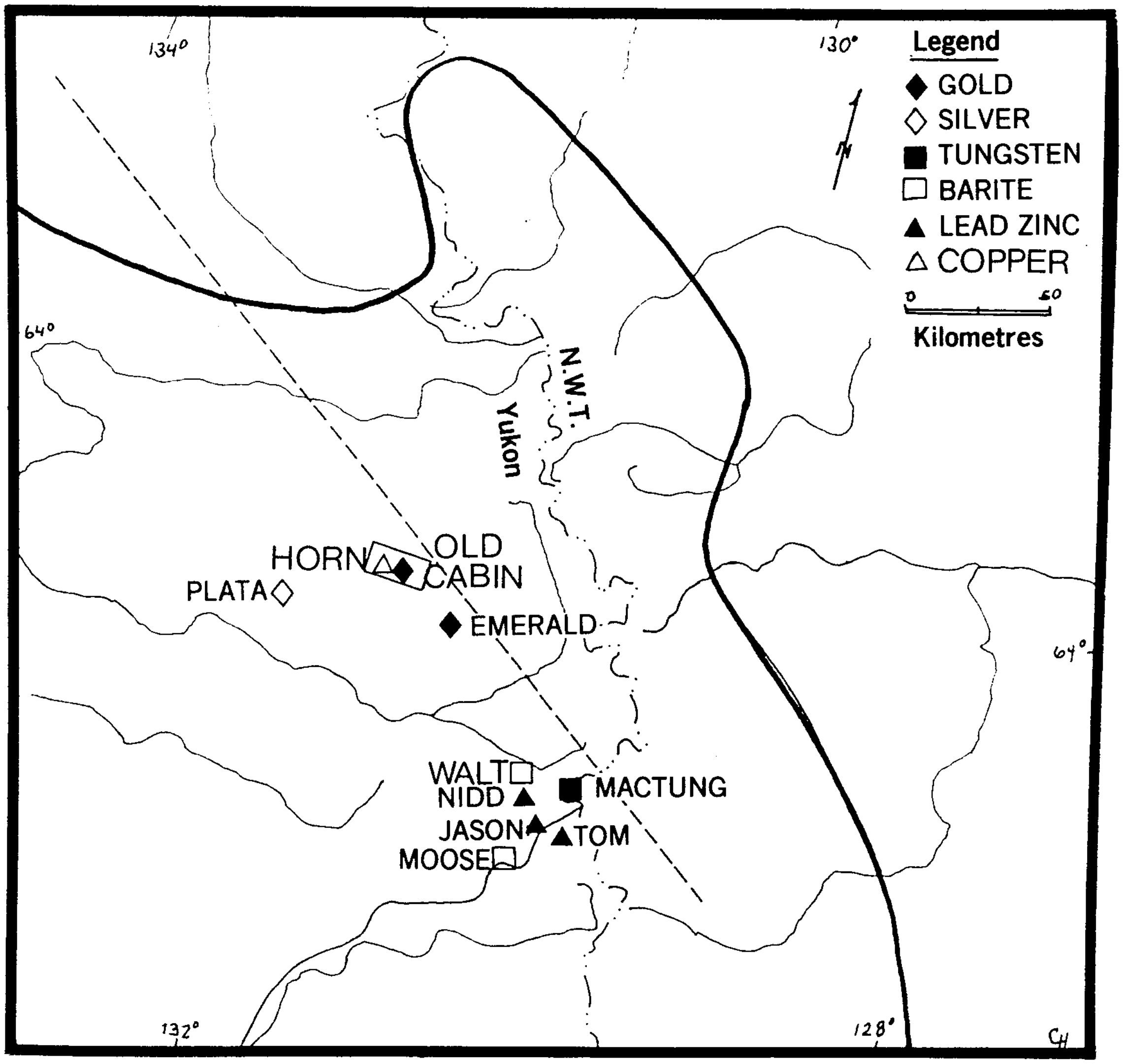


Figure 50: Locations of various economically significant mineral deposits in the northeastern Selwyn Basin.

7.1 MINERALIZATION AT OLD CABIN CREEK MASSIF

The economic potential of the Old Cabin Creek Massif has been recognized by several prospectors and mineral exploration companies over the last two decades.

In 1968, Canadian Oil and Gas Ltd. staked nine claims on a breccia zone (Marshall, 1970) associated with a north-trending fault. Veins of pyrrhotite, pyrite and minor chalcopyrite were reported in volcanic rocks associated with a zone of quartz-carbonate-limonite alteration up to 120 feet long. A sample taken from 30 feet along the vein gave a value of 0.21% Cu, while the best sample returned 0.49% Cu.

