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STRATIGRAPHY, STRUCTURE AND TECTONIC EVOLUTION OF SOUTHERN PELLY MOUNTAINS IN THE INDIGO LAKE AREA, YUKON TERRITORY

S.P. Gordey

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Preface

Pelly Mountains and adjacent parts of the Yukon Plateau are considered to have a good potential for metallic mineral deposits and in 1973 the Geological Survey of Canada began studies in the area designed to provide information on the relationship between stratigraphy, structure, sedimentary facies and mineral deposits. This report presents the results of one such project.

Indigo Lake map area was chosen for study at the scale of 1:50 000 because the stratigraphic succession there is fairly complete and is representative of this part of the northern Cordillera. The rocks range in age from Late Cambrian to Triassic. In places klippen of metamorphosed sedimentary rocks cap the mountains. The klippen are parts of a large thrust sheet whose roots lie 120 km to the southwest and whose remnants are found hundreds of kilometres northwest and southeast of Indigo Lake map area.

The information presented in this report will permit more detailed interpretations of the geology of the northern Cordillera and will thus aid in the search for mineral resources. The report also forms the foundation for future geological studies in the region.

D.J. McLaren
Director General
Geological Survey of Canada

Ottawa, February 1979

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Abstract

Geological mapping of 800 km^2 in the Pelly Mountains at 1:50 000 scale outlines an autochthonous succession of 12 mappable stratigraphic units, about 6100 m thick, that is overlain by klippen of mylonite.

Autochthonous rocks are grouped into five assemblages: (1) Cambro-Ordovician basalt and pelitic rocks representing volcanism with contemporaneous and younger shale; (2) Siluro-Devonian siltstone and dolomite deposited on a shallow platform; (3) Devono-Mississippian clastic rocks with chert and acid volcanics that reflect influx of clastic detritus derived from a sedimentary source, and local acid volcanism; (4) Carboniferous and Upper Triassic shale, siltstone, and minor limestone deposited on a stable marine shelf; and, (5) Jura-Cretaceous greywacke and volcanic rocks, the former derived from volcanic and metamorphic terranes and the latter representing local volcanism.

The allochthonous mylonite is metamorphosed to lower greenschist facies and the mylonite fabric is folded and transposed.

Deformation of the autochthonous rocks by northeast thrusting and folding and emplacement of the mylonite occurred in the Jura-Cretaceous. An anastomosing system of steep faults adjacent to and possibly related to strike-slip displacement along Tintina Trench postdates and cuts folds and thrust faults. Late normal faults disrupt the early structures and divide the area into fault-bounded panels of different structural level. Devono-Mississippian and Late Triassic (?) normal faults are important locally.

The mylonite is part of an extensive thrust sheet possibly produced during closing of the Teslin Suture and obduction of the Anvil Allochthon in the Mesozoic. Mylonite fragments in Jura-Cretaceous greywacke may derive from the advancing mylonite sheet.

Résumé

La cartographie géologique de 800 km^2 des monts Pelly, à l'échelle de 1/50 000, met en évidence une succession autochtone composée de 12 unités stratigraphiques définissables d'environ 6100 mètres d'épaisseur, qui est recouverte par des klippes constituées de mylonite.

Les roches autochtones sont groupées en cinq assemblages: (1) des basaltes et roches pélitiques, d'âge cambrien et ordovicien, formés pendant un épisode de volcanisme, accompagné et suivi du dépôt de schistes argileux; (2) des siltstones et dolomites d'âge silurien et dévonien, déposés sur une plate-forme peu profonde; (3) des roches clastiques d'âge dévonien et mississippien, accompagnées de chert et de roches volcaniques acides, qui indiquent un apport de débris clastiques à partir d'une source sédimentaire, et un volcanisme acide local; (4) des schistes argileux, siltstones, et de petites quantités de calcaire, d'âge carbonifère et triasique supérieur, déposés sur une plate-forme marine stable; et (5) des grauwackes et roches volcaniques d'âge jurassique et crétacé; les premières proviennent de terrains volcaniques et métamorphiques, les secondes d'une activité volcanique locale.

La mylonite allochtone a été métamorphisée dans le faciès inférieur des roches vertes, et la texture mylonitique a été remodelée par des plissements et des transpositions.

C'est pendant le Jurassique et le Crétacé qu'a eu lieu la déformation des roches autochtones sous l'effet de charriages de direction nord-est et de plissements, et que s'est constituée la mylonite. Un réseau anastomosé de failles très inclinées, situées à proximité de rejets horizontaux qui bordent le sillon de Tintina, et peut-être en rapport avec eux, est ultérieur aux plissements et chevauchements et les recoupe. Des failles normales plus récentes dérangent les structures anciennes et subdivisent la région en secteurs encadrés par des failles de niveau structural différent. Les failles normales formées au Dévonien et au Mississippien, ainsi qu'au Trias supérieur (?) sont localement importantes.

La mylonite fait partie d'une vaste nappe de charriage sans doute engendrée pendant le Mésozoïque par la fermeture de la suture de Teslin, et le recouvrement par l'allochtone d'Anvil. Les fragments mylonitisés que contient la grauwacke d'âge jurassique et crétacé ont peut-être été amenés par la nappe de mylonite.

STRATIGRAPHY, STRUCTURE AND TECTONIC EVOLUTION OF SOUTHERN PELLY MOUNTAINS IN THE INDIGO LAKE AREA, YUKON TERRITORY

INTRODUCTION

This investigation of the stratigraphy, petrology and structure of an area 80 km southeast of Ross River, Yukon Territory, is aimed at understanding the sedimentary history and structural evolution of southern Pelly Mountains. Prior to this study detailed information on the stratigraphy and structure of Pelly Mountains was not available. From early reconnaissance work (Green et al., 1960; Wheeler et al., 1960) the structure was poorly understood and thought to be complex; the stratigraphic succession had been subdivided into a few generalized rock units; an enigmatic body of metamorphic rocks thrust over unmetamorphosed strata had been outlined; and dextral transcurrent movement of 450 km along Tintina Trench was recognized (Roddick, 1967; Tempelman-Kluit, 1970).

This report presents (1) a geological map of part of the region; (2) a subdivision of the stratigraphic column, and a description of the petrography, stratigraphic relations, age and correlation of each unit; (3) an analysis of structure; (4) a description of the petrography, metamorphism, structure and possible origin of the overthrust sheet of metamorphic rocks; and, (5) an outline of the tectonic evolution of Pelly Mountains.

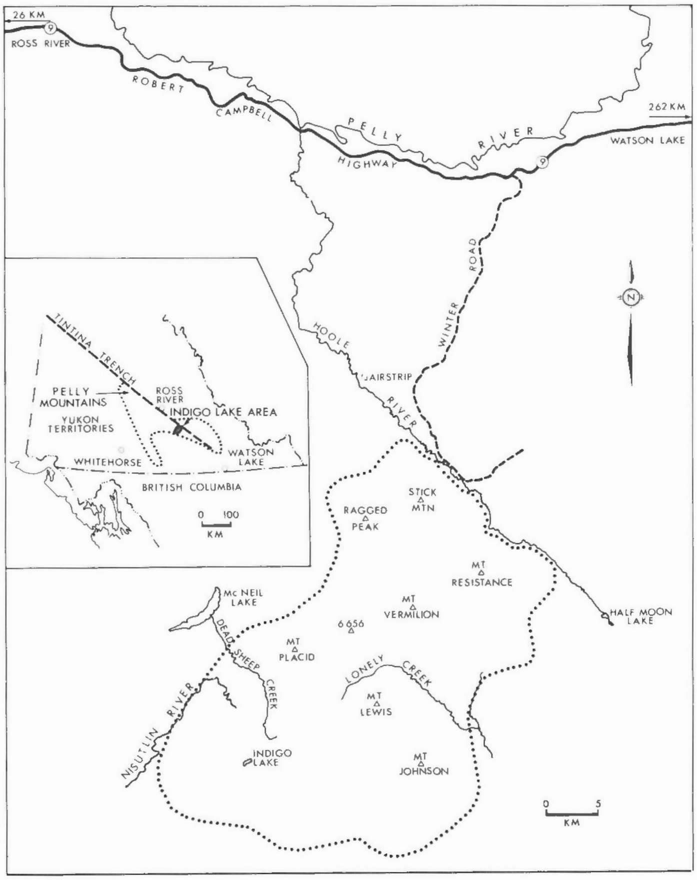

Figure 1B. *Location of the Indigo Lake area.*

Location, Access, and Field Work

Indigo Lake area embraces the southern part of the St. Cyr Range, Yukon Territory and extends southwesterly about 40 km from Hoole River, and about 25 km southeasterly from a northeast trending line drawn from the headwaters of Nisutlin River (Fig. 1B).

The area is not serviced by road but can be reached by helicopter chartered in Ross River; small fixed-wing aircraft with floats can land on McNeil and Indigo lakes. It can also be reached from an unmaintained airstrip, most recently used in 1973, situated north of the map area. The Robert Campbell Highway passes within 30 km of the area, and a winter road from this highway reaches the east side of Hoole River. Sparse trees and shrubs and relatively subdued topography allow easy foot travel through most of the region.

Field work during 19 weeks of 1974 to 1976 involved geological mapping of about 800 km^2 at 1:50 000 scale. To give an idea of the degree of ground control on the geology an index map of traverse routes and localities visited by helicopter is given in Figure 2.

Physiography

The map area lies within the Pelly Mountains physiographic region (Bostock, 1948) and is centred on the drainage divide of the Pelly, Teslin, and Liard river systems. It is characterized by smooth ridges of moderate elevation, broad U-shaped subalpine valleys occupied by meandering streams, and by local areas of high elevation and rugged topography. Elevations range from about 1220 m in some valley bottoms to just over 2140 m near Ragged Peak. Local relief reaches 460 m to 610 m. Southerly facing slopes are smooth, moderately steep, and dissected by shallow stream gullies; northerly facing slopes are locally rugged and carved into small cirques.

During the last advance of the Cordilleran ice sheet the Pelly Mountains were covered by two major ice lobes, one flowing westward from Selwyn Mountains and the other flowing northward from Cassiar Mountains (Hughes et al., 1969). Scoured U-shaped valleys, local drumlinoid forms on valley bottoms, ice marginal meltwater channels, and strandlines above Indigo Lake are some of the conspicuous physiographic products of the glaciation. Minor alpine glaciation likely produced the small cirques in north facing slopes. Good bedrock exposures along some streams shallowly incised into broad valley floors suggest that glacial and fluvial deposits are thin.

Exposures above timberline are excellent. In many places where shale or siltstone forms the bedrock, scree covers minor outcrop. Except in stream cuts exposures below timberline are rare.

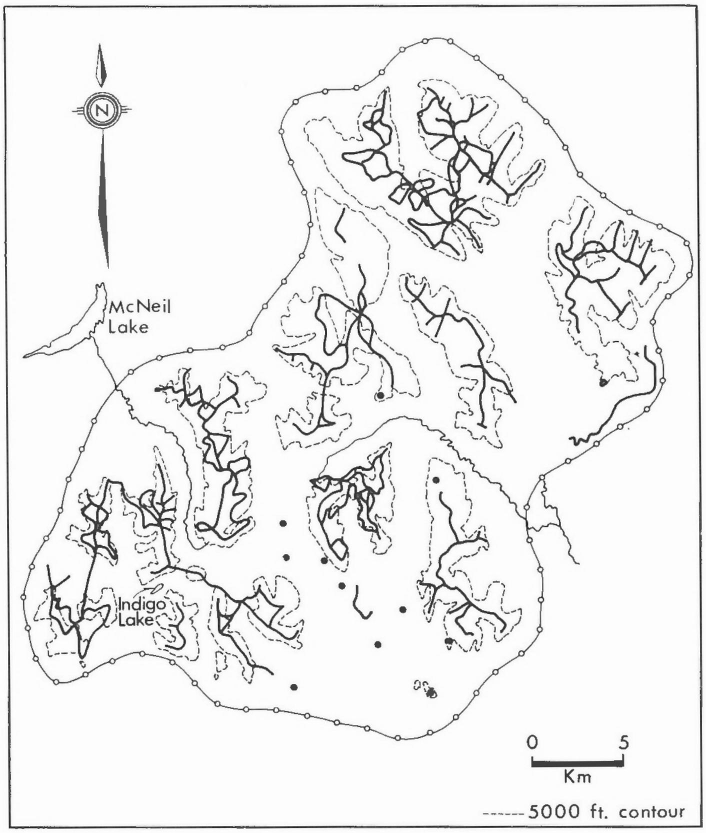

Figure 2. *Traverse routes and localities visited.*

Previous Investigations

The basic stratigraphic and structural framework of the region was established during an initial reconnaissance by the Geological Survey of Canada during 1958 and 1959. A brief account of this operation and a summary of the geological results are given by Green et al. (1960) whose report includes a diagrammatic structure section through the Indigo Lake area. The geological map of Finlayson Lake map area (scale 1 inch = 4 miles) by Wheeler et al. (1960) also includes the Indigo Lake area.

During the summers of 1973 to 1976 D.J. Tempelman-Kluit of the Geological Survey of Canada conducted a systematic geological investigation of Quiet Lake map area (NTS 105 F), and Finlayson Lake map area (NTS 105 G). The objective of this work was to develop a clearer understanding of the stratigraphy and structure of the region and to prepare geological maps for publication at 1:250 000 scale. The preliminary results (Tempelman-Kluit et al. 1974, 1975, 1976, 1977; Tempelman-Kluit, 1977) provide a framework for the interpretation of the Indigo Lake area. A preliminary report on the present work has been published by Gordey and Tempelman-Kluit (1976).

A regional study of the limits of glaciation and patterns of glacial flow in southern Yukon Territory by Hughes et al. (1969), based mainly on air photograph interpretation, included the present map area.

Acknowledgments

The writer thanks D.J. Tempelman-Kluit of the Geological Survey of Canada for suggesting the study and for his assistance in the field. The writer was accompanied in the field by G. O'Neil and D. Harper in 1974, G. Cavey and R. VanAppelan in 1975 and K. Pivnick in 1976. The work was accomplished while the writer was a student at Queen's University, and he appreciates the supervision of R.A. Price, and the technical assistance of E. Fernando, F. Dunphy, and B. Foster. Financial support was provided by National Research Council Postgraduate Scholarships from 1973-74 to 1976-77. Financial support for petrographic and analytical work was provided by National Research Council Operating Grant A5541 to R.A. Price.

GEOLOGICAL SETTING

The regional tectonic framework of southern Yukon Territory and northern British Columbia has been outlined by Gabrielse and Wheeler (1961), Gabrielse (1967a), Douglas et al. (1970), Wheeler and Gabrielse (1972), Tempelman-Kluit (1976, 1978), and Tempelman-Kluit and Blusson (1977)[1]. The location of Indigo Lake area with respect to regional tectonic elements is shown in Figure 3.

In early and middle Paleozoic time the northwestern margin of North America was flanked by a belt of shallow water carbonate comprising Mackenzie Arch and MacDonald Platform which changed facies southwesterly to shale and chert in Selwyn Basin and Kechika Trough. Cassiar Platform, a peninsular centre of shallow water sedimentation outboard of the main carbonate belt, developed in Silurian and Devonian time above thick accumulations of Late Cambrian and younger volcanic rocks. Carbonate of this platform changed facies to shale both to the northeast and southwest. During the Late Devonian and Mississippian, shale, siliceous greywacke and chert pebble conglomerate derived from a western (?) source or from fault-blocks within Selwyn Basin, spread over the platformal areas, Selwyn Basin, and Kechika Trough. The record of latest Paleozoic sedimentation is fragmentary, but where preserved indicates a return to normal clastic or carbonate shelf sedimentation. In Mesozoic time sediment largely derived from the Coast Plutonic Complex was shed eastward into a marine basin, the Intermontane Belt, which was floored by Paleozoic metamorphic rocks of southern Yukon Crystalline Terrane. This basin was possibly at the edge of North America but probably far removed from its present position. Early in the basin's history (Late Triassic) detritus was largely volcanic, but progressively became more granitic. By Late Jurassic or Early Cretaceous the Intermontane Belt was segmented into smaller successor basins accumulating nonmarine clastics and coal. Juxtaposition of the Intermontane and Omineca Crystalline belts occurred along the Teslin Suture in mid- to Late Cretaceous time. The Anvil Allochthon, composed of ultramafic rock, basalt, chert, mylonite and plutonic rock was obducted in the Mesozoic. The Omineca Crystalline Belt consists of remnants of these allochthons, metamorphosed shelf-edge equivalents of Cassiar Platform, and Mesozoic plutonic rocks. The Coast Plutonic Complex and the Yukon Crystalline Terrane were also loci of widespread Mesozoic plutonism. Mid- to late Cretaceous dextral displacement along Tintina and northern Rocky Mountain trenches offset the earlier formed tectonic elements.

The Indigo Lake area comprises two contrasting lithologic assemblages: the autochthonous miogeoclinal succession of Cassiar Platform, termed the autochthon, and an allochthonous body of mylonite of the Anvil Allochthon, termed the allochthon.

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[1] An important paper has subsequently been published by Tempelman-Kluit, 1979, Transported cataclasite, ophiolite, and granodiorite in Yukon: evidence of arc-continent collision; Geological Survey of Canada, Paper 79-14, 27 p.

AUTOCHTHON

Stratigraphy

The autochthonous rocks are subdivided into five assemblages, each representing different depositional environments:

(1) Cambro-Ordovician tuffaceous slate, basalt, and graptolitic shale representing marine volcanism with contemporaneous and younger shale deposition;

(2) Siluro-Devonian shallow water dolomite and platy siltstone representing a stable marine carbonate bank environment;

(3) Devono-Mississippian shale, sandstone, conglomerate, acid volcanic rocks, and chert representing respectively, a clastic wedge deposited on a subsiding carbonate bank, local contemporaneous volcanism, and a sediment-starved basin following the clastic influx;

(4) Carboniferous to Upper Triassic shale, calcareous siltstone, and minor limestone representing stable marine shelf conditions; and,

(5) Jurassic or Cretaceous volcanogenic sandstone and intermediate volcanic rocks, representing an unstable environment of eroding volcanic and metamorphic terrane(s) and local volcanism.

Map units are named informally and acronyms on the map and in Table 1 denote their age and lithology.

Cambro-Ordovician Assemblage

Slate-Diabase (u€Opd)

Slate and intercalated diabase sills occur north of Mount Johnson, and in a narrow band south of peak 6656. Individual sills cannot be traced laterally, and tend to be unevenly distributed so that there are local areas of slate without diabase. Because of structural complexity and because its base is not exposed the thickness of the unit is not known.

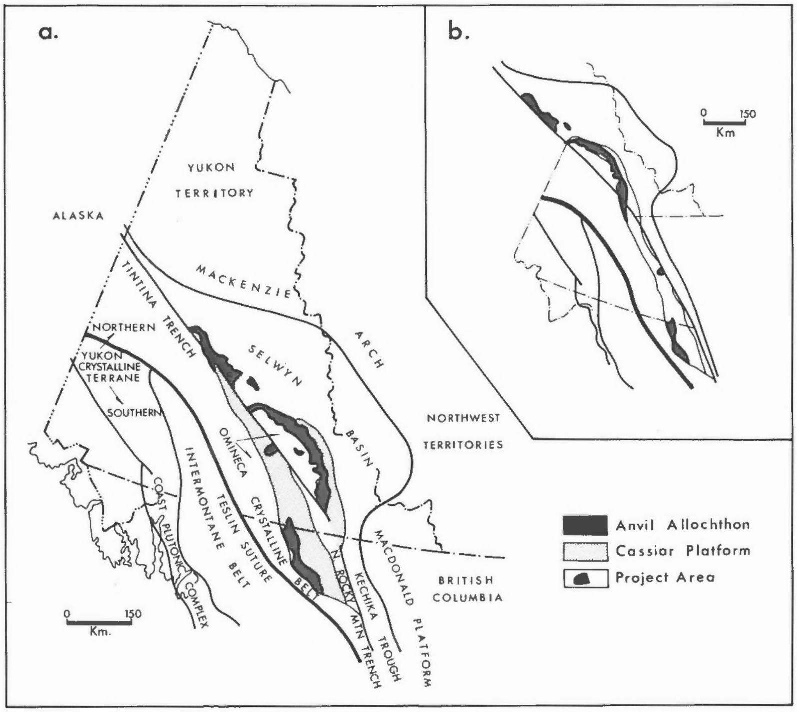
The slate-diabase unit contains lustrous silver-grey, recessive weathering fissile slate. Bedding, observed rarely, is defined by faint colour lamination, by thin beds of limestone, or by parallel rows of limestone nodules. Quartz-carbonate veins are abundant. Nontuffaceous slate predominates over tuffaceous varieties. Towards contacts with diabase sills the slate grades into hornfels as much as 15 m thick. The hornfels is a brittle, whitish green weathering, laminated rock composed of zoisite and sphene in a sieve-textured groundmass of quartz and albite.

Sills of the slate-diabase unit are resistant and form good exposures with blocky talus, which weathers orange to buff. They are commonly 6 to 30 m thick and have chilled border zones up to 1 m thick. Grain size ranges from aphanitic to medium grained. Fresh surfaces of the aphanitic varieties are dark grey-green; coarse grained varieties are of similar colour with a poor granitic texture. The sills consist of saussuritized plagioclase and augite replaced by chlorite or actinolite. Patchy carbonate is another common alteration product. Relict ophitic and subophitic textures are typical. Two chemical analyses from different sills, one from a fine grained chilled margin, are shown in Table 2. They are compositionally similar to Cambro-Ordovician basalt (compare Tables 2 and 3).

No fossils were found in the slate-diabase unit and its age is not known. It is similar to tuffaceous slate of probable Late Cambrian to Early Ordovician age which overlies it stratigraphically, and is unlike Lower Cambrian strata elsewhere in Pelly Mountains. Its age is probably Late Cambrian.

Tuffaceous Slate (u€Op1)

The tuffaceous slate unit is a heterogeneous assemblage of tuffaceous slate, basalt, calcareous slate, and limestone that is well exposed north of Mount Johnson, and both north and south of peak 6656. It is about 1000 m thick, but because of the rapid thickness variations inherent in volcanic rocks and because its base is taken as the highest diorite sill, which may not be at a consistent stratigraphic level, the thickness may vary. Tectonic thickening is possible but its importance is not known.



a *Tectonic elements in their present relative positions.*

b *450 km of dextral strike slip along Tintina and northern Rocky Mountain trenches restored.*

Figure 3. *Tectonic subdivisions of the northern Canadian Cordillera (modified after Tempelman-Kluit (1976, 1977, 1978) and Wheeler and Gabrielse (1972).*

Table 1

Table of Formations

ERA	PERIOD OR EPOCH		UNIT	MAP SYMBOL	ROCK TYPE	THICKNESS (METRES)
UPPER PALEOZOIC	Devonian to Carboniferous		Klondike Schist	DCk	Feldspar-mica-quartz mylonite	500+ (Structural)
MESOZOIC	TECTONIC CONTACT-THRUST ON CTRps AND JKsv					
	Jurassic and(?) Cretaceous		Greywacke-Tuff	JKsv	Greywacke; tuff; quartz porphyry; andesite	0-350+
	DISCONFORMABLE ON CTRps, uDMps					
	Carboniferous and Upper Triassic		Shale-Siltstone	CTRps	uTR: Siltstone, calcareous; shale; limestone	500
PALEOZOIC					DISCONFORMABLE ON CARBONIFEROUS CTRps Mt, uDMps	
					C: Siltstone; shale	
	Upper Mississippian		Chert	Mt	Chert; thin-bedded	0-300+
	Upper Devonian and Mississippian		'Black Clastic'	uDMps	Shale; lithic greywacke; chert pebble conglomerate	550
	DISCONFORMABLE ON uSDc, Ss, LOCALLY ON uꞒOp$_1$					
	Upper Devonian and Mississippian		Acid Volcanic	uDMv	Acid volcanic flows and tuffs	0-1700+
	DISCONFORMABLE (?) ON uSDc					
	Upper Silurian to Middle Devonian		Dolomite	uSDc	Dolomite; quartz arenite; dolomite breccia; minor limestone	0-1400+
	LOCALLY ANGULAR UNCONFORMABLE ON Ss					
	Silurian		Siltstone	Ss	Siltstone, tan, platy	400
	DISCONFORMABLE ON Op uꞒOp$_1$; LOCALLY CONFORMABLE (?)					
	Ordovician	KECHIKA GROUP	Graptolitic Shale	Op	Shale, black, graptolitic; quartz arenite	0-300
	Upper Cambrian and Ordovician		Basalt	uꞒOv	Basalt; agglomerate	0-450
			Orange Slate	uꞒOp$_2$	Slate, lustrous, orange weathering	(?)
			Tuffaceous Slate	uꞒOp$_1$	Tuffaceous slate, lustrous, grey weathering; basalt; limestone	1000
			Slate-Diabase	uꞒOpd	Slate, lustrous, grey weathering; diabase sills	(?)

Table 2

Chemical analyses of diabase

	A	B
SiO_2	45.61	49.38
Al_2O_3	12.4	11.7
Fe_2O_3	2.3	10.4*
FeO	8.7	-
MgO	9.45	10.75
CaO	8.45	8.29
Na_2O	2.90	3.45
K_2O	1.41	0.19
TiO_2	2.85	2.47
MnO	0.15	0.14
P_2O_5	0.50	0.35
L.O.I.	3.4	5.0
Total	98.1	102.0
Visually Estimated Modes		
Primary Minerals		
Plagioclase	58	62
Augite	15	20
Ilmenite	tr	2
Alteration Minerals		
Actinolite	2	5
Chlorite	10	10
Carbonate	-	1
** Fine-grained and indeterminate	15	-

* Total iron as Fe_2O_3

** Indeterminate – includes fine-grained minerals; largely alteration products, for which mode cannot be reliably estimated.

tr – trace

A – 60°19.2'N, 131°40.3'W; chilled margin

B – 60°14.1'N, 131°39.6'W

Analyst – F. Dunphy, Queen's University, Ontario; FeO by Geological Survey of Canada.

Method – X-ray fluorescence; FeO by titration

The dominant rock type is pale green to light brown weathering, slightly lustrous tuffaceous slate, in which bedding is rarely seen. Cleavage surfaces display faint pale green to brown or black subcircular patches, commonly less than 1 cm in diameter, that are the intersection of slaty cleavage with flattened fragments. Fragment types include volcanic rocks and minor fine grained limestone.

Massive black weathering basalt flows up to 15 m thick are intercalated with the slate. Fresh surfaces reveal a dark green aphanitic rock, locally with small pyroxene phenocrysts. This basalt is like that of the basalt unit, but in the tuffaceous slate unit is volumetrically minor.

Intercalated with the basalt and tuff but typically occurring high in the unit are rusty weathering limestone lenses, generally less than 30 m thick, which cannot be traced laterally (Fig. 4). The limestone is grey on fresh surfaces and is finely crystalline and locally silty. In one exposure small volcanic fragments are embedded in the carbonate.

Towards its top the unit becomes nontuffaceous, and more lustrous, and light grey, finely crystalline limestone forms thin boudinaged interbeds typically less than 2 cm thick. Near Ragged Peak these carbonate interbeds are notably absent. Where slaty cleavage across bedding is absent, the pelite has a bedding fissility which, like the cleavage, has a slightly lustrous sheen.

No fossils were found within the tuffaceous slate and its age is inferred from stratigraphic relations. It underlies Lower to Upper Ordovician black graptolitic shale (Op) at most localities, and elsewhere directly underlies Silurian siltstone (Ss). The tuffaceous slate is unlike Lower Cambrian strata. Its age is probably Late Cambrian to Early (?) Ordovician.

Orange Slate (uЄOp2)

Exposures of the orange slate unit are limited to the northeastern part of the map area within narrow, fault-bounded strips. It weathers recessively and forms poor outcrop partly covered by scree. From a distance the unit is distinguished by its orange weathering colour. Lack of marker horizons, the faulted contacts with other units, and probable internal structural complexity preclude reliable estimates of its thickness. Neither the base nor the top of the unit are exposed.

The slate can be subdivided into bright orange weathering slate and orange blue-grey weathering slate present in roughly equal amounts. These are either thinly interbedded or may occur in beds to 150 m thick. The first is blue-grey on fresh surfaces, locally calcareous, and finely laminated. Cleavage, rarely parallel to bedding, produces a "slabby" splitting habit. In the second variety cleavage surfaces are crenulated, are more lustrous, and produce a "papery" splitting habit. Small limonite spots or pyrite cubes are abundant.

Quartz or carbonate veins and pods, less than 0.5 m thick or long, are abundant. Veins and pods of quartz plus carbonate are less common.

Fossils were not found in the orange weathering slate. The most closely similar strata are the slate-diabase and tuffaceous slate units which are probably Upper Cambrian to Lower Ordovician. Similar strata in Quiet Lake map area to the west, have yielded a sparse Late Cambrian trilobite fauna (D.J. Tempelman-Kluit, personal communication, 1977). The orange slate is likely Upper Cambrian to Lower (?) Ordovician.

Basalt (uЄOv)

The basalt unit composed of dark weathering basalt and agglomerate, is well exposed at peak 6656 and east of Ragged Peak. Near peak 6656 it is about 450 m thick. Elsewhere it is too thin to be separated and is included in the tuffaceous slate unit.

Near peak 6656 the unit consists of dark weathering, dark grey to dark green aphanitic basalt in which individual flows were not recognized. Augite and feldspar phenocrysts and small amygdules of calcite or chlorite occur in places in the basalt. The amygdules are locally flat and elongate, and the resulting planar alignment of infilling chlorite defines a weak foliation. The flattening is considered a result of primary flow as it is variable in intensity. On foliation surfaces the chlorite appears as oval green and light red patches up to 7 mm in diameter.

The basalt includes augite-bearing and augite-free varieties, both strongly altered. Augite-bearing types contain augite phenocrysts up to 5 mm in diameter which comprise up to 20 per cent of the rock. The phenocrysts are set in a groundmass of altered feldspar microlites, sphene

Table 3
Chemical analyses of basalt

	A	B	C	D	E	F	G	H	I	J	K	L	M
SiO	49.85	45.67	43.95	48.49	46.32	41.05	48.95	46.78	45.66	51.73	46.85	41.05 - 51.73	45.4
Al_2O_3	15.0	11.3	14.9	16.5	16.1	13.1	14.6	12.1	15.8	11.2	14.06	11.2 - 16.5	14.7
Fe_2O_3	9.9	10.5	7.5	8.1	9.1	12.5*	10.9	6.6	8.5	6.7	8.6	7.5 - 10.5	4.1
FeO	2.3	4.4	4.9	5.0	5.1	-	4.1	6.9	4.8	4.1	4.6	2.3 - 6.9	9.2
MgO	5.50	8.18	8.18	4.90	6.55	11.60	7.35	9.30	7.02	9.25	7.78	4.90 - 9.30	7.8
CaO	3.70	7.54	4.62	3.73	1.45	5.23	0.94	5.82	3.60	5.91	4.25	0.94 - 7.54	10.5
Na_2O	2.25	2.38	4.90	4.70	4.40	3.45	3.45	3.68	4.80	4.17	3.82	2.25 - 4.90	3.0
K_2O	3.30	2.27	0.21	1.60	0.87	0.09	1.41	0.84	0.60	0.55	1.17	0.09 - 3.30	1.0
TiO_2	3.93	3.65	4.30	3.81	4.29	3.00	3.16	3.52	3.90	2.54	3.61	2.54 - 4.30	3.0
MnO	0.13	0.13	0.13	0.12	0.13	0.35	0.16	0.17	0.18	0.16	0.17	0.12 - 0.35	0.2
P_2O_5	0.52	0.52	0.72	0.46	0.53	0.36	0.41	0.49	0.40	0.30	0.47	0.30 - 0.72	0.4
L.O.I.	3.5	2.7	4.1	3.0	3.4	11.2	4.4	3.9	4.1	3.2	4.4	2.7 - 11.2	-
TOTAL	99.88	99.24	98.41	100.41	98.24	101.93	99.83	100.10	99.36	99.81	99.72	98.24 - 101.93	-
Mode (Visually Estimated)													
Plagioclase	3	tr	45	56	77	tr	5	-	80	-			
Augite	-	5	-	-	-	-	-	-	-	tr			
Opaque	5	10	10	7	15	20	20	3	5	4			
Sphene/Leucoxene	10	8	10	15	-	-	-	10	15	10			
Actinolite	-	4	-	-	-	-	-	12	-	tr			
Carbonate	-	tr	-	-	-	4	-	1	-	tr			
Chlorite	-	1	20	-	5	2	3	4	tr	-			
**Indeterminate	82	72	15	20	-	74	67	70	-	79			
Amygdules													
Chlorite	1	-	-	2	3	-	-	-	1	7			
Quartz	1	-	-	-	-	-	5	-	-	-			

*Total Fe as Fe_2O_3

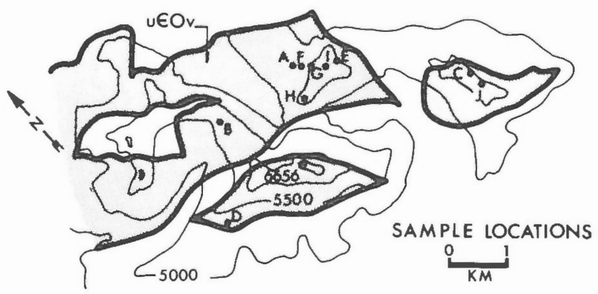
**Indeterminate – includes fine-grained minerals; largely alteration products, for which mode cannot be reliably estimated.

tr =trace

A to J	Analyses of basalt of unit uCOv
K	Average of analyses A to J
L	Range analyses A to J
M	Typical 'K-poor' alkali olivine basalt (Irvine and Baragar, 1971)

Analyst – F. Dunphy, Queen's University, Ontario;
FeO by Geological Survey of Canada

Method – X-ray fluorescence; FeO by titration



SAMPLE LOCATIONS

Figure 4. *Peak 6656 viewed from the east. Resistant basalt flows of the basalt unit cap the peak and overlie tuffaceous slate and lenses of orange weathering limestone (1) of the tuffaceous slate. (GSC 203586)*

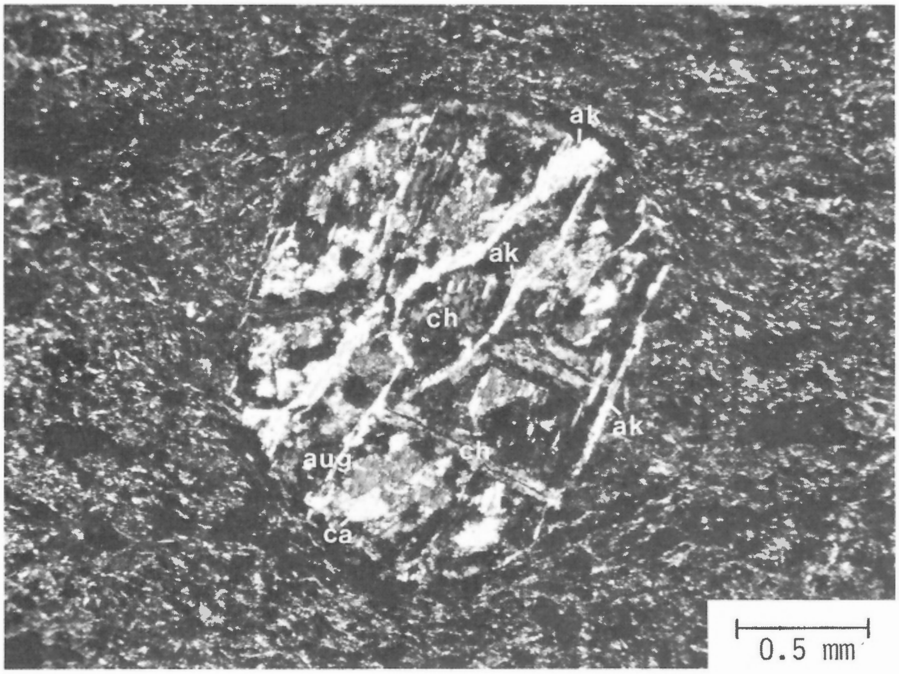


Figure 5. *Photomicrograph (crossed nicols) of an altered augite phenocryst in an augite porphyry of the basalt (uЄOv). The phenocryst is altered to a boxwork pattern of actinolite (ak) enclosing patches of chlorite (ch) and calcite (ca). Small patches of augite (aug) have escaped alteration. Strong alteration of the basalt is common. (GSC 203586-B)*

and/or leucoxene, chlorite, opaque minerals, actinolite, carbonate, quartz, and locally epidote. Augite is altered to a boxwork of actinolite enclosing rectangular patches of chlorite, with remnants of fresh augite (Fig. 5). Actinolite within the groundmass occurs as needles and felted crystals up to 0.1 mm in length. Augite-free varieties consist of densely packed feldspar laths, locally with preferred form orientation, up to 0.25 mm long set in an intergranular matrix of opaque minerals, sphene and/or leucoxene, and chlorite. Feldspar phenocrysts up to 2 mm long make up a few per cent of the rock and commonly form glomeroporphyritic clots. Locally the phenocrysts are bent (Fig. 6).

Plagioclase (sodic) is altered to sericite or calcite, and commonly contains small inclusions of sphene. Small amygdules of quartz, calcite, or chlorite, occur throughout the basalt. Sphene and/or leucoxene comprises up to 10 per cent of the rock. Opaque minerals, which may comprise up to 20 per cent, consist mainly of finely disseminated hematite, which gives the rock its characteristic purplish cast in hand specimen.

Chemical analyses of ten unweathered specimens of basalt with as small a proportion of amygdules as possible are shown in Table 3. The analyses show small scatter on an AFM diagram and on an alkali-silica diagram plot in the alkaline field (Fig. 7) (Irvine and Baragar, 1971). They are chemically similar to Irvine and Baragar's (1971) "K-poor" alkali olivine basalt. The high ratio of ferric to ferrous iron reflects the common abundance of hematite.

On the ridge-crest 5 km southeast of Ragged Peak the unit consists of 150 m of agglomerate which grades 5 km to the northwest into a fine grained laminated brittle mudstone. The dark weathering agglomerate is massive and consists of rounded cobbles and small boulders, up to 60 cm in diameter, of dark green aphanitic basalt and feldspar porphyry, evenly

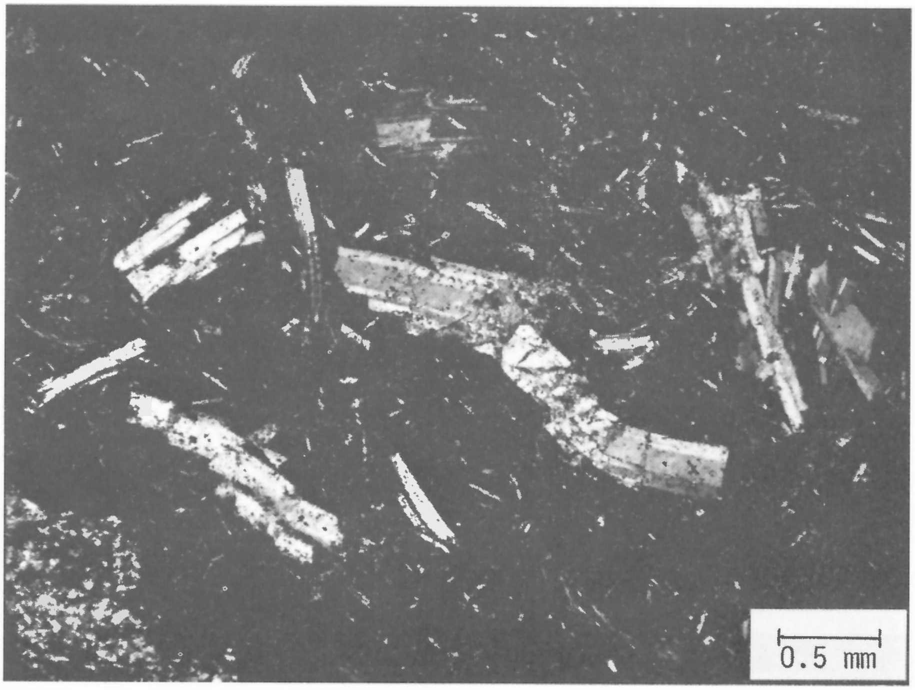


Figure 6. *Photomicrograph (crossed nicols) of basalt (uЄOv), showing glomeroporphyritic texture of plagioclase and bent and cracked plagioclase phenocrysts. The matrix consists of feldspar microlites in opaque material. The phenocrysts were probably deformed during viscous primary flow. (GSC 203586-A)*

distributed in a coarse grained volcanic sandstone matrix (Fig. 8). The clasts make up an estimated 10 per cent of the rock. Both the larger clasts and the volcanic grains of the matrix are similar to the basalt near peak 6656.

At peak 6656 the basalt is overlain by Ordovician shale (Op) and underlain by tuffaceous slate (uЄOp1) that is probably Upper Cambrian to Lower (?) Ordovician. Southeast of Ragged Peak the agglomerate is overlain by Lower Ordovician black shale. The age of the basalt unit is probably uppermost Cambrian to Early (?) Ordovician.

Graptolitic Shale (Op)

Black graptolitic shale and white quartz arenite (Op) is best exposed southeast of Ragged Peak. It is thickest (about 300 m) in this area, but elsewhere ranges to zero thickness. Where the unit is absent Silurian siltstone (Ss) rests directly on Cambro-Ordovician tuffaceous slate (uЄOp1).

The shale is recessive and weathers black, producing an earthy black scree. Bedding is rarely discernable, but the shale is fissile and abundant graptolites are preserved. Slaty cleavage is typically lacking.

Fine- to medium-grained quartz arenite interbedded with the shale is grey-white to orange weathering and resistant, forming good outcrops and a blocky talus. Bed thickness ranges from 50 cm to 10 m southeast of Ragged Peak, and individual beds are massive, with no internal sedimentary structures. Bedding contacts with the shale are sharp. Argillaceous quartz arenite beds locally contain black shale chips to 5 cm in diameter. The grain-size distribution in beds is bimodal, with a small proportion of evenly distributed large grains. All grains have high sphericity and roundness. Quartz overgrowths are abundant, and calcite cement is minor.

Southeast of Ragged Peak the quartz arenite comprises up to 60 per cent of the unit. Elsewhere, where the graptolitic shale is thinner, the quartz arenite is rarer and in beds less than one metre thick.

Graptolite collections from the black shale are long ranging and span the Ordovician and Early Silurian (see Appendix I). Graptolite collections from similar rock elsewhere in Pelly Mountains have the same range of ages (D.J. Tempelman-Kluit, personal communication, 1977). The graptolitic shale unit is Early to Late Ordovician and possibly also earliest Silurian in age.

Stratigraphic Relations and Depositional History of the Cambro-Ordovician Assemblage

Stratigraphic relations of Cambro-Ordovician strata are shown schematically in Figure 9. The assemblage is characterized by intertongueing volcanic and nonvolcanic facies which indicate marine and local subaerial (?) environments. Units within the assemblage are conformable and gradational, although the graptolitic shale (Op) and tuffaceous slate (uЄOp1) have a sharp contact. The overlying siltstone (Ss) is disconformable on these rocks.

Basalt flows formed thick local accumulations that may have stood above sea level. The agglomerate, with its well-rounded cobbles and boulders, is a slump deposit derived from the rapidly (?) built and subaerially exposed volcanic pile. Eruptions of the basalt were not explosive as breccia is not intimately associated with them; however, the tuffaceous character of the slates may indicate some explosive activity. To the northeast, volcanism did not directly affect the sedimentation of the pelite of the orange slate unit. Diabase sills have intruded the sediments and are chemically like the basalt; they may be their intrusive equivalents. The irregular accumulation of basalt flows and tuffaceous sediments formed a varied topography on the seabottom. The lenticular limestones may have been deposited in shallow water on local topographic highs. Deposition of the Ordovician graptolitic shales, which overlie the basalt and tuffaceous slate and which may represent a relative increase in water depth, commenced after the cessation of volcanism. The quartz arenite interbedded with the shale may have accumulated as turbidite flows, but their source is not known. The southwesterly facies change from nonvolcanic to volcanic rocks in the Indigo Lake area may reflect facies variation around local volcanic centres.

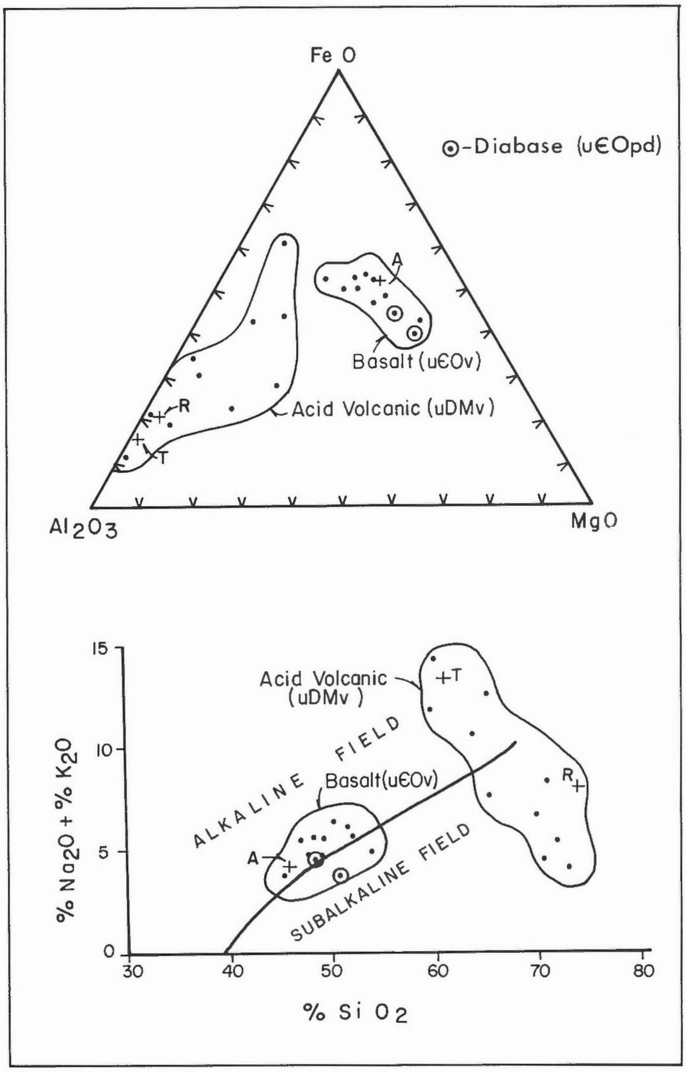


Figure 7. *AFM (a) and alkali-silica (b) diagrams for volcanic suites of the Indigo Lake area. Alkaline and subalkaline fields in (b) are as defined by Irvine and Baragar (1971).*

Correlation of the Cambro-Ordovician Assemblage

The Cambro-Ordovician strata correlate with phyllite and graptolitic shale which comprises the Kechika Group in McDame map area (Gabrielse, 1963). Similar and correlative strata occur in Wolf Lake (unit 4 of Poole et al., 1960), Watson Lake (unit 4 of Gabrielse, 1967b), Kechika (unit 6 of Gabrielse, 1962b), and Rabbit River (unit 4 of Gabrielse, 1962c) map areas. In these areas volcanic rocks are absent or a minor component of the sequence. In Quiet Lake map area correlative strata include abundant intermediate to basic volcanic flows (Tempelman-Kluit et al., 1976; Tempelman-Kluit, 1977). In Tay River map area similar and correlative strata are host to the large zinc-lead deposits near Faro (Tempelman-Kluit, 1972). Greenstone from this area (Tempelman-Kluit, 1972, unit 3a) is equivalent and chemically similar to the basalt unit.

Siluro-Devonian Assemblage

Siltstone (Ss)

A unit of siltstone with minor dolomite and volcanic rocks, about 400 m thick, is well exposed northeast of Ragged Peak, near Mount Johnson, 4 km south of peak 6656, and in the southernmost part of the map area.

The siltstone weathers tan and is light to dark grey on fresh surfaces. In the lower part of the unit it is well-laminated, the laminations ranging in colour from white to grey. The rock splits along the lamination into smooth plates. Higher in the section the lamination is discontinuous and wispy because of the effects of bioturbation and talus becomes less platy and more blocky. At the top of the unit south of Mount Johnson, the siltstone grades upward into a very fine grained whitish weathering quartz arenite.

The siltstone consists dominantly of quartz, but contains a few per cent detrital muscovite and rare grains of twinned plagioclase, microcline and tourmaline. Grain size is in the coarse silt range, the grains forming an interlocking mosaic with irregular long and sutured grain boundaries. Calcite and dolomite replace quartz in patchy areas or as scattered rhombs. Bedding fissility follows closely spaced, black, argillaceous seams.

Near Ragged Peak and 4 km south of peak 6656 massive, fine sugary dolomite occurs within the middle part of the siltstone unit. At the second locality it contains a sparse fauna of poorly preserved solitary and favositid-like corals.

Near Ragged Peak rusty weathering volcanic flows and tuffs, together about 25 m thick, are intercalated with the siltstone. The flows are pale green, aphanitic, and amygdaloidal with 5 to 10 per cent white to slightly pinkish calcite amygdules up to 1 cm in diameter. The rock is composed of randomly oriented, variably altered, feldspar needles up to 0.15 mm long, irregular patches of fibrous chlorite, patches of calcite, and scattered opaques. No mafic minerals are present, but some of the calcite patches and associated dusting of opaques have a regular and possibly inherited rectangular form.

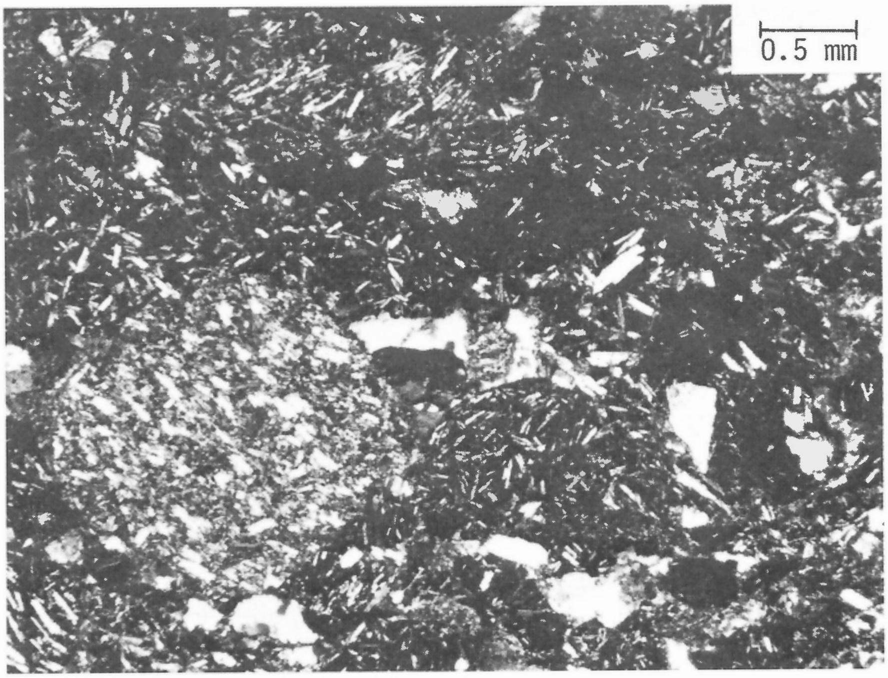
The tuffs are grain-supported and contain angular, pale green aphanitic volcanic fragments and fewer grey limestone fragments up to 1.5 cm in diameter in a calcite matrix. Volcanic fragments include varieties with abundant opaque minerals, and opaque-free types made up of chlorite. The former contain angular to round inclusions of calcite, chlorite, or quartz and small spherulites of chlorite, and the latter contain round inclusions of quartz, calcite, feldspar, sphene and/or leucoxene, and opaque minerals. Limestone fragments include coarse-crystalline types, but others have large carbonate plates in a micrite matrix. Sparse crinoid fragments are also found in the tuffs.