Most recently, in 1981 Union Carbide staked 185 claims on the Massif in an attempt to cover mineralization suggested by anomalous tungsten values from stream and soil geochemical samples. Further investigation uncovered weakly developed skarn mineralization in hornfelsed calcareous sediments, north and west of the main intrusive.

Subsequent investigations discovered six small gold-bearing quartz-arsenopyrite-pyrite veins. The veins were hosted in chert and interbedded in fine-grained clastic rocks with minor mafic volcanics. Veins range between 1 and 15 cm in width and tend to be continuous along strike for up to 40 metres. Samples assayed up to 22.42 g Au/t.

In 1982, 14 additional claims were staked to cover favourable ground. Showings of chalcopyrite and argentiferous galena were discovered and molybdenum-bearing quartz veins were found cutting the granodiorite stock.

While mapping the Massif, the author investigated mineral showings exposed on the property and collected samples for elemental analysis of Au, Ag, W, Cu and Pb (Table 3).

The remainder of this chapter will be dedicated to the description of various mineralization at the Old Cabin Creek Massif and its comparison and potential compared with similar mineral showings and deposits in Selwyn Basin.

7.1.1 GOLD

Anomalously high gold values were found at several locations in the Massif. Most appear to be associated with thin (1-5 cm) bifurcating, arsenopyrite-pyrrhotite-quartz bearing mesothermal veins which are often found to be sub-parallel with the contact between the volcanics and Cambrian argillite (Figure 51). Veins are continuous for several tens of metres and cut across faults and lithological contacts. Samples taken by the author from these vein systems gave values between 5315 and 9650 ppb, while those from the altered wall rock ranged from 5 to 12 ppb.

Extensive bleaching of the wall rock up to 20 cm either side of the thin (2-3 cm) veins is common. Wall rock bleaching is responsible for altering the original mineralogy of the host to mostly clays and hydrated metallic ochres (Figure 52). No silicification is seen and only small quartz crystals appear in the veins.

SAMPLE NUMBER	AU PPB	AG PPM	PB PPM	CU PPM	W PPM
CJA-84:GC-1	8.0	<0.2	<1.0	209.0	16.0
CJA-84:GC-2	400.0	<0.2	990.0	65.0	<4.0
CJA-84:GC-3	12.0	<0.2	82.0	27.0	<4.0
CJA-84:GC-4	5315.0	0.4	47.0	530.0	<4.0
CJA-84:GC-5	5580.0	<0.2	146.0	400.0	<4.0
CJA-84:GC-6	11.0	<0.2	3.0	480.0	24.0
CJA-84:GC-7	5.0	<0.2	106.0	340.0	<4.0
CJA-84:GC-8	6.0	0.2	45.0	113.0	<4.0
CJA-84:GC-9	9650.0	<0.2	480.0	1260.0	<4.0

Table 3: Multi-element geochemical assays taken from arsenopyrite veins, altered wallrock and quartz-carbonate-limonite breccias.

Figure 51: Arsenopyrite vein continuous for several tens of metres near contact between volcanics and Ca.

Figure 52: Extensive wallrock leaching and alteration to clays and metallic ochres.


Nikon

The fluids were probably very hot and not rich in silica. The source of fluids was probably a Cretaceous pluton emplaced late in the plutonic episode. The conduits appear to have been zones of shearing in the argillites beneath the more competent volcanic pile. Prospecting targets would then naturally be zones of hydrothermal alteration at the base of the volcanics near free silica-poor plutons.

Gold mineralization is found associated with arsenopyrite and stibnite in small fractures in a pluton and surrounding hornfelsed sediments just 10 km southeast of the Massif at the EMERALD claims. Originally staked to cover copper and molybdenum mineralization, further exploration work uncovered the presence of gold.

The close association of auriferous arsenopyrite veins with Cretaceous plutons suggest a genetic relationship. At other locations in the Yukon (i.e. Dublin Gulch), Tempelman-Kluit (1981) has recognized that fluid associated with Cretaceous intrusions may be the source for auriferous quart-arsenopyrite veining.

Although volcanic rocks at the Old Cabin Creek Massif are almost always close to areas of extensive veining, it is thought that the relationship is purely coincidental and that a genetic relationship does not exist.

7.1.2 SILVER

Although anomalous silver values were found in the Massif by Union Carbide, samples analyzed by the author were low (<1ppm).

It is thought by the author that higher values have a strong association with massive- disseminated galena bodies found near fault contacts in hornfelsed Cambro-Ordovician fine-grained clastics, and volcanics.

In all observations of this type, the host rock has been severely altered to brittle zeolite or siliceous tufa. Galena appears as 3 mm crystals within the host. Most galena had been weathered out, leaving euhedral cavities and staining the area with Pb-rich ochres.