The siltstone contains poorly preserved Silurian graptolites (Appendix I). Two collections from within the map area are late Early Silurian. Most graptolite collections from similar strata elsewhere in Pelly Mountains are from the Early and Middle Silurian, only a few being of Late Silurian age (D.J. Tempelman-Kluit, personal communication, 1977). The age of the siltstone unit is Early and Middle Silurian, but may range into the Late Silurian.

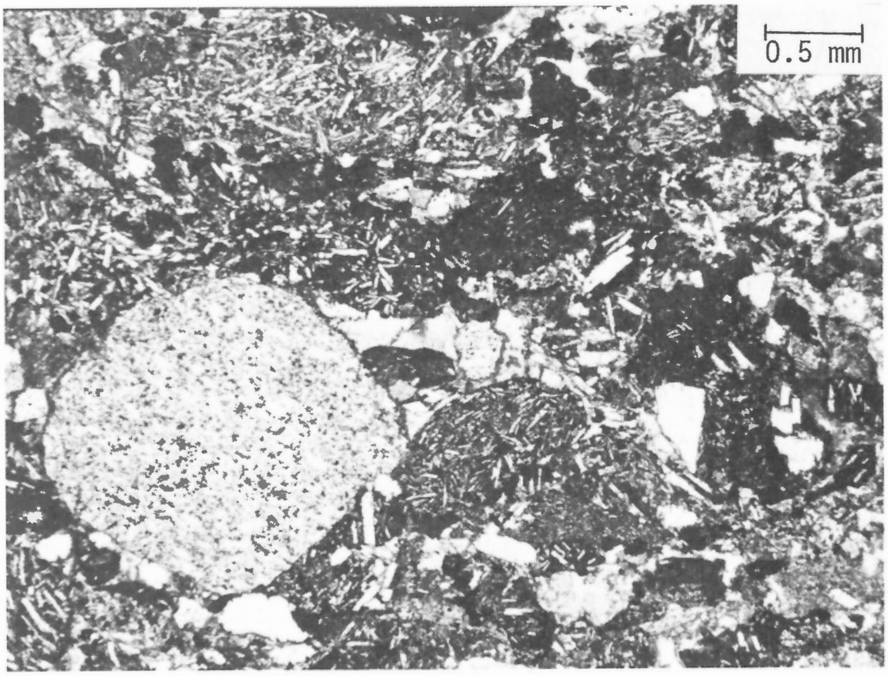
Dolomite

White and buff weathering dolomite, grey weathering quartz arenite, and minor black limestone comprise a resistant unit that forms prominent cliffy exposures at Mount Placid, in the vicinity of Mount Johnson, at Ragged Peak, and 4 km southeast of Indigo Lake. Because erosional truncation beneath overlying rocks differs, the preserved thickness of the dolomite unit ranges from zero to a maximum of about 1400 m near Ragged Peak.

The dolomite is finely crystalline, contains abundant fine quartz sand, and on fresh surfaces is black, grey, or white. It is well bedded in beds from about 0.3 to 1.5 m thick that weather grey, white, tan, and less commonly, orange or black. Both parallel laminated and massive beds are



(a) crossed nicols (GSC 203586-C)



(b) plane-polarized light (GSC 203586-D)

Figure 8. *Photomicrographs of the matrix of agglomerate of the basalt unit 5 km southeast of Ragged Peak. The constituent of grains, crowded with plagioclase laths, are of volcanic origin, and resemble basalt of the unit. Their roundness, like that of large well-rounded volcanic cobbles in the agglomerate, reflects substantial erosion before deposition.*

common. Bedding surfaces are usually planar, but locally are irregular and disconformable. Small rip-up clasts and mud cracks occur but are rare. Fossils, usually dolomitized or silicified and poorly preserved, are abundant in dark-coloured dolomite and in the few occurrences of limestone, but are sparse in light-coloured dolomite.

Dolomite within the northwest-trending, fault-bounded panels east of Ragged Peak although similar, is characterized by thicker bedding, and by abundant dolomite breccia. The dolomite is moderately to poorly bedded in beds less than one metre thick to up to 4.5 m thick that may be massive, or contain fine parallel lamination. Dolomite breccia is commonly associated with thick units of massive, finely crystalline dolomite. The breccia consists of angular to rounded dolomite clasts to 10 cm in diameter in a matrix of finer grained dolomite fragments and finely crystalline dolomite. Fragments are difficult to distinguish on weathered surfaces, and clasts of larger size may exist.

The dolomite is an interlocking mosaic of dolomite crystals to 0.1 mm in diameter. Quartz silt is evenly distributed or concentrated along laminae in amounts up to 50 per cent, and trace amounts of muscovite, plagioclase, and microcline occur with it. Solution and reprecipitation of quartz and carbonate have been extensive so that original grain boundaries are obscured. The quartz in some rocks forms monocrystalline or polycrystalline patches interstitial to idiomorphic dolomite grains. Rocks with more than 50 per cent detrital quartz grade into quartz siltstone and arenite.

Quartz arenite interbedded with the dolomite is present throughout the map area. In the northeast half of the area it is unimportant and forms thin beds (0.3 to 0.5 m) or thinly bedded units less than 15 m thick. Southeast of Indigo Lake it comprises an estimated one third to one half of the total exposed thickness of the unit. Here it is found as thin beds, or as thin- to medium-bedded, well bedded units as much as 75 m thick. Planar parallel lamination accentuated by weathering, and at some places by red oxide stain, is common. Small-scale planar cross-stratification and ripple marks are locally abundant.

The quartz arenite contains fine grained to medium grained, well-rounded quartz grains. Grain contacts are not sutured and cementation is by quartz overgrowths. Some arenites are bimodal with a few medium grained quartz grains scattered amongst more plentiful fine grained quartz.

Dark weathering, thinly bedded and well bedded, black, finely crystalline, argillaceous limestone occurs near Stick Mountain. Elsewhere limestone is rare.

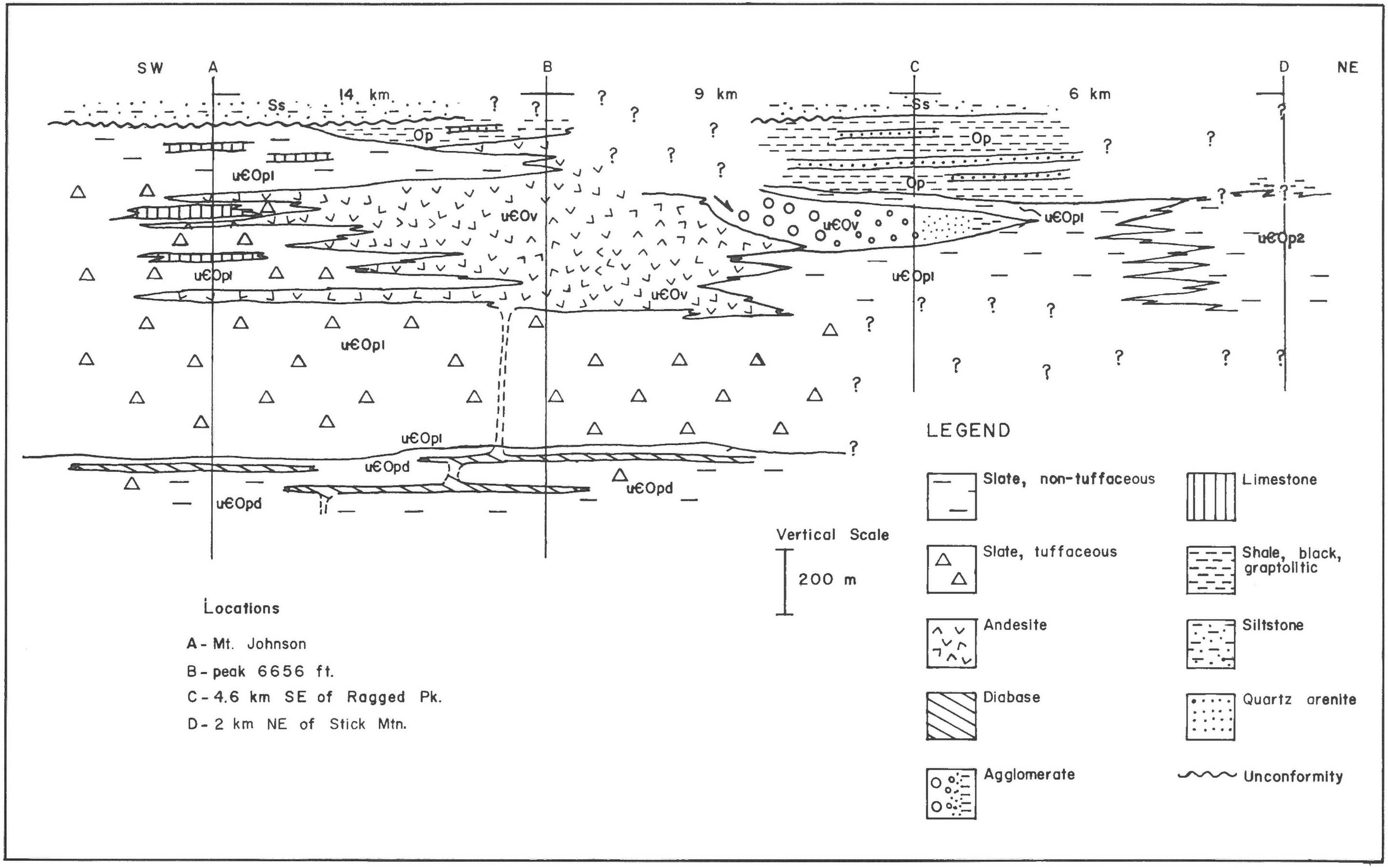


Figure 9. *Schematic diagram of stratigraphic relations of Cambro-Ordovician units.*

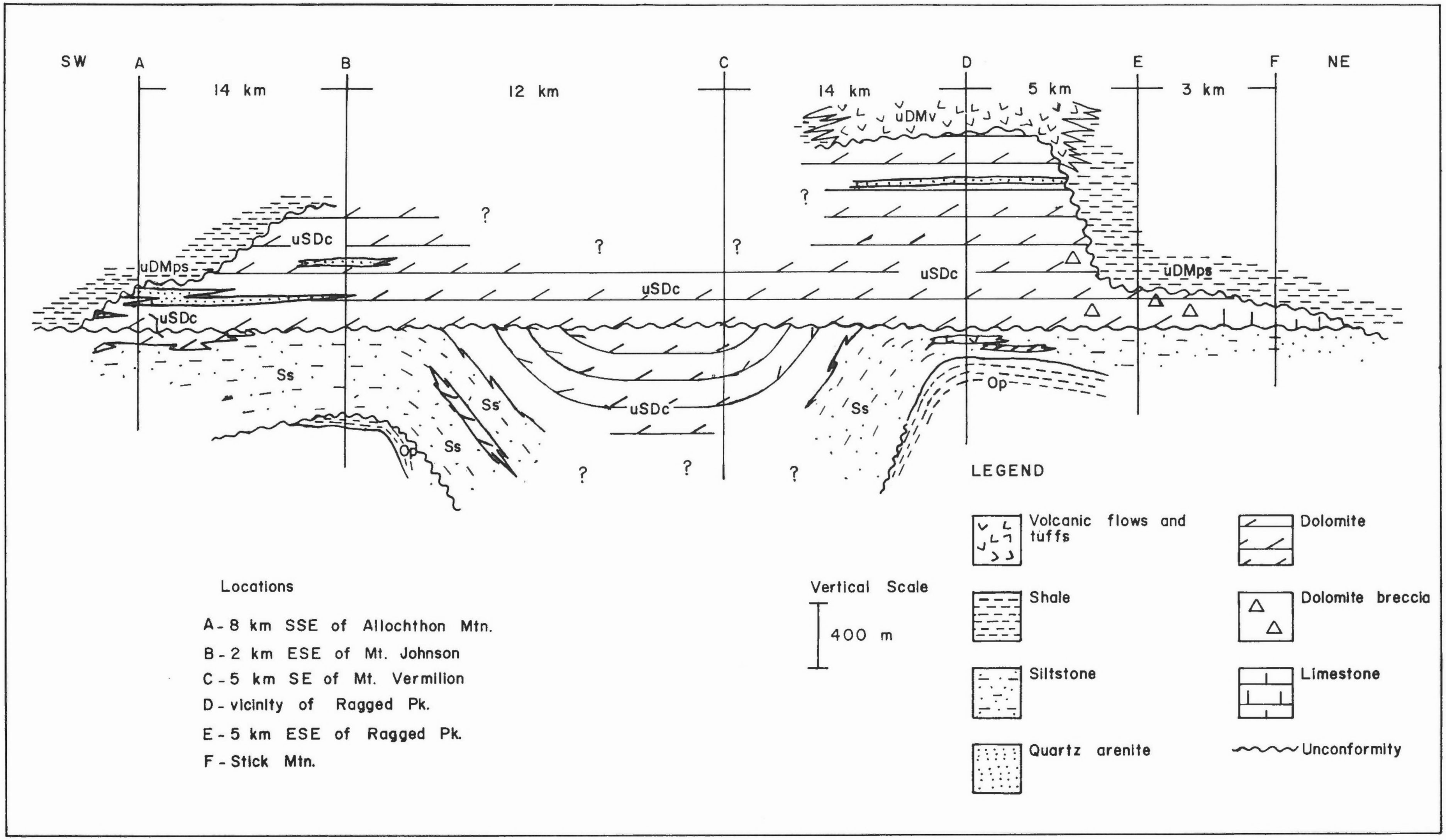


Figure 10. *Schematic diagram of stratigraphic relations of Siluro-Devonian units.*

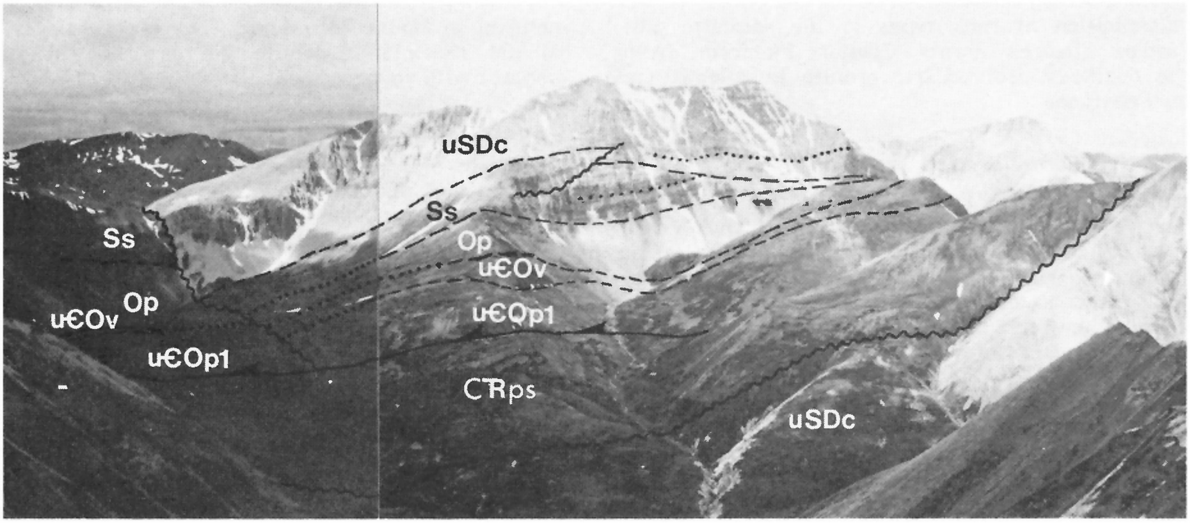


Figure 11. *Ragged Peak as viewed from the east. A low-angle unconformity separates the dolomite (uSDc) and siltstone (Ss) and is offset by a small fault. Cambro-Ordovician and younger strata rest above Carboniferous and Triassic strata (CŦps) on the gently dipping Ragged Peak Thrust. A steeply dipping fault (foreground) separates the Carboniferous and Triassic strata from the dolomite unit (uSDc). (GSC 203586-E)*

Of four fossil collections from the dolomite unit two are Silurian, and another is probably Middle or Late Silurian (Appendix I). Collections from similar strata elsewhere in Pelly Mountains range from probable mid-Silurian to Middle Devonian (D.J. Tempelman-Kluit, personal communication, 1977). Unfortunately, most of the collections are of long ranging fauna whose age was not precisely determined. The dolomite is most likely Late Silurian to Middle Devonian, but possibly ranges into the Middle Silurian.

Stratigraphic Relations and Depositional History of the Siluro-Devonian Assemblage

The stratigraphic relations of Siluro-Devonian strata are shown in Figure 10. Thickness changes of the graptolitic shale (Op) (0-300 m) and meagre faunal evidence indicate the Silurian siltstone (Ss) rests disconformably on the shale and, 6 km east of Indigo Lake, above Cambro-Ordovician slate (uꞒOp1). Graptolite collections from the shale in Pelly Mountains collectively span the Ordovician so that in some places, as near Ragged Peak where this shale is thickest and gradational with the siltstone unit, this sub-Silurian disconformity is minor or absent.

At Ragged Peak a prominent angular unconformity (Fig. 11) separates the dolomite and siltstone units yet elsewhere, as at 5 km southeast of Indigo Lake, their contact is gradational. In the latter instances the unconformity may be absent or unrecognized within the dolomite (see Fig. 10). The age of the unconformity is uncertain, but a latest Silurian to earliest Devonian age fits available fossil evidence. Dolomite beneath the sub-Devonian unconformity is a facies equivalent of the upper part of the Silurian siltstone unit, the respective parts of these units overlapping in age.

The dolomite and siltstone units are overlain with marked disconformity by Upper Devonian and Mississippian "black clastic" shale.

The shallow water Siluro-Devonian assemblage defines a northwest-trending shallow marine platform called the Cassiar Platform. Relief that may have remained from the irregular deposition of Cambro-Ordovician volcanic and pelitic rocks was likely beveled by pre-Silurian erosion. The widespread occurrence and uniform character of the Silurian platy siltstone indicates uniform deposition over a large area. Relatively shallow water deposition is suggested by the light colour of the siltstone and the local interbeds of light coloured dolomite of probable shallow water origin. Their fine parallel lamination indicates deposition in quiet water and their few fossils, an environment inhospitable to most marine life. Bioturbation was by soft-bodied organisms without preservable hard parts. Acid to intermediate flows and tuffs intercalated with the siltstone record local episodes of volcanism. In the Late Silurian the depositional regime began to change. Siltstone accumulated at the same time that shallow water carbonate was deposited elsewhere. Following local uplift and erosion, carbonate deposition continued over the area.

Features of the carbonates which indicate deposition in a relatively shallow water, restricted environment include their light colour, lack of argillaceous material, dolomitic nature, relatively sparse fauna, local mud cracks and rip-up clasts and fine algal (?) lamination. Quartz sand and silt suspended in the carbonate or concentrated as laminae may have been wind-blown. In the southwest, thick quartz arenite units with locally abundant crossbedding may represent offshore bars or shoals. In the northeast, near Stick Mountain, the dolomite contains much thin bedded argillaceous limestone interpreted to represent shaling out from Cassiar Platform into Kechika Trough to the northeast. The dolomite breccia may be solution collapse deposits related to the sub-Devono-Mississippian unconformity or to the solution of evaporites. Alternatively they may be local carbonate debris flows.

Quartz and muscovite in the Silurian siltstone were derived from a crystalline terrane, but the location of the source area and mode of transport are not known. Much of the widespread quartz silt and sand in the dolomite was windblown, and some of this probably contributed to the thick units interpreted as offshore bars. However, paleocurrent data are lacking, and the ultimate source area of the quartz is unknown.

The distribution of rock types in the dolomite unit indicates facies changes across Cassiar Platform from southwest to northeast from quartz arenite to dolomite to argillaceous limestone.

Correlation of the Siluro-Devonian Assemblage

During the Silurian and Devonian, deposition of shallow water carbonate and siltstone was widespread on Cassiar Platform. In McDame map area (Gabrielse, 1963; 1967a, Table 1), Silurian and Devonian graptolitic siltstone, dolomite, and quartz sandstone of the Sandpile Group have facies relations like those of Siluro-Devonian strata in the Indigo Lake area. Some strata of the dolomite unit may be correlative with the dolomite of the Middle Devonian McDame Group which overlies the Sandpile Group unconformably. Correlative carbonate strata extend northward through Wolf Lake (units 5 and 6 of Poole et al., 1960), Quiet Lake (unit 4 of Wheeler et al., 1960), Tay River (unit 4 of Roddick and Green, 1961b) and Glenlyon (Askin Group of Campbell, 1967) map areas. On northern Cassiar Platform, northeast of Tintina Trench, correlative carbonate strata are found in Watson Lake (units 5 and 6 of Gabrielse, 1967b), Frances Lake (unit 4 of Blusson, 1966), Finlayson Lake (unit 4 of Wheeler et al., 1960) and southernmost Sheldon Lake (unit 4 of Roddick and Green, 1961a) map areas. In Tuchodi Lakes map area on MacDonald Platform correlative strata comprise the carbonate and quartzite of the Silurian Nonda and Devonian Muncho-McConnell, Wokkpash, and possibly Stone formations (Taylor and Stott, 1973).

The unconformity beneath the siltstone unit may be the same as that found in most of the northern Cordillera between latest Ordovician or Silurian rocks and Middle Ordovician and older strata (Gabrielse, 1967a, p. 276). The poorly dated unconformity of probable sub-Devonian age is likely correlative with the sub-Devonian unconformity in Tuchodi Lakes (Taylor and Stott, 1973) and McDame (Gabrielse, 1963; 1967a, Table 1) map areas.

Devono-Mississippian Assemblage

Acid Volcanics (uDMv)

Acid volcanic flows and tuffs and intercalated shale, at least 1700 m thick, are exposed in a northwest-trending belt centred on Mount Vermilion. They overlie Upper Silurian to Middle Devonian dolomite but are not in stratigraphic contact with younger rocks.

The volcanics weather dark grey or rust with splashes of brilliant red and orange gossan around local concentrations of pyrite. Individual flows and pyroclastic beds are not distinguished and primary textures are rare. Shale like that of the Devono-Mississippian "black clastic" unit is intercalated with the volcanics, particularly near the base, and makes up about 10 per cent of the thickness of the unit.

The tuffs weather to rubbly talus and have a tendency to shatter into small fragments when broken. They are drab, homogenous, tan, brown, or green rocks composed of subangular to subrounded aphanitic volcanic fragments and sparse feldspar and quartz crystals (Fig. 12, 13). Clast size is generally less than 1 cm but ranges to 5 cm. Fragments are the same colour as the rock, so that fragmental textures are generally poorly displayed. More than 60 per cent of the unit consists of tuffs.

The flow-rocks are aphanitic, usually tan, grey, green or pale red and break cleanly along fresh surfaces. Small amygdules and feldspar phenocrysts are seen rarely. These rocks consist of up to 20 per cent anhedral to subhedral orthoclase phenocrysts, up to 5 mm long, in a sericitized finely microcrystalline matrix, or less commonly in a matrix of smaller interlocking Carlsbad-twinned orthoclase laths. Quartz and finely microcrystalline material are interstitial to the laths. Quartz as rare phenocrysts and recognizable interstitial fill constitutes less than 10 per cent. Nonporphyritic rocks composed of only the two matrix types are common. Mafic minerals are uncommon, although orthopyroxene was seen in one sample. Opaque minerals (up to 15 per cent of a sample) include a few per cent pyrite and translucent red to black iron oxide. Chlorite is present rarely but patches of carbonate constitute up to one tenth of the rock. Small amygdules of quartz and/or calcite are rare.

Massive grey-green chert, similar to the chert of the Mississippian chert unit was found at scattered localities interbedded with the flow rocks.

Ten unweathered specimens were analyzed for 10 major elements and sulphur (Table 4). The analyses show wide scatter on both AFM and alkali-silica diagrams (Fig. 8) and on the latter plot in both the alkaline and subalkaline fields (Irvine and Baragar, 1971). They show affinities to Irvine and

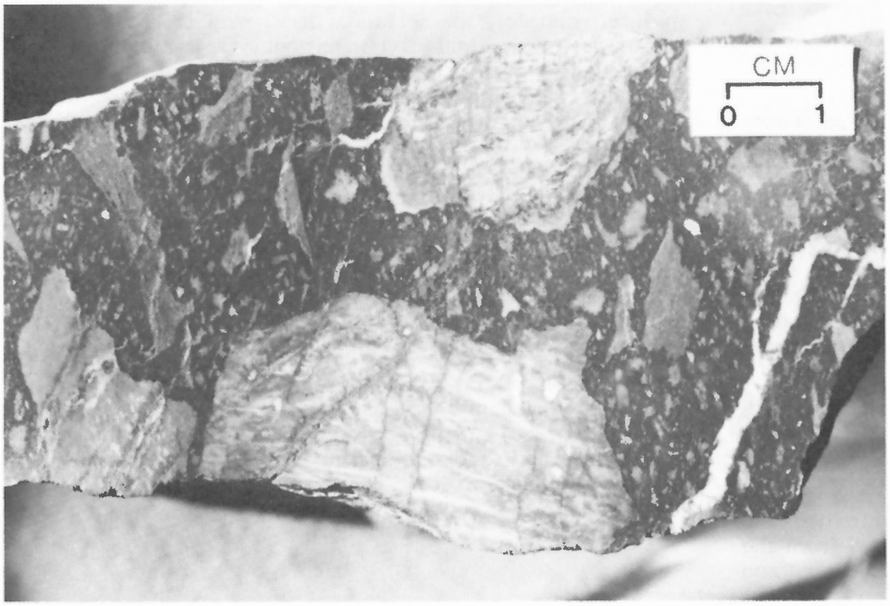


Figure 12. *Volcanic breccia of the acid volcanic (uDMv) from 7 km northwest of Mount Vermilion. This is the coarsest fragmental rock seen in the unit. Angular aphanitic pale green volcanic fragments are in a dark brown fine-grained matrix. (GSC 203586-F)*

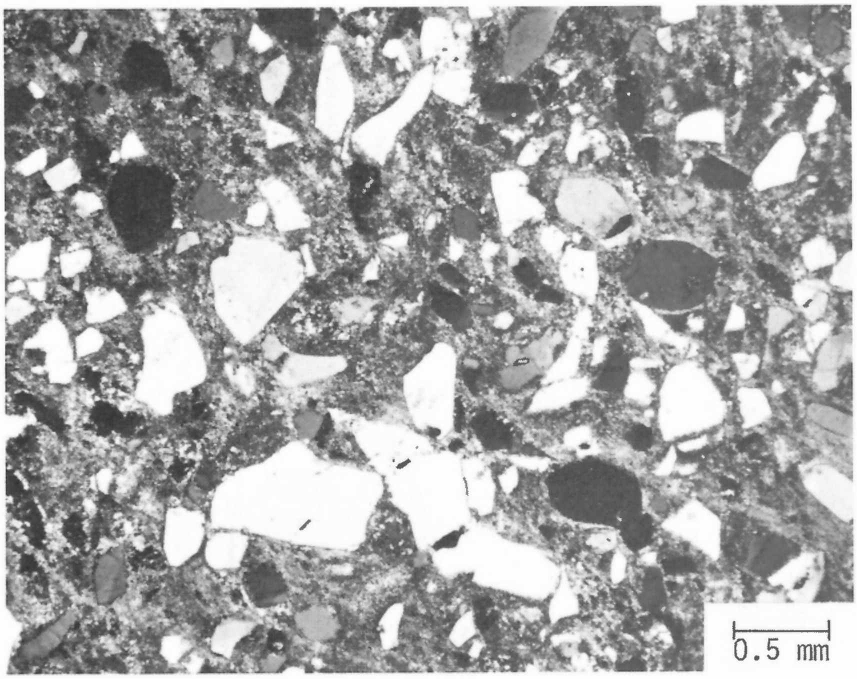


Figure 13. Photomicrograph (crossed nicols) of a rare quartz crystal tuff from the acid volcanic (uDMv) near Mount Vermilion. Angular quartz crystal fragments are set in a finely microcrystalline siliceous matrix. (GSC 203586-G)

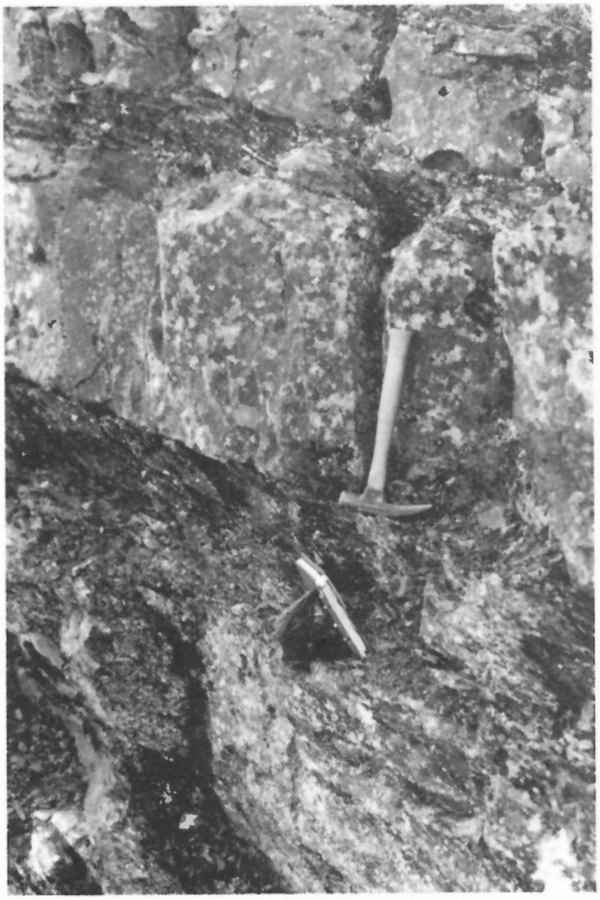


Figure 14. *Interbedded turbiditic greywacke and slate of the "black clastic" (uDMps) 4 km south-southwest of peak 6656 feet. The greywacke beds are size-graded from coarse-grained at their bases to fine-grained at their tops. The notebook is aligned parallel to the slaty cleavage in the slate. The greywacke lacks cleavage. (GSC 203586-H)*

Baragar's (1971) typical rhyolite and trachyte but have much higher potash, are very low in soda, and have slightly higher magnesia and lime. They are chemically distinct from Cambro-Ordovician diabase and basalt.

Fossils were not found in the acid volcanic unit and it is dated on its stratigraphic relations. It overlies Middle (?) Devonian carbonate unconformably (?) and is intercalated with shale like that of the "black clastic" unit. In Quiet Lake map area to the west, limestone within the acid volcanics has yielded Late Mississippian (Viséan) conodonts (D.J. Tempelman-Kluit, personal communication, 1977).

"Black Clastic" unit (uDMps)

Slate, greywacke and chert-pebble conglomerate, comprising a unit about 500 m thick, are exposed over large areas in the southwest half of the map area, in a northwest-trending belt near Stick Mountain, and near Mount Resistance. Most of the unit is slate, but within the top 80 m greywacke and conglomerate form an estimated 40 per cent and 5 per cent respectively. Near Mount Placid conglomerate and greywacke occur near the base of the unit.

The slate is black, siliceous, and recessive, and forms black weathering scree. It is generally well-cleaved, and the faint colour lamination in brown that is seen rarely, marks bedding. Slate at the base of the unit is like that seen stratigraphically higher where it is interbedded with the coarser clastics.

Outcrop of the greywacke is rare and its detailed distribution within the uppermost part of the unit is not known. Generally individual beds and "bundles" of beds form thin, sheet-like units within the slate. Rare good exposures, as at Mount Placid and 4.5 km south-southwest of peak 6656 show that the greywacke is rhythmically interbedded with slate in parallel-laminated beds several centimetres to one metre thick, or in graded beds as much as one metre thick (Fig. 14). Small-scale crosslamination is rare. These features suggest that at least some of the greywacke was deposited as density flows. Conglomerate was probably deposited by the same mechanism. Modal analyses of the sandstone by thin section point count of 300 points per slide

Table 4

Chemical analyses of acid volcanics

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
SiO_2	58.93	58.14	61.53	56.42	66.92	67.80	67.90	65.75	59.50	67.90	63.08	56.42 - 67.90	60.7	73.23
Al_2O_3	10.2	22.7	17.8	16.1	14.6	12.9	11.25	13.50	16.15	13.80	14.90	10.2 - 22.7	20.5	14.03
Fe_2O_3	0.5	<0.1	0.2	5.6	0.6	2.2	0.9	0.4	<0.1	0.9	1.1	<0.1 - 5.6	2.3	0.60
FeO	3.6	1.7	3.1	1.1	4.3	0.1	6.8	2.2	5.0	4.1	3.2	0.10 - 6.8	0.4	1.70
MgO	3.25	0.20	0.10	0.64	1.78	0.65	1.05	1.80	1.00	1.27	1.17	0.10 - 3.25	0.2	0.35
CaO	6.80	0.35	0.80	2.69	1.76	3.60	0.76	4.00	2.00	0.95	2.37	0.35 - 6.80	1.4	1.32
Na_2O	0.50	<0.50	<0.50	2.52	0.95	<0.50	<0.50	<0.50	2.12	0.65	0.67	<0.50 - 2.52	6.2	3.94
K_2O	6.40	14.0	12.1	8.75	3.34	8.05	3.85	6.52	7.87	4.52	7.54	3.34 - 14.0	6.7	4.08
TiO_2	0.49	0.78	1.09	0.73	0.78	0.62	0.30	0.30	0.38	0.31	0.58	0.30 - 1.09	0.5	0.24
MnO	0.13	<0.01	<0.01	0.14	0.10	0.04	0.22	0.12	0.20	0.13	0.11	<0.01 - 0.22	0.2	0.02
P_2O_5	0.07	0.37	0.38	0.14	0.12	0.07	0.07	0.07	0.10	0.05	0.14	0.05 - 0.38	0.03	0.05
L.O.I.	10.8	2.5	3.2	4.7	4.7	4.4	6.3	7.1	5.8	5.6	5.51	2.5 - 10.8	-	-
Total	101.67	100.74	100.30	99.53	99.95	100.43	99.40	101.76	100.12	100.18	100.40	99.53 - 101.67	-	-
S	0.15	1.25	3.45	0.04	0.08	0.03	0.15	0.15	0.28	0.27	0.59	0.03 - 3.45	-	-
Mode (Visually Estimated)														
Plagioclase	-	-	-	tr	-	-	-	-	-	-				
Orthoclase	70	10	80	79	tr	50	-	-	60	-				
Orthopyroxene		4	-	-	-	-	-	-	-	-	-			
Carbonate	-	-	tr	1	tr	10	3	7	7	3				
Opaque	1	5	7	15	tr	5	tr	tr	tr	tr				
Quartz	-	-	-	5	tr	7	10	3	-	10				
*Indeterminate		25	85	13	-	100	28	87	90	33	87			

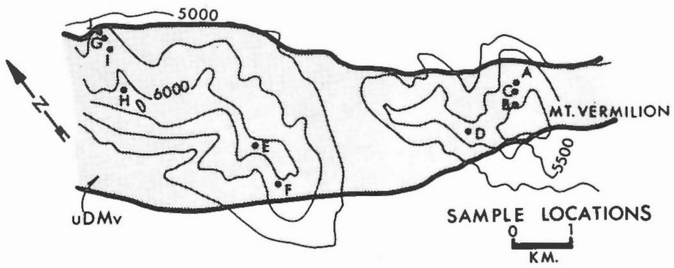
*Indeterminate – includes fine-grained minerals; largely alteration products, for which mode cannot be reliably estimated.

tr = trace

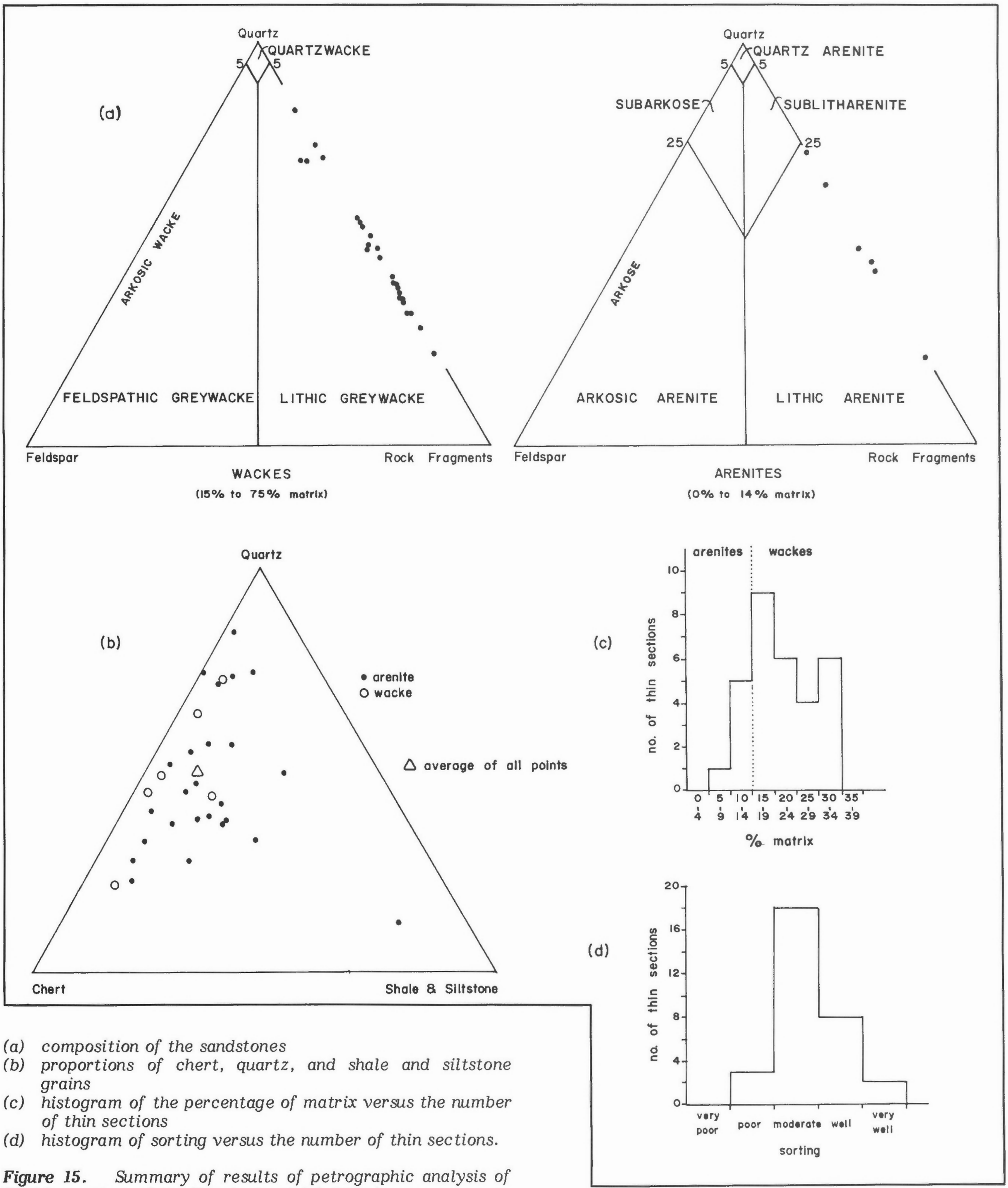
A to J Analyses of acid volcanic rocks of unit uDMv; all are of specimen of flow-rocks with exception of E which may be a fine-grained lithic tuff.
K Average of analyses A to J
L Range for analyses A to J
M Typical trachyte (Irvine and Baragar, 1971)
N Typical rhyolite (Irvine and Baragar, 1971)

Analyst – F. Dunphy, Queen's University, Ontario;
FeO by Geological Survey of Canada

Method – X-ray fluorescence; FeO by titration

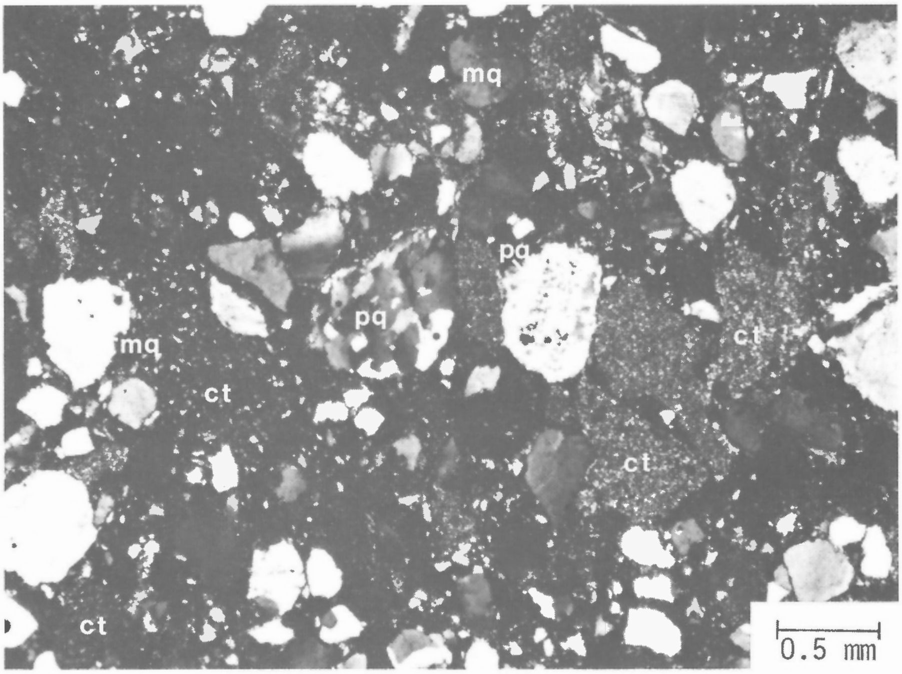


SAMPLE LOCATIONS

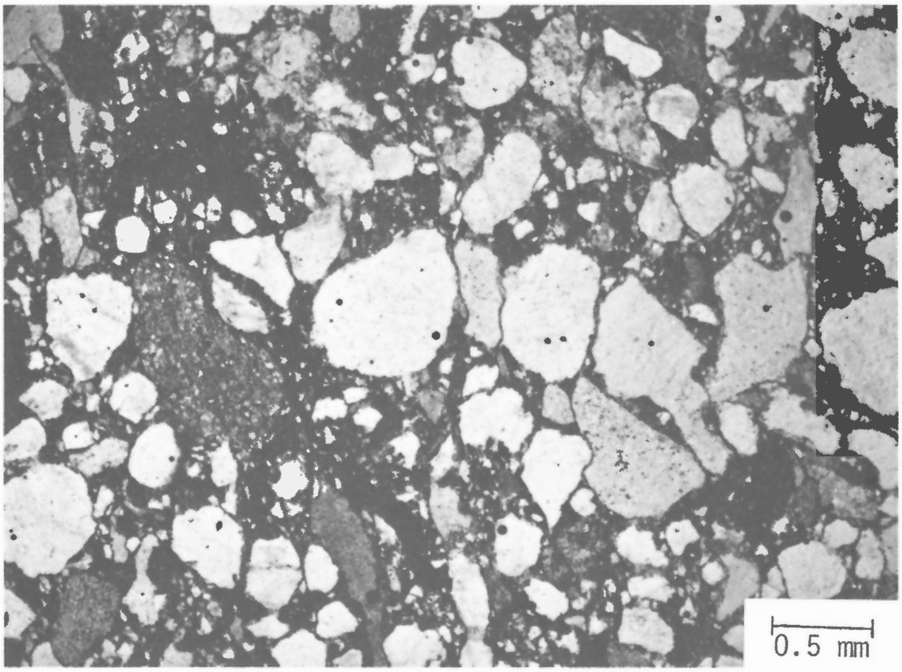


(a) *composition of the sandstones*
(b) *proportions of chert, quartz, and shale and siltstone grains*
(c) *histogram of the percentage of matrix versus the number of thin sections*
(d) *histogram of sorting versus the number of thin sections.*

Figure 15. *Summary of results of petrographic analysis of 30 thin sections of the "black clastic" (uDMps).*



(a) crossed nicols (GSC 203586-I)



(b) plane-polarized light (GSC 203586-J)

Figure 16. *Photomicrographs of typical moderately sorted "black clastic" (uDMps) lithic greywacke containing monocrystalline quartz (mq), polycrystalline quartz (pq) and chert (ct) in a dark argillaceous matrix.*

are summarized in Figure 15. Feldspar modes were checked by comparison with stained hand specimens. Sorting was determined by comparison with the sorting images of Pettijohn et al. (1973).

The sandstone is moderately well-sorted lithic greywacke consisting of monocrystalline and polycrystalline quartz, chert, shale clasts, feldspar, and muscovite in a matrix of fine clastic and opaque material (see Fig. 16). Microcline and twinned plagioclase comprise the feldspars. Polycrystalline quartz makes up less than 9 per cent. The amount of matrix shows little correlation with the degree of sorting possibly because of the difficulty in distinguishing deformed lithic fragments from matrix, the difficulty in recognizing small chert grains within the matrix, and the effects of the alteration of fine grained particles and the corrosion of grain boundaries during diagenesis. Most grain contacts are of the long type (Pettijohn et al., 1973, p. 91), but some quartz-quartz contacts are sutured. Grains range from rounded to subangular. Some quartz grains which show grain boundaries through overgrowths are well-rounded. Grain sphericity ranges from moderate to high and chert tends to have a slightly lower sphericity than quartz. The maximum grain size of both monocrystalline and polycrystalline quartz grains is about 2 mm. The grain size of chert ranges from the grades in the greywacke to pebbles and cobbles in the conglomerate. Bluish opalescent quartz can be observed in some hand specimens.

The chert pebble conglomerate is confined to isolated, resistant, black weathering exposures in the southwest half of the map area. Good outcrops occur on the hill 2 km southwest of Mount Johnson, and near the creek 2 km west of Mount Placid. Beds of conglomerate with both top and bottom contacts exposed were not seen. Conglomerate thickness estimated from the size of exposures is at least 30 to 60 m.

The conglomerate is homogenous, massive, and ungraded, but locally shows a parallel alignment of tabular-shaped clasts. It is poorly to moderately sorted and consists of chert pebbles and granules in a sand-size matrix of chert and quartz. The matrix is like the lithic greywacke but it has a lower argillaceous component. The conglomerate is well indurated because fragments interpenetrate to form long grain contacts and quartz overgrowths around matrix quartz.

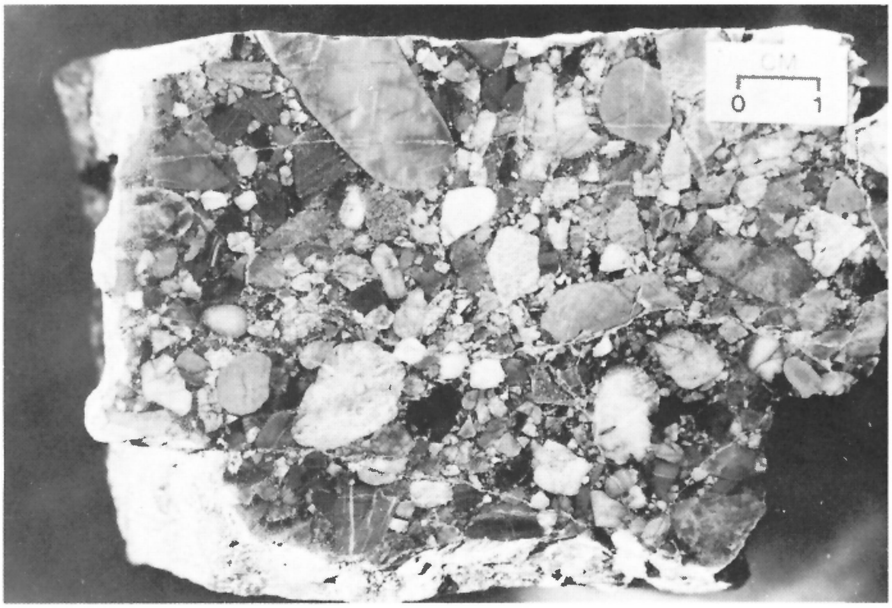


Figure 17. *Sawn and polished surface of poorly sorted chert-pebble conglomerate of the "black clastic" (uDMps). (GSC 203586-K)*

Chert clasts are black, grey, orange, white or turquoise on fresh and weathered surfaces. On sawn surfaces they appear mottled because of variable grain size within them (Fig. 17). Clasts are generally subrounded or rounded and their sphericity is typically moderate to high. Maximum fragment size is about 20 cm but the average is about 1 cm. Large clasts are rare; they are well rounded, and have a high sphericity.

A small proportion of the clasts, principally those of large diameter, are very fine grained to medium grained quartz arenite. The medium grained varieties have a few per cent scattered very coarse sand-size to small granule-size grains of bluish opalescent quartz. Such clasts include rounded monocrystalline and polycrystalline quartz, small amounts of twinned fresh plagioclase, and detrital muscovite, all of which are found in similar proportion in the greywacke.

No fossil remains were found in the "black clastic" unit. It lies stratigraphically below the chert unit of Late Mississippian (Viséan) age and unconformably overlies dolomite (uSDc) of probable Late Silurian to Middle Devonian age. It is probably Upper Devonian to Lower Mississippian.

Chert (Mt)

Argillaceous chert forms a distinctive resistant unit that is well exposed in the southwest half of Indigo Lake area, and in the northeast part of the area at Mount Resistance. The unit ranges in thickness from zero 4 km northeast of Indigo Lake, where the Carboniferous and Upper Triassic shale-siltstone unit directly overlies the "black clastic" unit, to at least 300 m about 3 km northwest of Indigo Lake where the top is not exposed.

The chert weathers to a bright orange talus of small angular chips. Fresh surfaces are green, grey-black or brown. The chert is well bedded in beds 5 to 10 cm thick with shaly partings, and rarely, faint colour lamination. Cleavage is locally well developed where the rock is argillaceous.

The chert is finely microcrystalline quartz, with up to 20 per cent quartz and feldspar silt, and lesser amounts of carbonate, sericite, and barite. Silt grains, less than 25 μm in diameter, are evenly distributed but may be concentrated in laminae. Carbonate constitutes 10 per cent of the rock and is evenly distributed as tiny patches and rhombs. Barite occurs as small irregular-shaped grains, and sericite as minute flakes. Rare spheres, up to 0.15 mm in diameter composed of barite or finely microcrystalline quartz and free of silt and sericite may have been radiolaria.

Three km west of Mount Johnson nodular and bedded barite occurs at the base of the unit. Unevenly distributed nodules, up to 23 cm in diameter and a bed of relatively pure barite 1.5 m thick, are restricted to a stratigraphic interval of about 25 m. The nodules are fetid on breaking, and black on fresh surfaces which reveal a radiating texture of coarse barite blades. The matrix replaced by the barite is poorly bedded siliceous argillite, a rock transitional between slate and chert. The bedded barite weathers grey but is black and finely crystalline on fresh surfaces.

No fossils were found in the chert. Carboniferous or Permian brachiopods and a trilobite (see Appendix I) were found in strata overlying the chert. In Quiet Lake map area the age of the chert unit has been bracketed by conodonts as Late Mississippian (Viséan) (D.J. Tempelman-Kluit, personal communication, 1977).

Stratigraphic Relations and Depositional History of the Devono-Mississippian Assemblage

Stratigraphic relations of Devono-Mississippian strata are shown schematically in Figure 18. The assemblage is disconformable on platy siltstone (Ss) and dolomite (uSDc) and 4.5 km east-southeast of Indigo Lake, on the tuffaceous slate (uЄOpl). Vertical faults truncated by the unconformity occur 3.5 km south-southeast of Indigo Lake and 4 km west of Stick Mountain. The chert (Mt) and the "black clastic" (uDMps) are conformable and shales of the latter intertongue with the acid volcanics (uDMv). The volcanics rest with sharp disconformable (?) contact on the dolomite unit. Carboniferous to Triassic siltstone and shale (C₮ps) disconformably overlie the chert and locally the "black clastic" unit (uDMps).