Rich silver veins with 4250 g Ag/t and 62% Pb are found at the PLATA and INCA properties just 20 km southwest of the Old Cabin Creek Massif. The veins are controlled by northwest-trending thrust faults in the identical Cambro-Ordovician stratigraphy as that at Old Cabin Creek. The morphology of this deposit suggests that ore-genesis is associated with late stage hydrothermal fluids using the fault planes as conduits. Although only a small fine-grained intrusive is exposed at surface it is thought by Abbott (pers. comm., 1985) that a larger intrusion exists beneath the present erosional surface and may have acted as a fluid source or thermal fluid driving mechanism.

At Old Cabin Creek, the potential exists beneath the weathered surface, for galena to be found in greater amounts, hosted similarly to the PLATA and INCA deposits. Prospecting targets would be thrust faults near intrusives.

7.1.3 TUNGSTEN

Tungsten mineralization at Old Cabin Creek was not seen by the author and only slightly anomalous values turned up in assay results of arsenopyrite veins. Hornfelsed samples were not lamped under ultra-violet light by the author.

Anomalous values obtained by Union Carbide were probably the result of either disseminated scheelite in hornfelsed or metasomatized sediments close to the main intrusion or from within pyrite and/or molybdenite veins in the intrusion.

Located 90 km southeast the MACTUNG orebody is the largest tungsten deposit in the free world with greater than 63 million tons of .96% WO_3 and significant Mo mineralization. The deposit occurs as a scheelite-bearing garnet-pyroxene skarn developed in limestone-rich Cambrian and Lower Ordovician units. The basal unit, a polymictic limestone slump breccia contains the lower ore zone and directly overlies early Cambrian clastics.

Approximately 100 m above the lower ore zone is a 100 m thick upper ore zone composed of 3 units of thinly interbedded calcareous shales and argillites.

A composite biotite-quartz monzonite intrusive (93.5 Ma), exposed just north of the deposit had previously been considered as the source of the hydrothermal fluids. Recent evidence (Atkinson and Baker, 1984) indicates that fluids were derived from a source at depth, south of the deposit and that the exposure of the stock near the deposit may be coincidental.

A near identical stratigraphic section exists in contact with an intrusive at Old Cabin Creek. In addition, a contact between the Hadrynian polymictic slump limestone and the intrusive is speculated to occur at depth, east of the intrusion.

7.1.4 COPPER

Copper mineralization is rare in the Selwyn Basin. Where seen it is typically hosted in skarns or Lower Paleozoic volcanics typical of the Old Cabin Creek Massif. At the study area copper mineralization is seen in four forms; i) disseminated chalcopyrite in pyrrhotite-rich volcanic flows; ii) flakes of chalcopyrite in quartz-sulphide vein networks; iii) disseminated chalcopyrite in quarts-carbonate-limonite breccia zones (as described previously in this chapter); and iv) irregular patches of crysocolla in limonitic, carbonate-rich altered volcanics (gossan). In all cases the mineralization is only weakly developed and probably not worth further examination.

7.2 FURTHER EXPLORATION

The presence of volcanic rocks intruded hornfelsed and faulted by a pluton provides an excellent prospecting target. The Old Cabin Creek Massif provides such a target and is host to varying types of mineralization. The potential for the discovery of a larger occurrence of such mineralization is large and may be uncovered with further exploration and prospecting.

All occurrences of volcanic rocks near Cretaceous plutons in the Selwyn Basin and Misty Creek Embayment would provide excellent sites for geochemical and geophysical exploration. The volcanics, the plutons, the hornfelsed contact aureole and any associated faults should be closely examined.

Considering the types of deposits commonly hosted in Selwyn Basin lithologies, the Old Cabin Creek Massif maintains an enormous economic potential.

8.0 CONCLUSIONS

Lithologies and structural style exposed at the Old Cabin Creek Massif are similar to those of the Selwyn Basin and Misty Creek Embayment. A volcanic pile composed mainly of hyaloclastics and pillowed flows is unusually thick and is probably proximal to a vent edifice.

The volcanism began in the late Cambrian and continued until the earliest Silurian. The original mineralogy of the volcanics has been changed by intense low-temperature alteration. Chemical analyses suggest the volcanics are tholeiitic basalts. The volcanics are part of the Marmot Formation and may be genetically similar to mid-Devonian Earn Group volcanics at MacMillan Pass.

The Cambrian/Precambrian contact at Old Cabin Creek is represented by a sudden proliferation of diverse trace fossils is strata directly above unit Hlb. Rocks beneath this contact are strata directly above unit Hlb. Rocks beneath this contact are Vendian and older "Lower Grit Unit" while those directly on top are Tommotian "Upper Grit Unit".

High values of gold (9650 ppb) in arsenopyrite veins at the lower contact of the volcanic pile are probably derived from the Cretaceous pluton. The potential for other mineral deposits to occur is high and is related to the complex structure and stratigraphy of the Massif.

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