In Middle to Late Devonian time, subsidence and local block faulting terminated platform carbonate deposition and led to erosion of the uplifted blocks. Further subsidence allowed deposition of dark marine shales during the Late Devonian and Early Mississippian and contemporaneous volcanism produced local accumulations of acid tuffs and flows intertongued with the shales. The clastic influx prohibited carbonate deposition and Cassiar Platform continued to sink. Detritus carried by density currents was

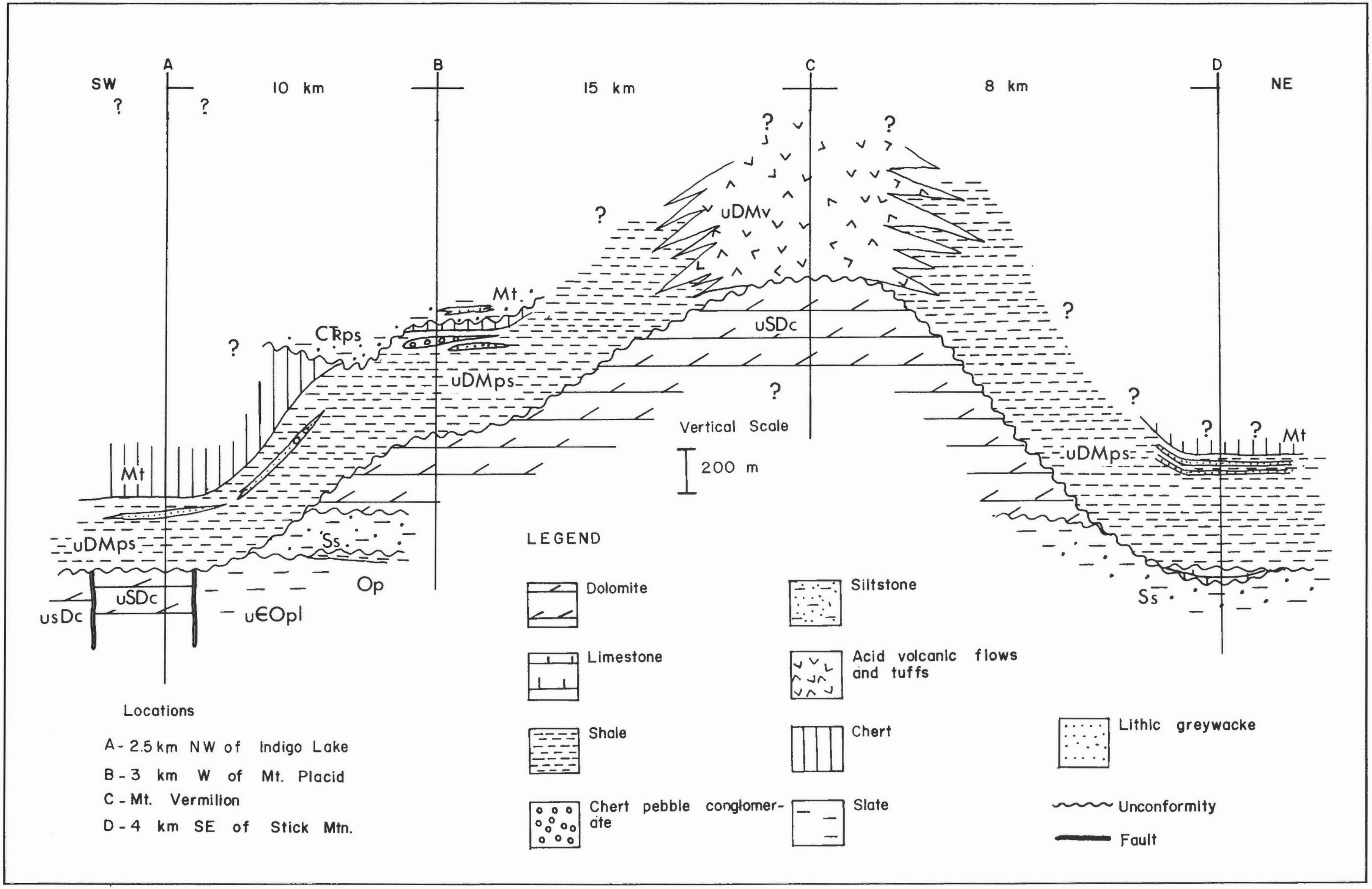


Figure 18. *Schematic diagram of stratigraphic relations of Devono-Mississippian units.*

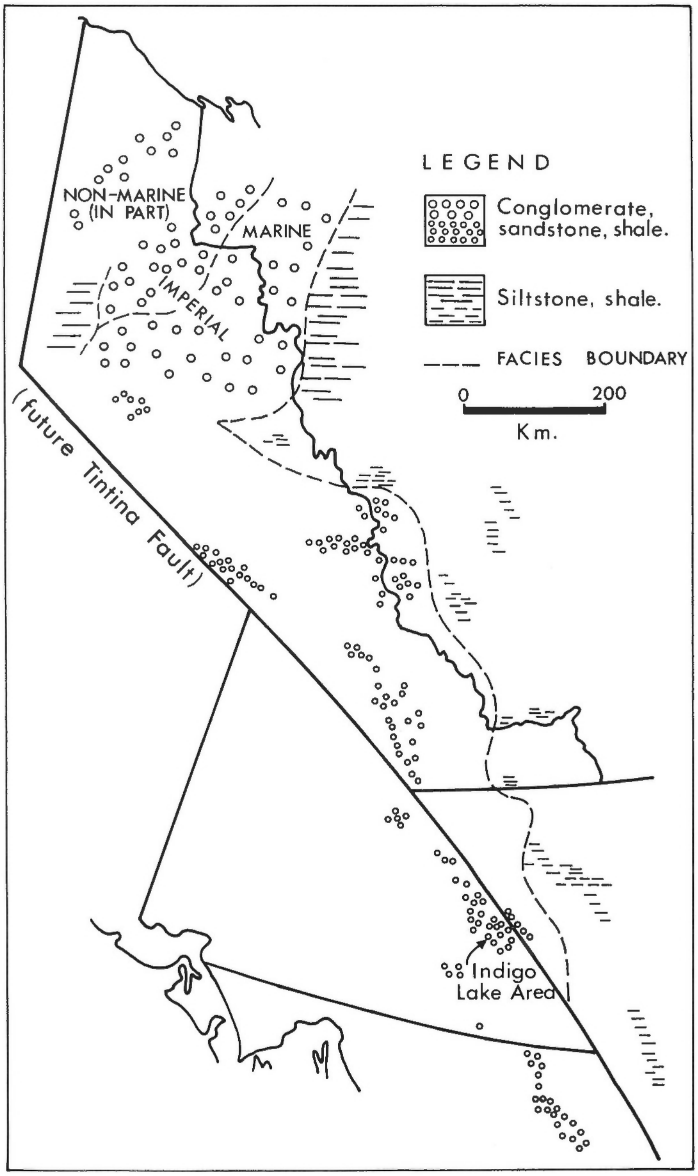


Figure 19. *Distribution of Upper Devonian and Mississippian clastic rocks in Yukon Territory and northern British Columbia after restoring 450 km of dextral strike slip along Tintina Fault. Data for the northern Yukon (large symbols) is from Lenz (1972, Fig. 12). Data for other areas are from published and open file maps (1:250 000) of the Geological Survey of Canada.*

deposited as greywacke and chert-pebble conglomerate. Deposition of clastic detritus waned and argillaceous chert, possibly genetically associated with acid volcanism, was deposited.

Provenance and Regional Significance of the "Black Clastic" unit

The composition of the greywacke and chert-pebble conglomerate indicate they were derived from bedded chert. The monocrystalline quartz, polycrystalline quartz, plagioclase and microcline are derived from gritty siliceous sandstone, possibly that of late Windermere age, which includes these constituents. Shale fragments derived from shale which was interbedded with the chert or sandstone at the source.

Figure 19 shows the distribution of Upper Devonian and Lower Mississippian clastic strata in the Yukon Territory and northern British Columbia after 450 km of dextral strike-slip along Tintina Fault is removed. The strata comprise two clastic wedges which, although time equivalent and partly overlapping, were derived from distinctly different sources. In northernmost Yukon a clastic wedge (Imperial Formation), progressively finer grained to the southeast, was derived from a northwestern source probably oceanward of Alaska and northern Yukon Territory (Lenz, 1972; Churkin, 1969). The clastic wedge of northern British Columbia and southern and central Yukon is finer grained in the northeast and east and transgresses the earlier formed carbonate platforms. Although detailed descriptions are lacking, these latter clastics are largely shale, with subordinate quartz and chert siltstone, sandstone and conglomerate. The extent and general easterly fining of the detritus in British Columbia and southern Yukon suggested to Gabrielse (1967a, 1976) that it was derived from a westerly source and that it signifies major uplift in the western part of the northern Cordillera. Others have suggested (Gabrielse, 1976; Tempelman-Kluit and Blusson, 1977) that the clastics were derived from within Selwyn Basin largely from the chert-rich Ordovician to mid-Devonian Road River Formation.

Lack of paleocurrent data preclude direct determination of the source of the "black clastic" unit in the Indigo Lake area. However, taking into consideration the 450 km dextral strike-slip along Tintina fault, the area was, during Devono-Mississippian time, adjacent to a part of northern Rocky Mountains where a southwesterly source for correlative and similar clastics has been demonstrated (Gabrielse and Dodds, 1977). The reconstruction in Figure 19 shows that during sedimentation possible source areas in Selwyn Basin were far removed from the Indigo Lake area.

Correlation of the Devono-Mississippian Assemblage

As discussed above, correlative Upper Devonian and Mississippian clastic rocks are widespread in the northern Cordillera. Correlative strata in northeastern British Columbia, as in Tuchodi Lakes map area (Taylor and Stott, 1973), comprise the shale of the Besa River Formation. Chert like that of the Indigo Lake area is reported at many places but is not separated from the clastic rocks. In Tuchodi Lakes map area (Taylor and Stott, 1973) the western facies of the Prophet Formation is chert and may be equivalent to the chert unit. Acid volcanics similar to those described here occur in Quiet Lake map area (Tempelman-Kluit et al., 1976), but are not known elsewhere.

The unconformity beneath the "black clastic" unit is represented in some areas, as in Kechika and Rabbit River map areas (Gabrielse, 1962b, 1962c), but not in Tuchodi Lakes map area (Taylor and Stott, 1973). Because this unconformity reflects local uplift and erosion associated with block faulting of a generally subsiding platform some areas were not eroded but received sediment continuously.

Carboniferous to Triassic Assemblage

Shale-Siltstone (CTrps)

Dark brown weathering shale, siltstone, very fine grained sandstone, limestone and minor chert and argillite is exposed within fault-bounded panels southeast and east of Ragged Peak, and over large areas in the southwestern part of the map area. The estimated thickness of the unit is 500 m. About 3 km southwest of Mount Placid these rocks are 750 m thick but there the unit may be structurally thickened.

Figure 20. *Well bedded thin bedded shale and siltstone of the shale-siltstone (CTRps) 5 km southwest of Mount Lewis where it lies beneath mylonite of the allochthon. (GSC 203586-L)*

In the southwestern part of the map area the rocks are recessive, brownish weathering, well bedded calcareous siltstone and very fine grained sandstone in beds to 10 cm thick interbedded with shale (Fig. 20). Fine planar parallel lamination is common but in places is obliterated by bioturbation; locally, both horizontal and vertical burrows are seen. Small-scale planar crosslamination and scour and fill structures occur locally in silty and sandy beds. Parallel laminated beds of grey weathering, black silty argillaceous micrite less than 30 cm thick are abundant near the bottom of the unit. Towards the top siltstone and limestone are less abundant and shale predominates.

In the northeastern part of the map area, the unit is more resistant weathering and contains less shale than in the southwest. Beds are thicker (about 1 m) and small-scale crosslamination and scour are common.

The grey to black siltstone and fine grained sandstone are moderately sorted arenite to wacke composed of quartz and minor twinned plagioclase, muscovite, biotite, microcline, chert (?) and traces of zircon and tourmaline. Quartz occurs as interlocking grains, the original grain boundaries having been destroyed by pressure solution and reprecipitation of quartz. Where original grain shape is discernible quartz grains have moderate to low sphericity, and are predominantly angular. Mica flakes are aligned with bedding. The matrix is a mixture of finely microcrystalline and opaque material and tiny flakes of mica. Calcite, which cements the rock and replaces both matrix and quartz, occurs in various amounts.

Near the top of the unit 4 km south of Mount Placid, are poorly bedded, thin bedded chert and argillite. Similar thin bedded, rusty weathering argillite is found 6.5 km southeast of Ragged Peak.

One collection of pelecypods, and one of ammonoids (Appendix I) from the shale-siltstone unit indicate a Late Triassic (Norian) age. Another collection of brachiopods and a trilobite from an isolated outcrop is Carboniferous or Permian. A fourth collection of a coral and ammonoids is Ordovician to Permian. Numerous conodont collections were made from the unit (Appendix I) and these indicate the rocks are Late Triassic.

The unit is considered mainly Late Triassic (Karnian and Norian) but locally includes upper Paleozoic strata that are thin, lithologically indistinguishable, and not separately mapped.

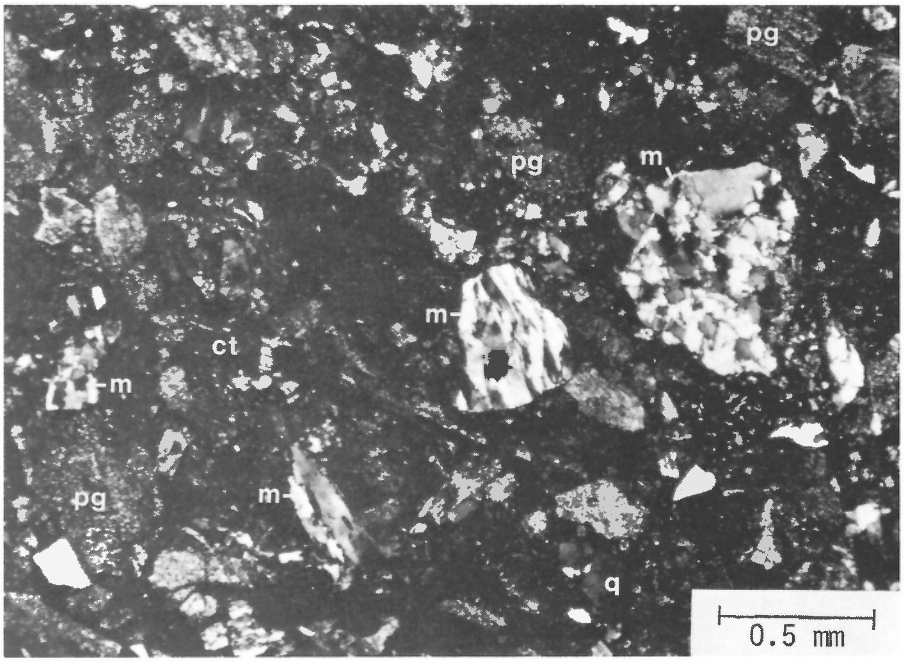
Stratigraphic Relations and Depositional History of the Carboniferous to Triassic Assemblage

Sediments of Early and Middle Triassic age have not been recognized in Pelly Mountains (D.J. Tempelman-Kluit, personal communication, 1977). This and the local thickening or absence of underlying chert suggests Upper Triassic strata rest disconformably on underlying units and that they may represent a generally transgressive sequence. Isolated occurrences of Paleozoic siltstone may be erosional remnants. The overlying Jurassic and (?) Cretaceous greywacke-tuff unit may be unconformable.

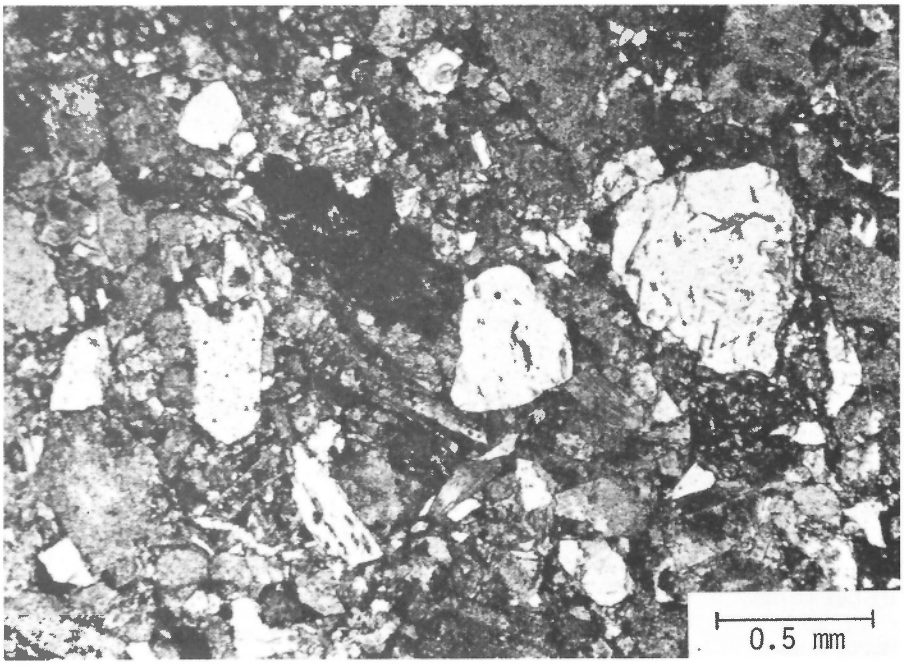
The preponderance of shale and siltstone, thin beds of argillaceous limestone, and sparse marine fossils indicate deposition in a quiet marine environment which supported few marine organisms. Minor thin bedded chert near the top of the unit was deposited under local (?) conditions of low clastic influx. Thicker beds, coarser grain size and abundant crosslamination in the northeastern part of the area suggest deposition in more turbulent and shallower (?) water. Low rounding of the clastic detritus indicates it is probably first cycle sediment and the sand composition suggests it was derived from a crystalline source area.

Correlation of the Carboniferous to Triassic Assemblage

The Carboniferous to Triassic siltstone and shale of the Indigo Lake area are not widespread. Equivalent strata occur in Quiet Lake map area (Tempelman-Kluit et al., 1976), and isolated occurrences, distinguished from older rocks because they have Late Triassic fossils, occur in Tay River (Roddick and Green, 1961b), McDame (Gabrielse, 1963), and Watson Lake (Abbott, 1977) map areas. Argillite, siltstone, sandstone, greywacke, conglomerate, and volcanic rocks in Teslin map area (Mulligan, 1963; units 9 and 10) may be partly correlative. The few Mississippian, Pennsylvanian and Permian occurrences in Pelly Mountains, including the Indigo



(a) crossed nicols (GSC 203586-M)



(b) plane-polarized light. (GSC 203586-N)

Figure 21. *Photomicrographs (crossed nicols) of poorly sorted feldspathic greywacke (JKsv) containing quartzose metamorphic rock fragments (m), highly altered plagioclase (pg), chert (ct), and quartz (q) in a dark argillaceous matrix. Metamorphic rock fragments (mylonite) derive from the allochthon now thrust over the greywacke-tuff. The fragment near the centre of the photograph is composed of strained quartz.*

Lake area, are lithologically similar and likely correlative with the Stoddart and Kindle formations of Tuchodi Lakes map area (Taylor and Stott, 1973).

In northeastern British Columbia a northwest-trending belt of marine shale, siltstone and sandstone, which had a northeasterly source (Pelletier, 1965) ranges in age from Early to Late Triassic (Gibson, 1975). The Lower Triassic strata rest disconformably on Permo-Carboniferous chert. Before transcurrent movement along Tintina Fault these strata were close to those of the Indigo Lake area.

Jura-Cretaceous Assemblage

Greywacke-Tuff (JKsv)

Greywacke, tuff, and local dykes and plugs of quartz porphyry and andesite comprise a thin assemblage (JKsv) exposed in the southwest part of the map area above the shale-siltstone unit. The stratigraphic top is not exposed but the thickness ranges to about 350 m, the best and thickest exposures being 4 km southwest of Mount Lewis. Greywacke and tuff occur in subequal proportions but estimates are hindered by their similar weathering properties and poor exposure. Exposures are poorly bedded or massive, grey-weathering, and heavily weathered.

The sandstone is poor- to well-sorted medium- to very coarse-grained feldspathic or quartz greywacke with a small proportion of chert and volcanic rock fragments, and minor biotite, serpentinite, and metamorphic rock fragments (Fig. 21). Muscovite, hornblende and pyroxene occur rarely. Grain contacts are of the point type and grains are angular. The matrix comprises 15 to 30 per cent finely microcrystalline material, opaques and sericite. Quartz grains are sharply angular and commonly strained and cracked, having a "crushed" appearance. Carbonate occurs along the cracks and variably replaces matrix. Sericitized, locally zoned, lath-shaped sodic plagioclase is the dominant feldspar. Biotite, present in small flakes or thick books is altered to chlorite and opaques. The majority of lithic fragments are microcrystalline volcanic chert-like clasts, some with inclusions of idiomorphic feldspar. Metamorphic rock fragments of polycrystalline quartz and muscovite make up a few per cent and resemble the mylonite of the allochthon.

The tuff is poor- to well-sorted crystal tuff and crystal lithic tuff (Fig. 22). Most crystal fragments are quartz and sericitized sodic plagioclase, and minor amounts are orthoclase.

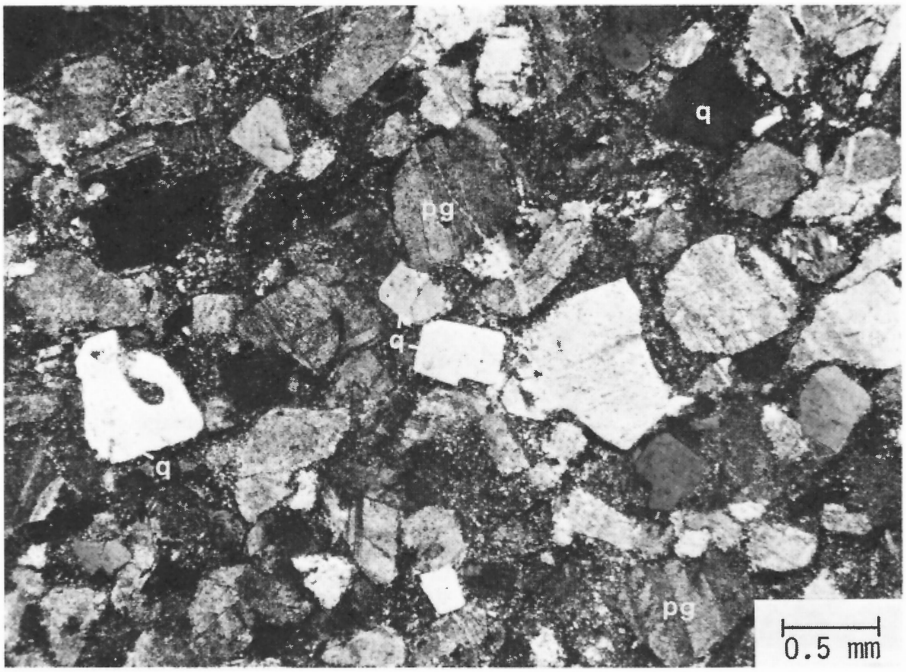


Figure 22. *Photomicrograph (crossed nicols) of well-sorted quartz feldspar crystal tuff (?) (JKsv), containing embayed and subhedral quartz (q), altered plagioclase (pg), and clear interstitial finely microcrystalline material. (GSC 203586-O)*

Some quartz occurs as subidiomorphic embayed crystals 5 mm across but most fragments are smaller and broken. The matrix is finely microcrystalline material present in variable amounts and variably replaced by patchy carbonate. Lithic fragments include dark green aphanitic volcanics and quartz-feldspar porphyry.

Southwest of Mount Lewis a rusty weathering, highly fractured white quartz porphyry flow (?), about 45 m thick, is intercalated with the greywacke and tuff, but is not persistent laterally.

A plug about 140 m in diameter, composed of equal proportions of andesite and medium grained hornblende diorite, lies 4 km southwest of Mount Lewis. The diorite invades the andesite, the latter forming blocky inclusions in the former. These rocks intrude the shale-siltstone unit but no contact metamorphic effects are seen 50 m distant from the intrusion. The hornblende diorite contains 30 per cent poikilitic hornblende, pleochroic in blue-green, and sodic plagioclase in twinned interlocking grains. The andesite contains altered interlocking sodic plagioclase, 10 per cent granular clinopyroxene, 15 per cent chlorite, and minor opaques and sphene.

A second plug, of grey-green andesite about 300 m in diameter, intrudes shale of the "black clastic" and shale-siltstone units 1 km north of Indigo Lake.

No fossils were found in the greywacke-tuff but it lies unconformably (?) above Upper Triassic shale and is therefore Late Triassic or younger. The age of the plugs is not known, but they intrude Upper Triassic shale and may be related to the volcanics intercalated with the greywacke.

Stratigraphic Relations and Depositional History of the Jura-Cretaceous Assemblage

The Upper Triassic or younger greywacke and tuff rest on Upper Triassic shale and siltstone unconformably (?). In a Late Triassic fault block 5 km northwest of Indigo Lake the contact is demonstrably unconformable, the greywacke resting on the "black clastic" Devono-Mississippian shale. A gently dipping thrust separates the greywacke-tuff from structurally overlying mylonite.

The assemblage accumulated in a marine (?) volcanic environment and the greywacke was eroded from the products of intermediate volcanism which produced contemporaneous crystal and crystal-lithic tuff, quartz porphyry, and andesite. Uplift by block faulting locally exposed older strata of the chert and "black clastic" units to erosion which contributed small amounts of nonvolcanic detritus to the sediments. The metamorphic rock fragments derive from the allochthon now tectonically above the greywacke-tuff unit. In addition to local sources, volcanic suites of the Anvil Allochthon may have furnished feldspar, minor mafic minerals and serpentine detritus.

Correlation and Regional Significance of the Jura-Cretaceous Assemblage

Strata correlative and similar to the greywacke-tuff unit are rare but are present in Tay River (Tempelman-Kluit, 1972, unit 10; personal communication, 1977) and Watson Lake (Gabrielse, 1967, unit 9c) map areas. Time equivalent Jurassic-Cretaceous strata in the Intermontane Belt are markedly dissimilar (Tempelman-Kluit, personal communication, 1977).

The occurrence of mylonite rock fragments and serpentine in the greywacke-tuff beneath the mylonite allochthon is regionally important, indicating that allochthonous sheets of the Anvil Allochthon were exposed and eroded before or during emplacement. The sandstone of the Jura-Cretaceous greywacke-tuff and rare correlative strata are remnants of what may have been a "clastic wedge" shed from the advancing allochthons.

Regional Stratigraphic Correlation – Summary

Regional stratigraphic correlations in Yukon and northern British Columbia must consider 450 km of dextral strike slip along Tintina Fault during the Late Cretaceous. Figure 23 shows the location of the Indigo Lake area and McDame, Kechika, and Tuchodi Lakes map areas in relation to regional tectonic subdivisions before strike-slip faulting and summarizes the correlations mentioned earlier. These correlations support other evidence of the timing and

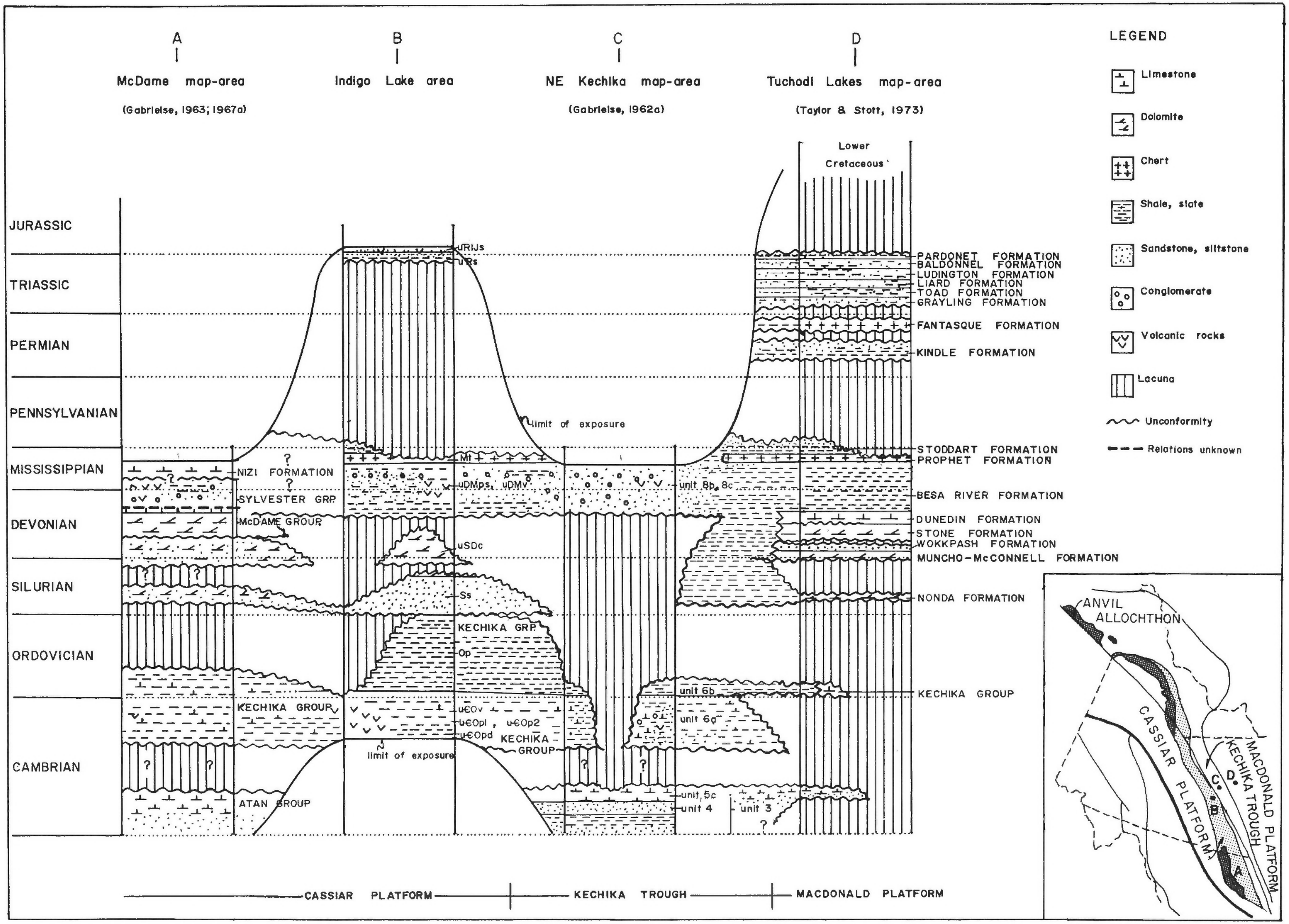


Figure 23. *Summary correlation chart for strata of the Indigo Lake areas with strata of McDame, northeastern Kechika, and Tuchodi Lakes map areas.*

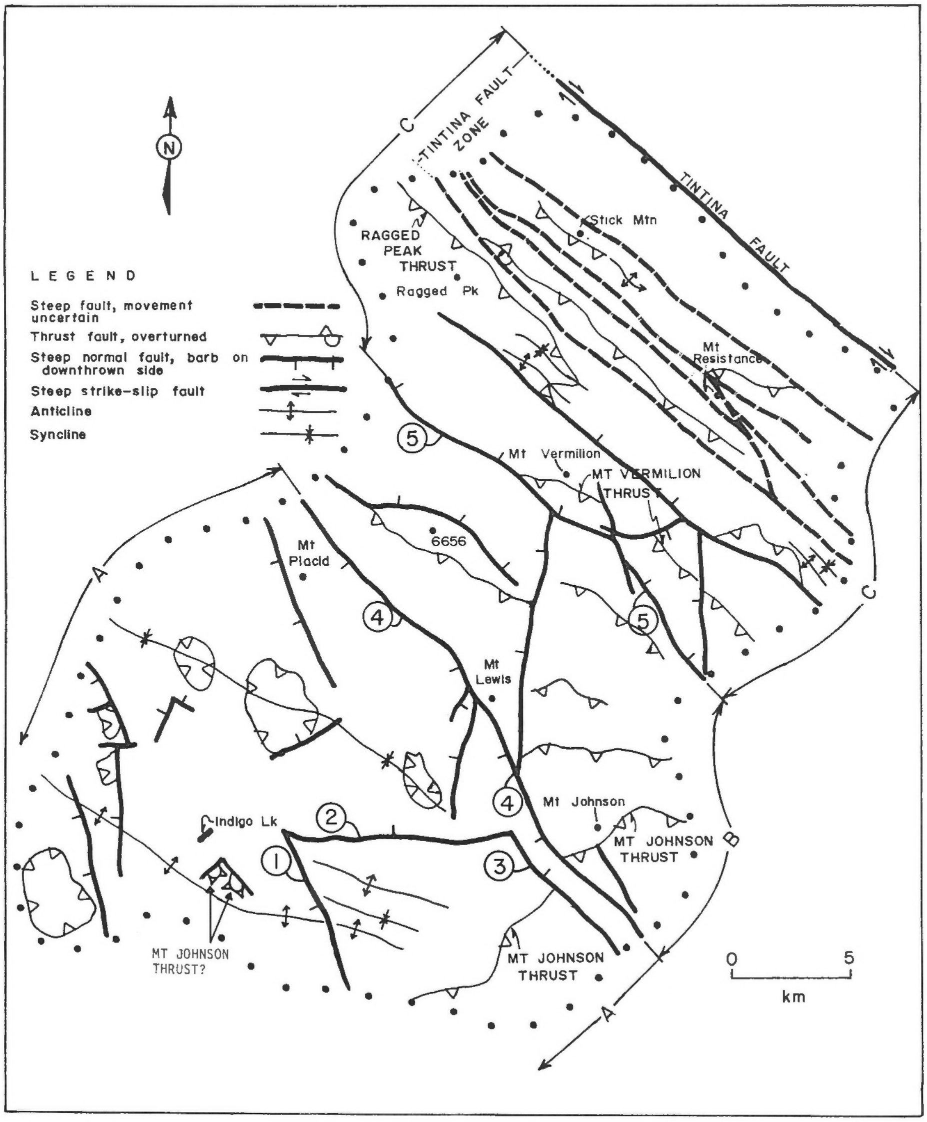


Figure 24. Sketch map of the major structural features of the Indigo Lake area. A, B, and C, and the numbers 1 to 5 refer to structures and structural subdivision discussed.

magnitude of movement along Tintina Fault (Roddick, 1967; Tempelman-Kluit et al., 1976; Tempelman-Kluit, 1977; Gabrielse and Dodds, 1977). They also support correlation of the unconformity beneath the Silurian siltstone unit with that beneath the Nonda Formation, and equivalence of the sub-Devonian unconformity in the Indigo Lake area with that below the Muncho-McConnell Formation in northern British Columbia. Exposures of upper Paleozoic strata in Pelly Mountains may be erosional remnants equivalent to the Stoddart, Kindle and Fantasque formations.

Structure

The main structures in the autochthonous sequence are northwest-trending folds and northeasterly overthrusts. The folds are upright and verge northeast and associated slaty cleavage dips southwest. Late normal faults disrupt the continuity of these earlier structures and define large fault-bounded panels. Three northwest-trending panels (A, B, and C in Fig. 24) of different structural level and style are recognized. From southwest to northeast structures undergo a transition from open folds and gentle dips to moderate southwest dips to tight folds and steep dips.

The southwesternmost panel (A) comprises Devono-Mississippian and younger rocks but includes Siluro-Devonian, and Cambro-Ordovician rocks. The main structures are open folds over which two flat overthrusts (base of allochthon and Mount Johnson Thrust) are warped. Bedding dips gently and slaty cleavage dips steeply southwest. Local tight folds verge northeast. Middle Devonian and Late Triassic normal faults are important locally. A fault block in the southeast part of the panel exposes Cambro-Ordovician slate and represents a slightly lower stratigraphic level than to the northwest.

The central panel (B) comprises Cambro-Ordovician slate and volcanics. Moderate to steep southwest-dipping thrusts and slaty cleavage, at most localities masking bedding, dominate the structure. Small upright or northeast-verging folds with axial planes parallel to the slaty cleavage are seen locally. A steep-dipping, spaced cleavage and kink bands overprint the slaty cleavage.

The northeastern panel (C) includes most units of the autochthon. In the southwest the structure is characterized by southwest-dipping bedding and northeast-directed thrusts. To the northeast bedding and thrusts dip more steeply or are overturned and dip to the northeast. In a relatively narrow zone adjacent Hoole River steep dips predominate, bedding and northeast directed thrusts being overturned and dipping to the northeast, slaty cleavage dips to the northeast, and tight folds verge to the southwest. A northwest-trending system of steep faults is superposed on the folds and thrusts. Slaty cleavage is pervasive in the incompetent Cambro-Ordovician and Devono-Mississippian pelite, but is locally developed in competent rocks. The steep slaty cleavage in Cambro-Ordovician strata adjacent Hoole River is gently folded and shallow-dipping, spaced cleavage is locally superposed.

Relative to adjacent panels the central panel is an uplifted block. The northwestern part is uplifted less than the southeastern because the former exposes stratigraphically higher rocks. The northeastern and central panels have no structure in common but, Cambro-Ordovician slate in the hanging-wall of the Ragged Peak Thrust may lie in the same thrust slice as the volcanics and slate in the central panel.

Major Structures

Folds

An open, northwest trending anticline-syncline pair is the dominant structure in the southwest panel. The folds are broad, upright, concentric structures with an amplitude and wavelength of 1 km and 7 km respectively. Southeast of Indigo Lake the anticline is locally overturned to the northeast. It probably extends into the uplifted block of Cambro-Ordovician strata (left side section CC', Map 1504) in the southeastern corner of the area.

Figure 25. *A comparatively large and tight example of the northeast verging folds in shales of the "black clastic" (uDMps) near the base of the chert (Mt) about 3 km west of Mt. Lewis. (GSC 203586-P)*

Near Mount Lewis and Indigo Lake, Mississippian chert (Mt) is folded in northeast-verging folds of variable spacing and tightness (Fig. 25). Folds in the chert and enclosing shale (uDMps and CTRps) vary from open to tight asymmetric structures and probably do not persist with depth into competent Devonian dolomite (uSDc). The chert is viewed as a thin competent layer, enclosed by incompetent shale, that buckled irregularly during shortening.

No large folds occur in the central panel of Cambro-Ordovician strata. Bedding dips moderately southwest and repetition of stratigraphy shows the rocks are thrust faulted.

Within Tintina fault zone (Fig. 24) major folds are upright or southwesterly overturned. Southeast of Stick Mountain the major, tight, upright anticline (section AA', Fig. 1A) plunges out to the southeast. Analysis of fabric data from a relatively small area of large open folds near Stick Mountain reveals a system of conical folds plunging southeast with related axial-plane cleavage dipping steeply east-northeast. The Mississippian chert unit caps Mount Resistance and the small peak 3.5 km to the southeast and forms the core of two southwest-verging synclines truncated by faults of Tintina fault zone (section C-C', Fig. 1A).

Thrust Faults

Ragged Peak Thrust. Near Ragged Peak Cambro-Ordovician slate (uCOp1) overlies Upper Triassic siltstone (CTRps) on a bedding thrust fault that extends northwesterly out of the map area. The fault juxtaposes two zones of bedding glide, one in the Cambro-Ordovician sequence and the other in Triassic rocks over a width of at least 2 km (Fig. 26). Close to the fault rocks are not deformed anomalously. Cambro-Ordovician slate in the hanging-wall is folded, but lack of markers precludes the recognition of large folds. Near Ragged Peak stratigraphic separation on the thrust is about 2500 m. Southeast of Ragged Peak the fault surface is folded into an anticline-syncline pair, and on the southwest it is cut by a younger, high-angle fault.

Southeast of Ragged Peak a northeast-striking, steep fault offsets stratigraphy in the thrust sheet, the thickness of the graptolitic shale (Op) differing on opposite sides of this fault. Further southeast along the structural trend the "black clastic" unit is thrust above Triassic siltstone (CTRps) on a splay (?) of the Ragged Peak Thrust.

Mount Vermilion Thrust. Near Mount Vermilion, Siluro-Devonian dolomite (uSDc) overlies acid volcanic rocks (uDMv) on the southwest-dipping Mount Vermilion Thrust. The fault is truncated by normal faults but may continue southeast beneath carbonate strata like those in its hanging-wall near Mount Vermilion. The stratigraphic separation on the thrust may be 1800 m.

Mount Johnson Thrust. The gently dipping Mount Johnson Thrust, which runs through the valley southeast of Mount Johnson, has a stratigraphic separation of about 700 m. Its southwestward extension assumes that intervening Devono-Mississippian strata are a down-faulted block with little relative movement of the rocks adjacent to this block. In the core of the large anticline about 3 km southeast of Indigo Lake, Silurian siltstone is thrust above Siluro-Devonian dolomite on a flat thrust. The relations on this fault are like those on the Mount Johnson thrust and this fault is presumed to be its continuation.

The northwest-trending steep fault southeast of Mount Johnson may be a tear fault that terminates against the Mount Johnson Thrust but because its trend is incompatible with northeast directed thrusting, it is more likely younger and unrelated.

Thrust Faults in the Cambro-Ordovician Assemblage. Repetitions of stratigraphic units in the central structural belt define the main thrust faults in the Cambro-Ordovician rocks. Small repetitions may be unrecognized because the stratigraphy is not known in detail.

The thrust faults are defined by comparatively wide zones of structural repetition within the slate-diabase unit. Three km east of Mount Lewis ten or more sills occur in an interval of 90 m. They probably represent structural repetition in the sole of one thrust sheet. About 4 km to the northeast a thrust within the same rocks follows a similar zone of imbrication. The original number of sills within the unit is unknown, but their occurrence as "swarms" in a restricted interval suggests they may be repetitions of a few sills and not swarms in the strict sense.

A moderately dipping thrust south of peak 6656 brings the slate-diabase unit above the basalt unit, a stratigraphic separation of about 1100 m. The thick basalt in the footwall is absent from the overthrust plate, presumably due to structural telescoping of facies. Eleven km southeast of Mount Vermilion, silver-grey weathering slate of the tuffaceous slate unit is juxtaposed against an orange weathering slate unit of the same age. The contact is abrupt and may also represent structurally telescoped facies.

Thrust Faults Within Tintina Fault Zone. Thrust faults within Tintina fault zone dip steeply and are difficult to distinguish from other faults of the zone. A steeply southwest-dipping

Figure 26. *View of Ragged Peak from the southeast showing the folded Ragged Peak Thrust. The fault and anticline are truncated on the southwest by a younger high-angle fault seen along the valley in the foreground. (GSC 203586-Q)*

sequence of Siluro-Devonian strata is faulted against moderately dipping strata of the same age 5 km east-southeast of Ragged Peak. Repetition of strata across the fault, parallelism of the fault with bedding in the hangingwall, and the shallow angle to bedding in the footwall suggest that it may be a northeasterly directed overthrust. To the northwest this fault dips more steeply and north of Ragged Peak is overturned, dipping to the northeast.

Near Stick Mountain a steeply dipping fault of small stratigraphic separation ends in the core of an anticline which plunges out southeastward. Similar thrust-to-fold transitions are documented for thrust faults in the southern Canadian Rocky Mountains (Dahlstrom, 1970, p. 360; Gardner and Spang, 1973) and by analogy this fault, although now "oversteepened", is interpreted as a thrust. To the northwest it is truncated by a steep fault.

Northeast of Mount Resistance Siluro-Devonian carbonate has overridden the "black clastic" unit along a thrust truncated on the west and east by later steep faults. On the east the thrust dips steeply but near its western end it dips moderately southwest.

Normal Faults

Middle Devonian Normal Faults. The unconformity beneath the "black clastic" unit is marked in the southern part of the Indigo Lake area. There the underlying Siluro-Devonian dolomite, up to 1400 m thick at Ragged Peak, is locally missing through erosion before deposition of the "black clastic" unit. Block faulting was associated with the uplift that led to erosion. Two vertical faults of small stratigraphic separation 3 km southeast of Indigo Lake (see Fig. 1A) cut Siluro-Devonian dolomite and quartz arenite (uSDc) and are truncated at the unconformity beneath the "black clastic" unit. The relationships indicate that these faults moved in Middle to Late Devonian (pre- or early "black clastic") time. About 5 km farther northeast "black clastic" shale rests directly on Cambro-Ordovician strata, this local stratigraphic omission possibly reflecting erosion following uplift by block faulting. The late normal faults near Indigo Lake (faults 1 and 2, Fig. 24) may predate the "black clastic" unit but were reactivated in the Mesozoic. Farther south in the same area the Siluro-Devonian dolomite thins gradually to the southeast beneath the unconformity.

Within Tintina fault zone near Stick Mountain the unconformity is also marked and indicates Middle to late Devonian uplift before deposition of the "black clastic" unit.

Late Triassic (?) Normal Faults. About 4 km northwest of Indigo Lake differences in stratigraphy across some of the steep faults show that they are Late Triassic (?), although reactivated following folding and thrusting. The relationships are sketched in Figure 27. Faults 2 and 3 partially bound a small fault block uplifted and eroded in the Late Triassic (?). Fault 2 is Late Triassic (?) as it cuts Upper Triassic shale-siltstone unit but is overlain by Jura-Cretaceous strata (JKsv). Fault 3 is of similar age because the Mississippian chert unit seen on the east side is absent on the west side. Reactivation of fault 3 after emplacement of the allochthon is indicated by offset of the allochthon. In the Late Triassic (?) the west side of fault 3 was upthrown relative to the east side; late movement was in the opposite sense. Late Triassic (?) stratigraphic separation across faults 2 and the southern part of fault 3, estimated from the omission of the Mississippian chert and Carboniferous-Triassic shale-siltstone units, is at least 800 m. The relationships of fault 1 and the northern continuation of fault 3 are uncertain as stratigraphic omission across them cannot be demonstrated. Southwest of Indigo Lake Upper Triassic strata (CTRps) are cut by several steep faults whose ages are not closely bracketed, and which could also be Late Triassic (?).

Late Normal Faults. Late, steep, normal faults have disrupted the continuity of early formed structures and divide the area into large fault blocks. The normal faults (no. 1 to 5, Fig. 24) have relatively sinuous traces, systems of minor splay faults, or terminate abruptly, which shows they have had little strike-slip displacement. Fault 2 (Fig. 24) dips about 70° to the north, but the dip of the others could not be determined. The faults juxtapose grossly different levels of exposure in adjacent fault blocks and must have large dip separations. Across faults 1 to 4 separation reaches 1500 m.

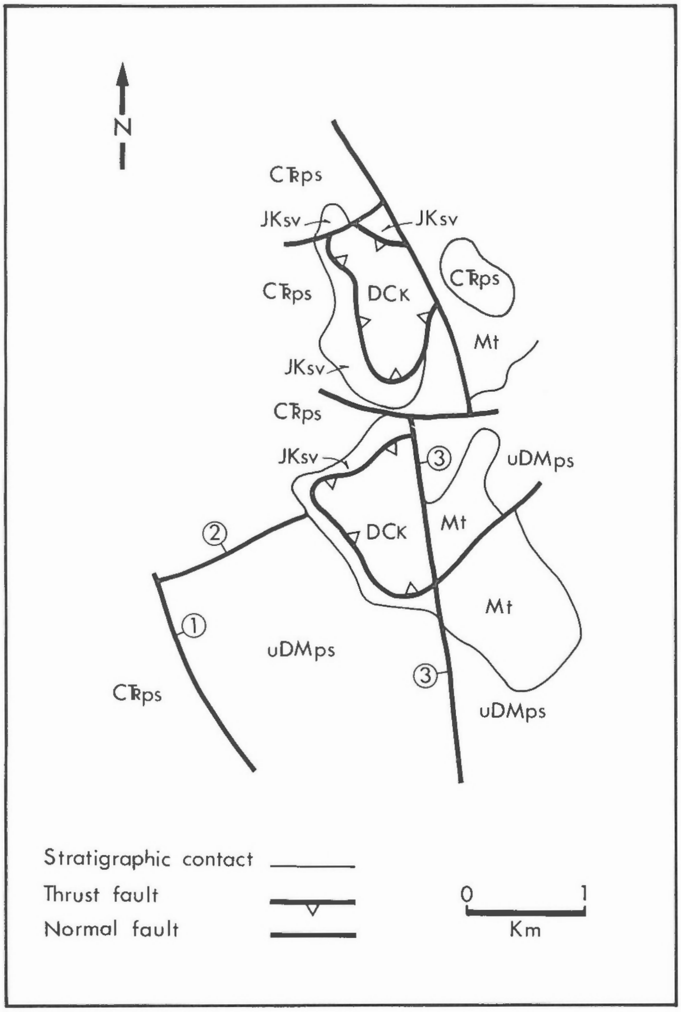


Figure 27. *Geologic map of the area 4 km west-northwest of Indigo Lake illustrating evidence for Late Triassic (?) normal faulting. Some of the faults are numbered for reference in the text.*

Assuming that the Cambro-Ordovician strata exposed in the hanging wall of the Ragged Peak Thrust are directly correlated with those of peak 6656 stratigraphic separation across fault 5 is at least 4300 m.

Tintina Fault Zone

The Tintina Fault is a northwest-trending system of faults within Tintina Trench, a topographic lineament that extends from southeastern Yukon northwestward into Alaska. Roddick (1967) postulated 450 km of right-lateral movement by matching an offset belt of gritty Proterozoic rocks, and Tempelman-Kluit (1970, p. 83) proposed the same sense and amount of displacement to account for the apparent offset of Lower Cretaceous strata. Right-lateral offset of about 450 km also matches disrupted parts of Cassiar Platform (Fig. 3) (Tempelman-Kluit, 1976). The stratigraphic succession of the Indigo Lake area matches closely that in northern British Columbia 450 km to the southeast on the opposite side of Tintina Fault and is compatible with the postulated displacement.

In central Alaska the Tintina Fault apparently joins the Kaltag fault, a west-trending, right-lateral transcurrent fault along which movement probably occurred in latest Cretaceous or earliest Tertiary time (Tempelman-Kluit, 1970, p. 83). To the southeast Tintina Fault joins or is en echelon with the northern Rocky Mountain Trench. Gabrielse et al. (1977) and Gabrielse and Dodds (1977) have recently recognized a zone of Late Cretaceous or Tertiary right-lateral strike slip along northern Rocky Mountain Trench. They suggested 450 to 500 km displacement to explain the anomalous width of a belt of mid-Cretaceous quartz monzonite plutons in south-central and southeastern Yukon Territory.

In the Indigo Lake area an anastomosing network of steep faults adjacent to Tintina Trench (Tintina fault zone, Fig. 24) cuts folded and thrust-faulted strata. Stratigraphic separation across the faults reaches 1700 m, the total stratigraphic section in the zone. Fault-related joint sets, slickensided fractures, or secondary folds are absent. Tintina Fault, the locus of dextral strike-slip, juxtaposes metamorphic rocks on the northeast against the sedimentary strata of the Indigo Lake area. The magnitude and sense of slip on the other faults are unknown because there are no markers which can be matched across them. Because they anastomose and are close to Tintina Fault they are likely related to the transcurrent movement. They may have formed as dip-slip secondary faults inclined to the trend of main transcurrent movement or they may have a strike-slip component, their vertical separation being caused by offset of plunging structures (see Lensen, 1958). Tertiary normal faulting postdating strike-slip has been demonstrated elsewhere within Tintina Trench (Wheeler et al., 1960) and may have affected the Indigo Lake area.

The Tintina fault zone coincides with the zone of steep or overturned bedding and thrust faults, and vertical or steep northeasterly dipping cleavage. This may reflect a genetic relationship between the faulting and the overturning but the mechanism is not understood. More likely the steep dips may represent backfolding that developed during the regional northeast directed deformation.

Subfabrics

Mesoscopic fabric elements include bedding, slaty cleavage, spaced-cleavage, hinge lines of minor folds in bedding, and cleavage-bedding intersection lineations. Slaty cleavage is variably developed and its spacing depends on the competence of the rock and proximity to folds. Cambro-Ordovician slate is locally overprinted by a later cleavage, spaced about 1 cm apart, that is axial planar to kink bands or minor open folds in the slaty cleavage. Small-scale folds in bedding are rare.

Variation in subfabrics across the area is illustrated by equal-area projections of the fabric elements for the three structural subdivisions of the area (Fig. 28). Great circle patterns of dispersion of poles to bedding suggest it is cylindrically folded about gently southeast plunging axes parallel to the intersection of cleavage and bedding, and minor fold axes. The cleavage is the axial surface to the folds and the surface of maximum finite flattening. Its orientation shows that maximum horizontal compression during folding was oriented southwest-northeast. Moderate dips and variable dip direction of bedding in panel A reflect the broad open folds and local tight folds in the Mississippian chert. Data from panel B depict an essentially homoclinal area. Those in panel C reflect the southwest overturned structures near Tintina Trench where cleavage dips steeply northeast and overturned bedding dips northeast.

Estimate of Shortening

An estimate of the minimum horizontal shortening on the thrust faults can be made from their present overlap, assuming that the sheets have not undergone internal

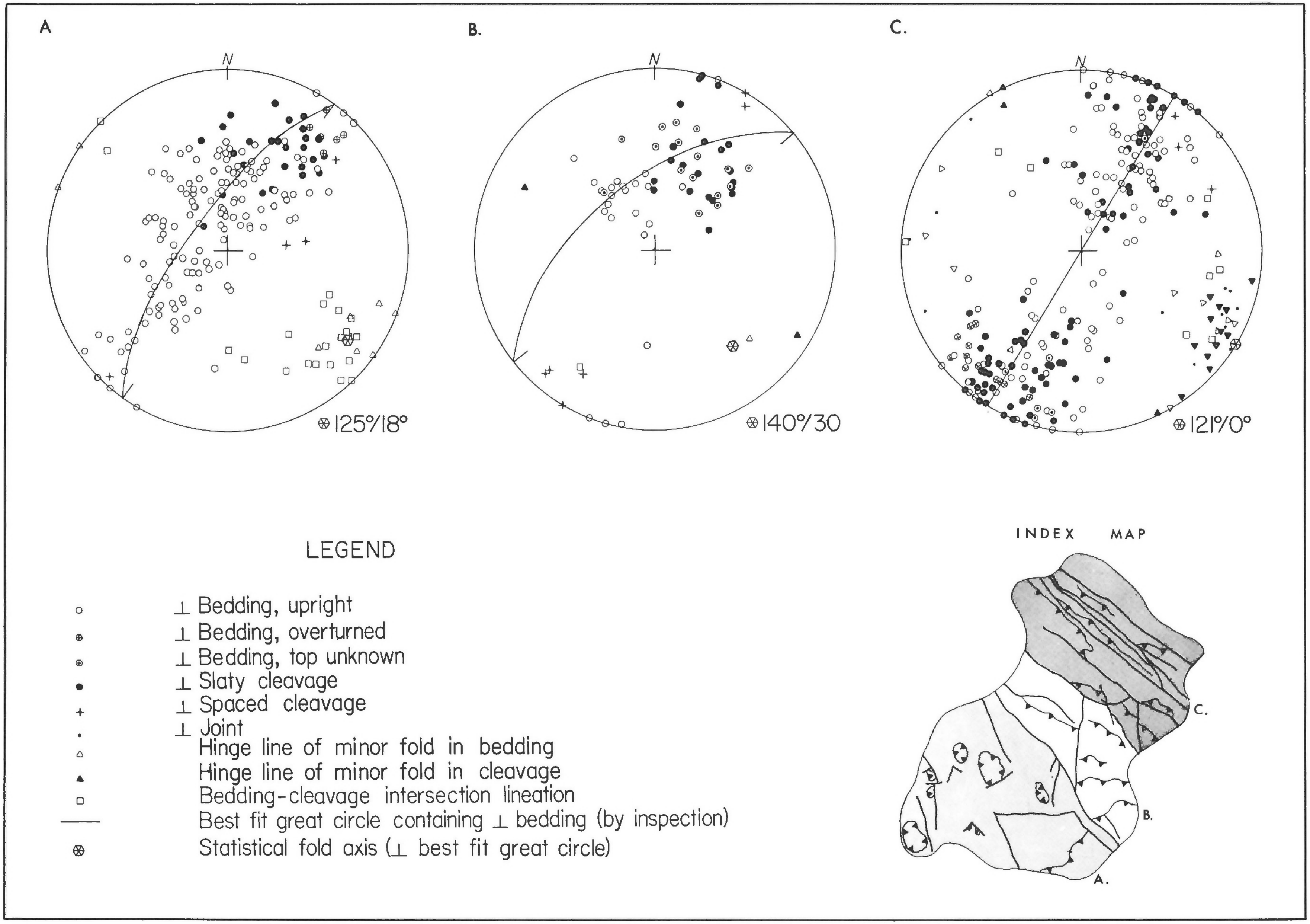


Figure 28. *Orientation of fabric elements – autochthon (plotted on Schmidt stereographic nets, lower hemisphere). Domains of the stereograms are shown on the index map.*

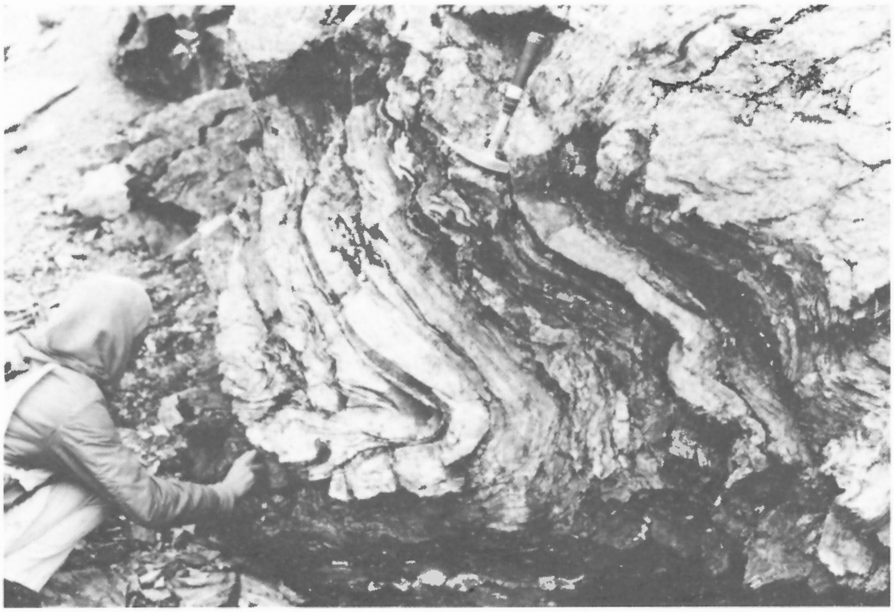


Figure 29. *Recumbently folded layering in siliceous mylonite (DCK) 4 km southwest of Mount Lewis. The layering, which may in part reflect bedding, is a result of cataclasis. The mylonite tectonically overlies unsheared Carboniferous and Upper Triassic and Jura-Cretaceous sediments of the autochthon (see Fig. 20). (GSC 203586-R)*

deformation. The overlap across the Mount Johnson Thrust is about 10 km. That on the Ragged Peak Thrust, assuming a constant angle of intersection with bedding of 30°, is about 7 km. On the same basis the overlap of the Mount Vermilion Thrust is about 3.5 km and that of thrusts within Tintina fault zone about 2.5 km. Shortening by thrusting within the Cambro-Ordovician assemblage in the central part of the area (B, Fig. 24) is unknown but may be 3 km. Minimum shortening by thrusting is therefore about 26 km.

Horizontal shortening by folding is difficult to estimate but is probably less than that by thrusting. The open folds in the southwestern part of the area indicate shortening of about 0.5 km. No large folds are known in the Cambro-Ordovician pelitic rocks in the central part of the area (B, Fig. 24) but they are cleaved and have probably undergone bulk shortening perpendicular to the slaty cleavage (Wood, 1974). This belt is 8 km wide and if shortened by 50 per cent, 4 km of shortening has occurred. Folds within Tintina fault zone are fairly tight (see Structure Sections, Fig. 1A) and about 40 per cent horizontal shortening by folding or 3 km is reasonable. The total shortening by folding may be 10 km.

The minimum total shortening is therefore about 36 km.

Age of Deformation

Folding and thrusting occurred after the Late Triassic but before the mid-Cretaceous. The older limit is defined by the age of the youngest dated deformed rocks, and the younger limit by the mid- to Late Cretaceous plutons which intrude and arch imbricated strata in adjacent parts of Finlayson Lake and Quiet Lake map areas (Tempelman-Kluit et al., 1976). The Jura-Cretaceous greywacke-tuff has not been dated closely but deformation occurred after its deposition. Late Cretaceous transcurrent movement along Tintina Fault postdates deformation.

ALLOCHTHON

General Geology

Lithology

Klippen of mylonite (Klondike Schist) cap mountains in the southwestern part of the area, the structurally thickest klippe 6 km northeast of Indigo Lake reaching 500 m in thickness. The mylonite lies above unmetamorphosed and unsheared Carboniferous and Upper Triassic shale-siltstone and Jura-Cretaceous greywacke-tuff. The contact is covered but outcrops 20 m below it are not sheared or metamorphosed. Their mylonite fabric shows that the allochthonous rocks have a tectonic history distinct from the autochthonous strata they overlie.

Rocks of the allochthon are slightly recessive weathering in shades of grey or greenish grey. They are well-exposed at most localities but locally form slumped or frost-heaved blocks. Bedding is recognized rarely as thin (<0.5 m) highly disrupted calc-silicate bands. At other localities colour banding less than 1 cm thick in feldspathic mylonite may represent original layering or may be cataclastic. The dominant fabric element is a pervasive, gently dipping, cataclastic foliation or fluxion structure (Fig. 29). Small-scale folds of the foliation are ubiquitous but large-scale structures are not recognized because the rocks lack marker horizons.

Quartz-muscovite mylonite and lesser albite-chlorite mylonite make up most of the allochthonous rocks. In the first type foliation is defined by dark anastomosing seams of crushed micas bounding thin (<1-2 mm) white to black quartzofeldspathic folia (Fig. 30, 31). Continuity of the seams is proportional to mica content. Some thick (5 cm) lensoid folia are the tightly appressed hinges of rootless folds. Muscovite and chlorite comprise up to 25 per cent of the rock but chlorite may be absent. Quartz with less albite makes up the remainder. Orthoclase is present locally. Biotite fringes chlorite and muscovite or occurs rarely as small grains.

The albite-chlorite mylonite has thin, discontinuous colour banding in shades of pale green, parallel to microscopically recognized discontinuous seams of crushed micas, and augen-shaped albite porphyroclasts (Fig. 32). Micaceous minerals comprise up to 30 per cent and calcite or dolomite up to 20 per cent. Porphyroclastic albite and less abundant quartz constitute the remainder.

Brown weathering, grey, calc-silicate rocks comprise a small part of the unit and consist of calcite and dolomite, some quartz, and minor albite and muscovite. Their foliation, defined by laminae of different compositions, is best seen on weathered surfaces.

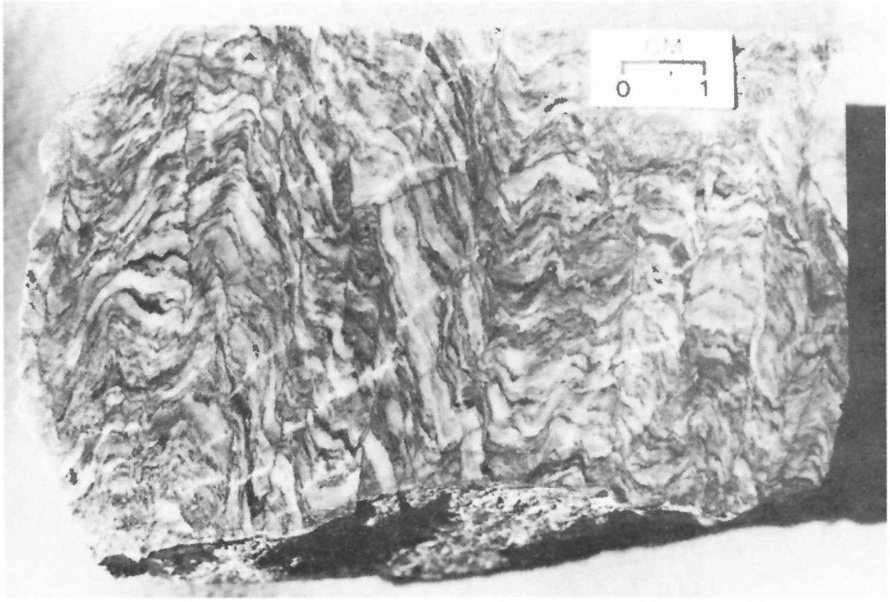


Figure 30. *Sawn and polished surface of siliceous mylonite (DCK) showing cataclastic foliation. The folia are bounded by thin discontinuous seams of mica. The foliation is folded by F_2 folds. Slip has occurred on discrete planes parallel to the axial surface. (GSC 203586-S)*

Minor dark grey to dark green phyllonite is also seen in the allochthon.

Mylonite textures seen in thin section include crushed and bent micas, ribbon quartz, and augen-shaped quartz and albite porphyroclasts, some of which are rotated. Average grain size is about 0.07 mm, but porphyroclasts to 1 mm across are common. Recognizable relict primary textures are absent.

Metamorphism

Mineral assemblages found in rocks of the allochthon, as determined in thin sections and by X-ray diffraction include:

in QUARTZ-MUSCOVITE MYLONITE

(1) quartz-albite-muscovite (4)[1]
(2) quartz-albite-muscovite-chlorite ± sphene ± biotite (7)
(3) quartz-albite-muscovite-orthoclase (1)

in ALBITE-CHLORITE MYLONITE

(4) albite-quartz-chlorite-muscovite-zoisite ± sphene (3)
(5) albite-quartz-chlorite-muscovite-clinozoisite/low iron epidote ± biotite (5)
(6) albite-quartz-chlorite-muscovite-calcite (4)
(7) albite-quartz-chlorite-muscovite-dolomite (1)

in CALC-SILICATE MYLONITE

(8) calcite-dolomite-quartz-muscovite (1)
(9) dolomite-quartz-albite-chlorite (1)

The specimens analyzed are representative and each of the klippen is represented by samples.

The assemblages represent the lower greenschist facies (Turner, 1968) or the lower part of the low-grade division (Winkler, 1974) of regional metamorphism. Clinozoisite and/or low-iron epidote without zeolite indicates temperatures above the zeolite facies while the presence of the pair biotite-muscovite indicates temperatures near those of the biotite zone. Metamorphic temperatures were in the range of 375°C to 450°C (see Winkler, 1974, Fig. 15-2). The assemblage dolomite-quartz is compatible with these temperatures; at higher temperatures, depending on total fluid pressure and partial pressure of CO_2, dolomite and quartz react to produce talc or tremolite. Estimates of pressure during metamorphism are broad as the assemblages are stable over a range of pressures from 1-7 kb*.

The deformed minerals are mostly metamorphic indicating that metamorphism predates cataclasis. Metamorphism also occurred during cataclasis because angular crushed mineral fragments and unrecrystallized groundmass are absent. Because relatively coarse grained minerals such as ribbon quartz and deformed micas are not much recrystallized temperatures probably fell rapidly after cataclasis ceased. Sphene and zoisite are locally grown across the fabric and there is local postrotation growth on albite porphyroclasts, so that in some parts of the mylonite body cataclasis may have ceased relatively early, before metamorphic temperatures waned.

The allochthonous rocks were formed by cataclasis and low-grade metamorphism of predominantly sedimentary rocks. The calc-silicate likely represents original limestone and/or dolomite beds, and the highly siliceous composition of some mylonite indicates derivation from chert or siliceous sediment like quartz or chert sandstone or conglomerate. Part of the unit may have originated as felsic volcanic rocks. The albite-chlorite mylonite may derive from intermediate or basic volcanics.

Age and Correlation

The allochthon is Jura-Cretaceous or older because grains of the mylonite are found in the Jura-Cretaceous greywacke. Likely parent rocks most closely resemble the autochthonous Devono-Mississippian assemblage and on the basis of similar regional lithologic correlations Tempelman-Kluit (1976) suggested that the Klondike Schist may be Devono-Mississippian.

McConnell (1905) introduced the informal term Klondike Schist for distinctive metamorphic rocks in parts of the northern Yukon Crystalline Terrane (Tempelman-Kluit, 1974). As used here the term is intended to imply lithologic similarity and broad equivalence with these rocks. Metamorphic rocks of the Yukon Crystalline Terrane and

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[1] Numerals in brackets are number of samples analyzed.

*1 kb = 10^5 kPa.

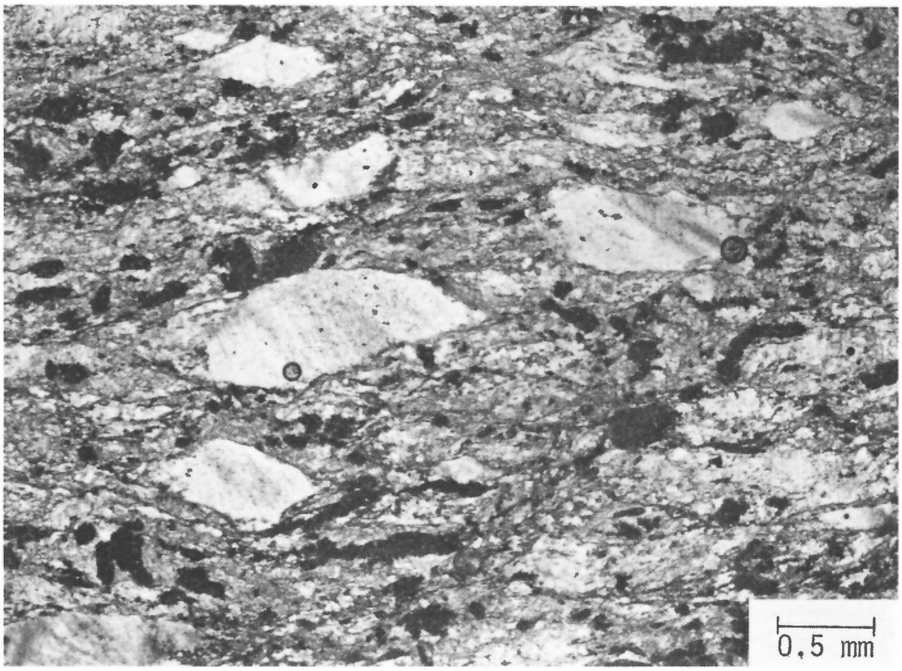

Figure 31. *Photomicrograph (plane-polarized light) of quartz-rich mylonite (DCK) with quartz porphyroclasts in fine-grained quartz and muscovite. Dark grains grown across the foliation are sphene and zoisite. (GSC 203586-T)*

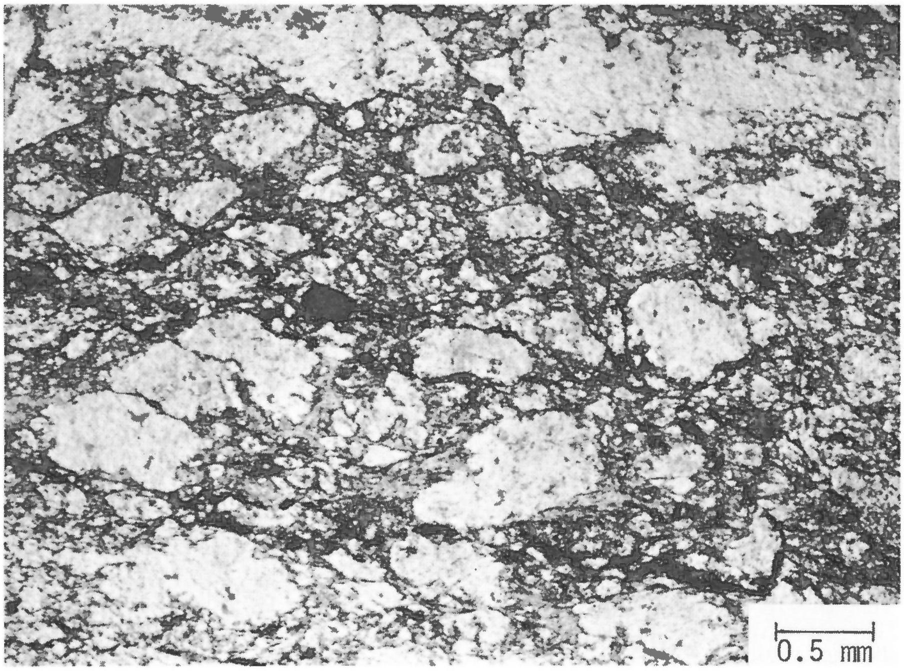

Figure 32. *Photomicrograph (plane-polarized light) of quartz-chlorite-albite mylonite (DCK). The large augen-shaped grains are albite porphyroclasts in a matrix of knotted chlorite and smaller quartz and albite fragments. (GSC 203586-U)*

northern Omineca Crystalline Belt are not known in sufficient detail to support firm correlations. Similar rocks in other areas may comprise all or part of:

(1) the Klondike Schist in Dawson map area (Green, 1972), Snag and Stewart River map areas (Tempelman-Kluit, 1974), and Finlayson Lake and Quiet Lake map areas (Tempelman-Kluit, 1977);

(2) unit 6 in Glenlyon map area (Campbell, 1967);

(3) the Big Salmon Complex, and Englishman's Group (unit 3) in Teslin map area (Mulligan, 1963); and,

(4) the Big Salmon Complex and Oblique Creek Formation in Jennings River map area (Gabrielse, 1969).

Rocks of the northern Yukon Crystalline Terrane, like those in the Indigo Lake area, are sheared and exhibit a closely spaced flaser structure, and compositional layering in the Klondike Schist, if present, is a flaser structure that results from granulation and shearing (Tempelman-Kluit, 1976).

Structural Geology

Fabric

The allochthonous mylonite has a distinctive fabric whose dominant element is a pervasive, gently dipping cataclastic foliation that is folded by two minor fold sets. Folds and refolded folds on the scale of one metre are ubiquitous but larger structures are not known.

The fabric of the mylonite is described in terms of the following fabric elements:

S_1 a pervasive cataclastic foliation defined by subparallel anastomosing seams of crushed micas, quartzofeldspathic folia, colour lamination, or discontinuous colour streaking. Quartz is slightly flattened in the plane of S_1. Helicitic albite porphyroclasts have inclusion trains at high angles to S_1;

S_2 defined by the axial planes of subisoclinal recumbent folds of S_1. In more siliceous rock types the folds are more open, with slip on discrete planes parallel to S_2. S_2 is not associated with new mineral growth except locally where small muscovite flakes parallel it;

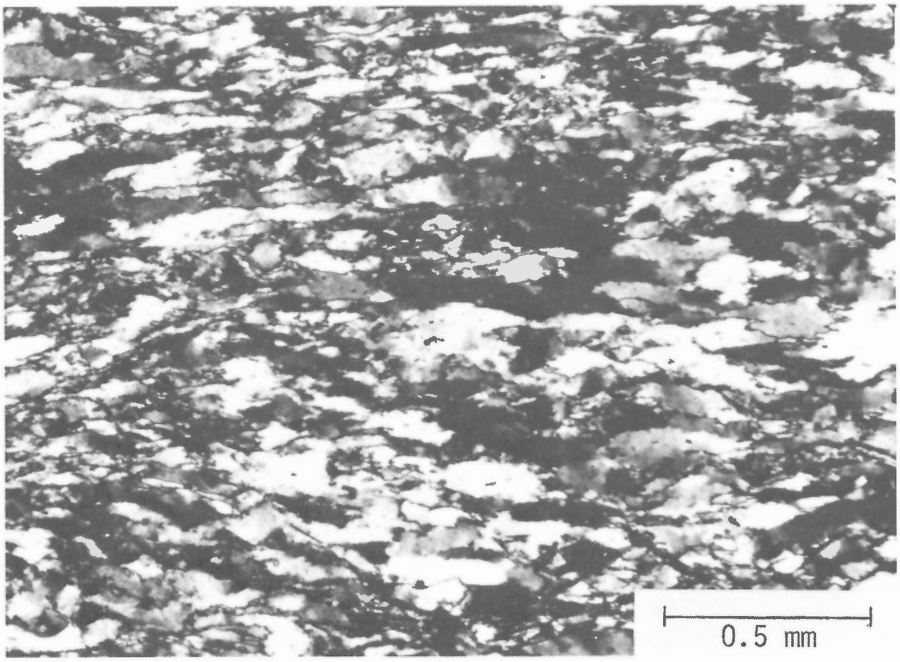

Figure 33a. *Photomicrograph (crossed nicols) of quartz mylonite (DCK) showing elongation of quartz parallel to the mesoscopic microrodding lineation, L_1. The thin section parallels the lineation, and is perpendicular to S_1. The trace of S_1 is horizontal (GSC 203586-V)*

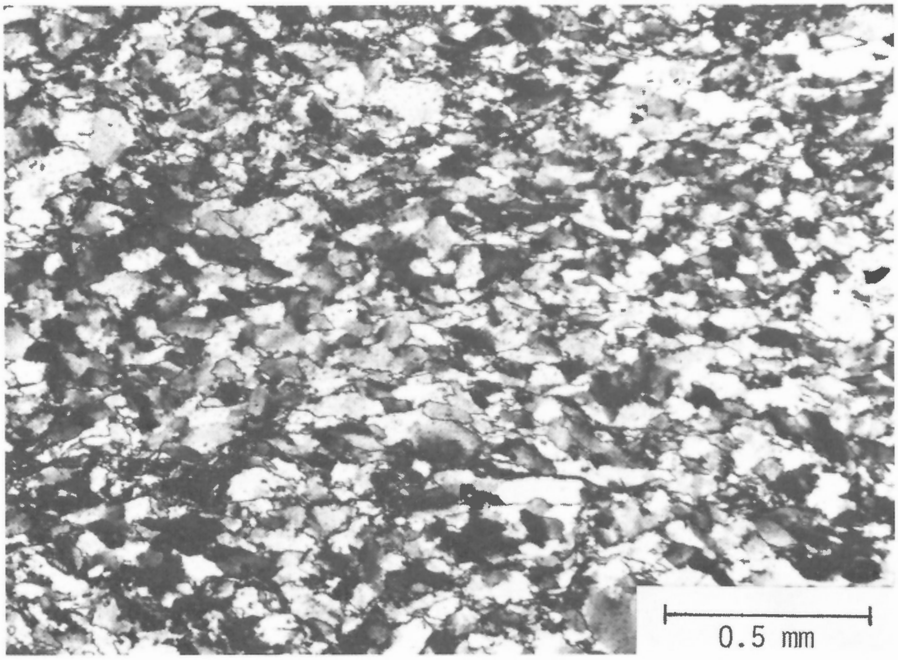

Figure 33b. *Photomicrograph (crossed nicols) of quartz mylonite, of the same specimen as for (a). The thin section is perpendicular to the micro-rodding lineation, L_1. L_1 is a stretch lineation defined by "pencils" of quartz (see (a)). The quartz is also slightly flattened parallel to S_1 (horizontal in this figure). (GSC 203586-W)*

S_3 defined by the axial planes of upright to overturned folds of S_1 and S_2 that verge northeast. S_3 is not associated with new mineral growth, and is subparallel to a local axial-plane cleavage and related folds in the autochthon;

L_1 defined by local small-scale rodding or microrodding within S_1. Extreme elongation of quartz is seen in thin section (Fig. 33);

L_2 defined by the hinge lines of folds in S_1 that have S_2 as an axial surface;

L_3 defined by the hinge lines of folds in S_1 and S_2 that have S_3 as an axial surface. Rarely, in rocks with S_1 defined by large amounts of mica, it is expressed as a crenulation of S_1;

F_2 folds with S_2 as axial plane and L_2 as hinge line; and,

F_3 folds with S_3 as axial plane and L_3 as hinge line.

The style of minor folds and relationships between the fabric elements are shown in Figures 34, 35. The style and orientation between F_2 and F_3 folds appear gradational.

The orientation of mesoscopic fabric elements is summarized in Figure 36. The method of analysis of F_3 folds is after Hansen (1971). Asymmetry of F_3 folds is shown using arrows to indicate the sense of rotation of the short limb with the fold viewed down-plunge. The direction of slip is contained within the separation angle (Hansen, 1971). Asymmetry of the F_2 folds could not generally be recognized.

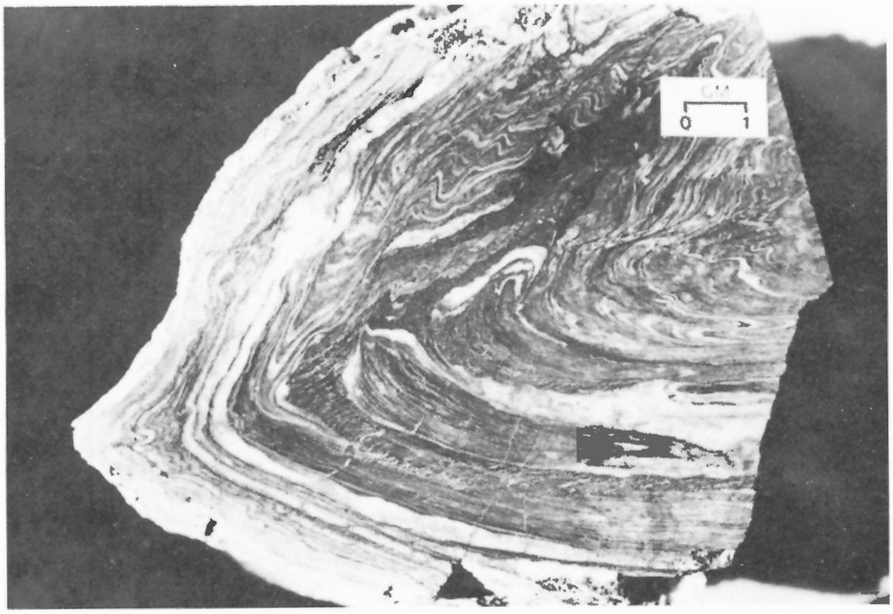

Figure 34. *Sawn and polished section through refolded folds in mylonite (DCK). The compositional layering is S_1, the folded axial surface of the isoclinal folds is S_2, and the axial surface of the open folds is S_3. (GSC 203586-X)*

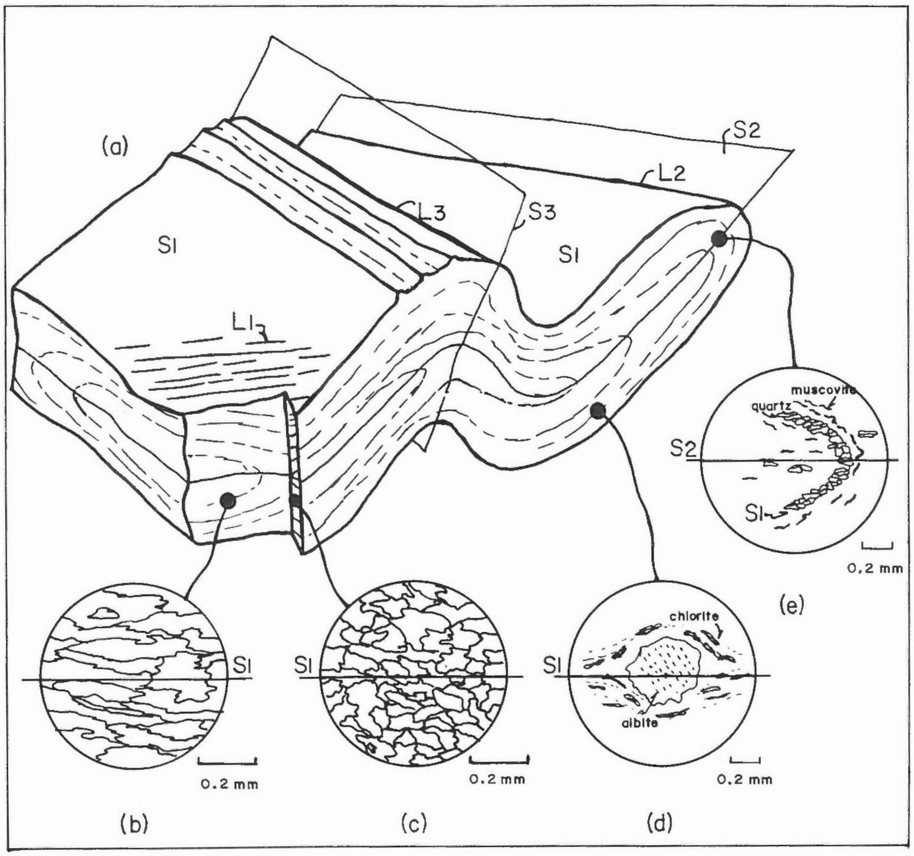

Figure 35. *Composite schematic diagram of the fabric of the allochthonous rocks (DCK). (a) mesoscopic fabric. L_2 and L_3 are at a small angle to one another, consistent with most orientation data in Figure 36. However, both L_2 and L_3 are dispersed (Fig. 36) and some rare refolded folds have L_2 and L_3 at relatively high angles. (b) texture of quartz in quartz mylonite on a section parallel to L_1 and perpendicular to S_1. L_1 defines a stretch lineation. (c) texture of quartz in quartz mylonite on a section perpendicular to L_1 (and S_1). There is a slight flattening of quartz parallel to S_1. (d) albite porphyroclast with trace of inclusion trains at high angles to S_1. S_1 is defined by deformed chlorite which wraps around the porphyroclast. (e) F_2 microfold outlined by a thin quartz layer with quartz flattened parallel to S_2, and by aligned deformed (squashed and kinked) muscovite. Rare tiny muscovite flakes are aligned parallel to S_2.*

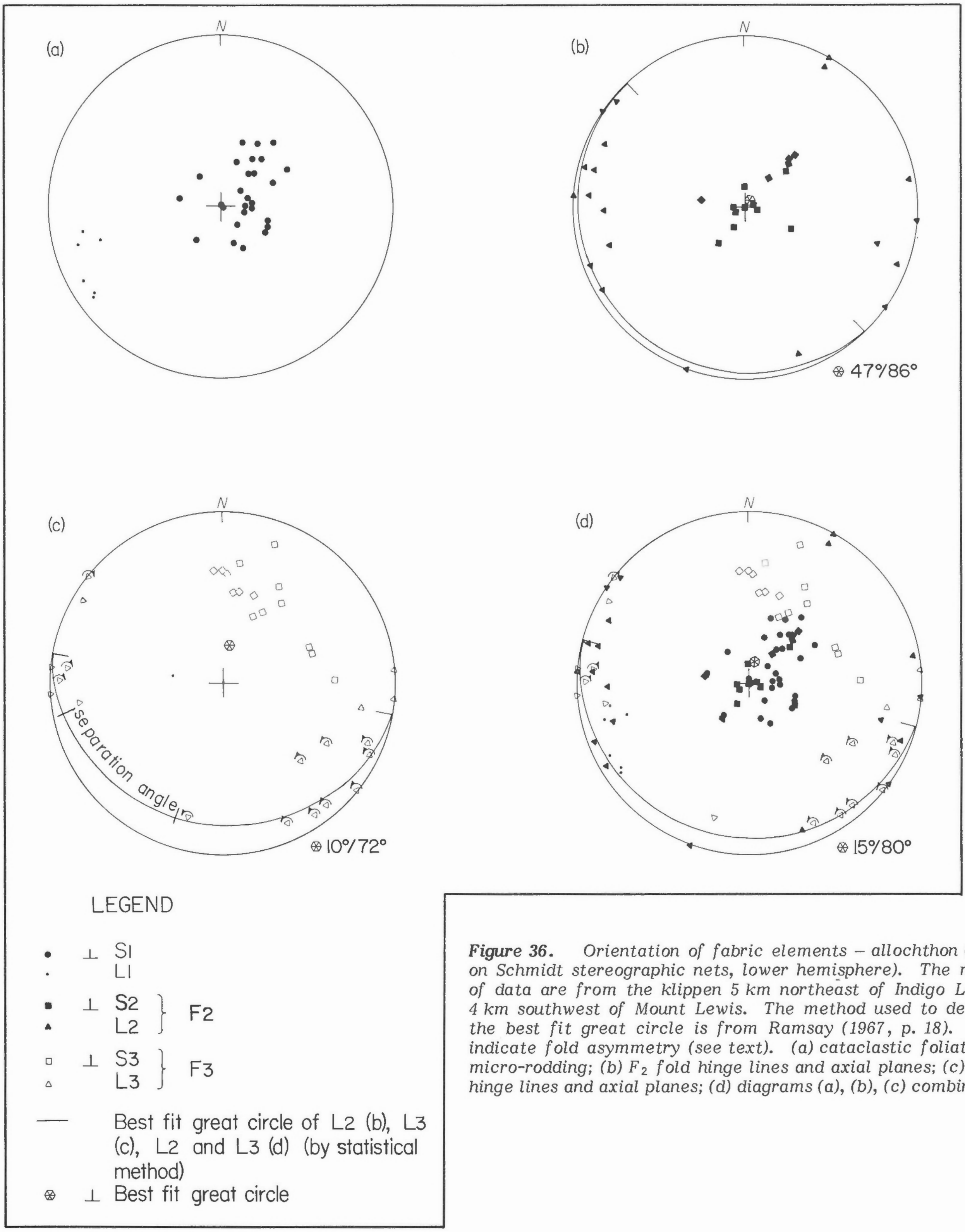

Figure 36. *Orientation of fabric elements – allochthon (plotted on Schmidt stereographic nets, lower hemisphere). The majority of data are from the klippen 5 km northeast of Indigo Lake and 4 km southwest of Mount Lewis. The method used to determine the best fit great circle is from Ramsay (1967, p. 18). Arrows indicate fold asymmetry (see text). (a) cataclastic foliation and micro-rodding; (b) F_2 fold hinge lines and axial planes; (c) F_3 fold hinge lines and axial planes; (d) diagrams (a), (b), (c) combined.*

Most of the orientation data are from the klippen south of Mount Placid and southwest of Mount Lewis. The following conclusions are drawn from these data;

(1) S_1 dips gently southwest and shows some northeast-southwest dispersion reflecting later gentle northeast-southwest warping;

(2) S_2 is subparallel to S_1;

(3) S_3 dips moderately to steeply to the southwest and shows some northeast-southeast dispersion;

(4) L_1 shows little dispersion about a subhorizontal west-southwesterly plunge;

(5) L_2 is widely dispersed;

(6) L_3 is widely dispersed and trends more northwesterly than L_2; and,

(7) the direction of slip (shear) associated with F_3 folds plunges gently to the southwest, congruent with L_1, and the plane of slip (shear) is parallel to S_1. The sense of shear is a relative overriding to the northeast.

Interpretation of Structure

The folded mylonite fabric is similar to that seen in mylonite zones of the Blue Ridge thrust sheet of the southern Appalachians, and the Moine thrust zone in Scotland. The interpretation of the structures in the Indigo Lake area follows that proposed by Bryant and Reed (1969) for those areas. S_1 was produced by cataclasis, and the microrodding may be the direction of shear and elongation during cataclasis. F_2 and F_3 folds were likely initiated during mylonitization, and were overturned, flattened, and rotated towards the direction of maximum shear and elongation during the deformation. F_2 folds were initiated early in cataclasis and were rotated and flattened more than the later-initiated F_3 folds. The northeast vergence of F_3 folds defines the direction of transport during deformation. The F_2 and F_3 folds are end members of a continuum formed during one progressive deformation and do not represent two distinct folding episodes. The great circle girdles which contain the hinge lines of F_2 and F_3 folds reflect both the initial orientation of the hinge lines and their subsequent rotation towards the plane of shear in the direction of maximum shear and elongation during progressive deformation. The flat-lying cataclastic foliation parallels the thrust surface at the base of the mylonite and likely acted as a plane of weakness along which the allochthon detached and slid during emplacement.

Age, Origin, and Regional Significance of the Allochthon

Cataclasis occurred before deposition of the Jura-Cretaceous greywacke-tuff unit, because the greywacke contains mylonite fragments. Metamorphism and cataclasis occurred in the allochthon before its emplacement. The mylonite may have formed during obduction of the Anvil Allochthon, and was thrust with it over the Omineca Crystalline Belt and in some places onto Cassiar Platform. Internal structure of the mylonite is consistent with northeasterly shear by overriding blocks. The Teslin Suture was likely the root zone of the mylonite sheet, deformation and obduction occurring along the suture during its closing in the Mesozoic. If so the mylonite has a minimum displacement of some 120 km, measured southwesterly from its leading edge in the Indigo Lake area to the suture. Fifteen km are demonstrated in the Indigo Lake area and another 9 km beneath a klippe in Quiet Lake map area to the southwest. The time-span between cataclasis and allochthon (mylonite) emplacement may have been short, the latter occurring in the Jura-Cretaceous (post-Late Triassic to pre-mid-Cretaceous), concurrent with deformation of the autochthon.

Relations in the Indigo Lake area indicate that the mylonite represents a large and probably regionally extensive thrust sheet of which similar rocks in other areas may be a part, but whose structural relations have not been recognized.

SUMMARY AND CONCLUSIONS

Autochthonous sedimentary and volcanic rocks of Late Cambrian to Jura-Cretaceous age are overlain by allochthonous mylonite. The autochthon comprises five assemblages:

(1) Cambro-Ordovician basalt and tuff were erupted from local centres and intertongue with contemporaneous marine pelite. The basalt forms thick local accumulations that may have been built above sea level. Ordovician black graptolitic shale conformably overlies the volcanic succession.

(2) Siluro-Devonian marine platy siltstone and shallow water carbonate were deposited on a broad, tectonically stable platform. Widespread Lower and Middle Silurian siltstone is succeeded by Upper Silurian to Middle Devonian dolomite and lesser quartz arenite. A sub-Devonian unconformity occurs within the assemblage. The platform was produced by latest Ordovician uplift and erosion.

(3) Devono-Mississippian quartz-chert turbidites, chert, and acid volcanics represent a time of tectonic instability and foundering of the Siluro-Devonian platform. Trachyte and rhyolite flows and tuffs erupted from local centres and intertongue with the clastics. The assemblage lies above a disconformity that locally cuts Cambro-Ordovician strata. The disconformity reflects local uplift and erosion associated with block faulting of a generally subsiding platform, so that regionally, some areas were not eroded but received sediment continuously. Composition of the turbidites indicates derivation from bedded chert and gritty siliceous sandstone, the latter possibly of late Proterozoic age.

(4) Carboniferous and Upper Triassic marine shale, siltstone and minor limestone were deposited on a stable marine shelf. A disconformity separates Upper Triassic from Paleozoic rocks. Regional correlation and local remnants of Carboniferous strata suggest this Upper Triassic unconformity may be combined with several upper Paleozoic unconformities.

(5) Jura-Cretaceous greywacke is derived from volcanic and metamorphic terranes and volcanic tuff and andesite were produced by contemporaneous intermediate volcanism. The greywacke contains mylonite fragments derived from the allochthon tectonically above it; volcanic detritus may derive from local sources or from volcanic suites of the Anvil Allochthon. The greywacke and rare correlative strata are remnants of what may have been a "clastic wedge" shed from these allochthons during their emplacement. The assemblage lies unconformably on Upper Triassic strata.

The autochthon is folded and imbricated by northeasterly directed thrust faults. Slaty cleavage is pervasive, dipping moderately to steeply southwest and folds are upright or overturned to the northeast and plunge gently southeast. In a narrow zone of backfolding adjacent Tintina Trench bedding and northeasterly overthrusts are overturned to the southwest and cleavage dips steeply northeast. Post-Late Triassic pre-mid Cretaceous shortening amounted to 36 km, about 10 km of this by folding. Adjacent to Tintina

Trench a narrow zone of anastomosing faults cutting folds and thrusts was produced in response to Late Cretaceous dextral movement along Tintina Fault. Late normal faults of large displacement divide the Indigo Lake area into fault-bounded panels of different levels of exposure and destroy the continuity of earlier structures. Reactivation of Late Triassic and possibly Middle Devonian faults occurred locally.

The allochthon occurs as klippen of mylonite above unsheared and unmetamorphosed Jura-Cretaceous and Upper Triassic strata. Quartz-muscovite mylonite, lesser albite-chlorite mylonite and minor calc-silicate are the main rock types. Metamorphism is of lower greenschist facies grade.

The internal structure of the allochthon indicates a complex structural history. Bedding is rarely discernible and large-scale structures are not known. A flat-lying cataclastic foliation is the dominant planar fabric and is folded by two generations of folds. Open to tight northwest-trending recumbent folds are overprinted by open to tight folds of similar trend with a strong northeast vergence. The two phases are end members of a continuum formed during one progressive event. The fabric and fold geometry indicate that the rocks are mylonites produced by northeasterly shear. Textural evidence shows that metamorphism predates and was contemporaneous with cataclasis. The cataclastic foliation served as a plane of weakness along which the allochthon detached and slid during its emplacement coincident with deformation of the autochthon. The mylonite may have formed during obduction of the Anvil Allochthon, the Teslin Suture being the likely root zone of the mylonite sheet. If so, the mylonite allochthon has a displacement measured southwesterly from its leading edge in the Indigo Lake area to the suture of some 120 km.

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APPENDIX

Fossil Identifications

The following fossil collections, made by the author from various parts of the map area, were identified by paleontologists of the Geological Survey of Canada.

Field no.	Location, Fauna & Age	G.S.C. loc. no. Identified by:
Graptolitic Shale - Op		
TOM-74-88C1	61°24.8'N, 131°34.3'W diplograptid **Climacograptus** sp. age: Middle Ordovician to Early Silurian	C-46784 B.S. Norford
TOM-74-88B1	61°24.8'N, 131°34.3'W graptolite fragments **Phyllograptus**? sp. age: Early to Middle Ordovician, Probably Arenig to Llanvirn	C-46784 B.S. Norford
TOM-74-71B4	61°23.3'N, 131°31.3'W indeterminate graptolites **Climacograptus** sp. age: Middle Ordovician to Early Silurian, probably Ordovician	C-46788 B.S. Norford
TOM-74-96C1	61°23.8'N, 131°32.6'W **Climacograptus** sp. **Dicellograptus** sp. diplograptid age: Ordovician, Llandeilo to Ashgill	C-46798 B.S. Norford
TOM-74-95C1	61°23.8'N. 131°32.5'W **Climacograptus** sp. **Dicellograptus** sp. diplograptid age: Ordovician, Llandeilo to Ashgill	C-46799 B.S. Norford
TOM-74-90I1	61°24.3'N, 131°33.3'W **Climacograptus** sp. **Dicellograptus** sp. **Dicranograptus** sp. diplograptid age: late Middle Ordovician, Caradoc	C-46800 B.S. Norford
TOM-74-88D3	61°24.8'N, 131°34.3'W diplograptid **Climacograptus** sp. **Glossograptus** sp. age: Middle Ordovician, Llanvirn to Caradoc	C-46850 B.S. Norford
TOM-75-124A	61°11.5'N, 131°28.2'W **Didymograptus** sp. **Phyllograptus**? sp. **Tetragraptus** sp. age: Ordovician, Arenig to Llanvirn	C-45515 B.S. Norford
Siltstone - Ss		
TOM-74-106E1	61°25.3'N, 131°29.5'W **Climacograptus**? **Monograptus**? **M. ex** gr. **M. spiralis** (Geinitz) age: Early Silurian, late Llandovery, **Monograptus spiralis** Zone	C-46796 B.S. Norford
TOM-74-110I1	61°23.8'N, 131°28.8'W **Monograptus**? sp. **M. ex** gr. **M. spiralis** (Geinitz) **Retiolites**? sp. age: Early Silurian, late **Monograptus spiralis** Zone	C-46797 B.S. Norford
TOM-75-157A	61°11.7'N, 131°41.5'W **Monograptus** sp. age: Silurian	C-44516 B.S. Norford

Dolomite - uSDc

Field no.	Location, Fauna & Age	G.S.C. loc. no. Identified by:
TOM-75-520B	61°15'N, 131°34'W undetermined fossil echinoderm debris indeterminate solitary coral **Spinatrypa** sp. age: Middle Silurian (Wenlock) to Late Devonian (Frasnian) probably Middle or Late Silurian	C-46790 B.S. Norford

Comments

The material is poorly preserved but the biconvex nature of the **Spinatrypa** indicates Silurian rather than Devonian age. **Spinatrypa** is not characteristic of Llandovery faunas.

TOM-75-76B	61°18'N, 131°27'W echinodenm debris pentamerid brachiopod **Catenipora**? sp. indeterminable rugose corals age: Silurian	C-47996 B.S. Norford
TOM-75-450B	61°17.9'N, 131°42.8'W **Amphipora**? sp. **Coenites** sp. echinodern ossicle with single axial canal age: Devonian	C-53043 A.W. Norris
TOM-75-146A	61°11.8'N, 131°43.9'W **Amphipora**? sp. - replaced by crystalline dolomite age: Devonian?	C-53046 A.W. Norris

Shale-Siltstone - CTRps

TOM-74-57C1	61°22.8'N, 131°29.9'W **Monotis** sp. indet. age: Late Middle Norian (Columbianus Zone) or Upper Norian	91785 E.T. Tozer
TOM-74-55C2	61°22'N, 131°29.5'W 2 crushed ammonoids – probably **Juvavites** (s.s.) sp. age: Probably Middle Norian (Magnus Zone)	91786 E.T. Tozer
TOM-74-76A1	61°23.2'N, 131°29.5'W impressions of serpenticone ammonoid sculptured only with radial lirae moulds and impressions of solitary coral, apparently with bilateral symmetry age: Possibly Paleozoic. The coral specimens will be submitted to E.W. Bamber. I am not aware of anything comparable from the Triassic.	91787 E.T. Tozer
TOM-74-76A1	61°23.2'N, 131°29.5'W rugose coral-unidentifiable ammonoids-unidentifiable according to W.W. Nassichuk age: Late Middle Ordovician to Permian. The sample has been scanned, but not disintegrated for conodonts. None were found.	91787 E.W. Bamber

Field no.	Location, Fauna & Age	G.S.C. loc. no. Identified by:
TOM-75-8A	61°20.5'N, 131°20'W trilobite pygidium hapsiphyllid coral, probably new genus ? **Prospira** sp. orthotetid, productoid, spiriferid, and rhynchonellid brachiopods-poorly preserved age: Definitely Carboniferous or Permian; probably Late Tournaisian or Early Visean (=middle Mississippian)	C-41894 E.W. Bamber
TOM-75-231A	61°14'N, 131°47'W fish tooth conodonts: juvenile **Neogondolella** – approximately 20 specimens (probably **N. navicula navicula** (Huckriede)) 1 unidentifiable juvenile platform **Enantiognathus ziegleri** (Diebel) **Ozarkodina** sp. **Neospathodus** sp. conodont bar and blade fragments age: Late Triassic, Karnian or Norian	93435 B.E.B. Cameron
TOM-75-420B	61°16.7'N, 131°44.5'W pellets spines fish debris bone fragments radiolaria nodosarid foraminifer conodonts: **Metapolygnathus polygnathiformis** (Budurov & Stefanov) – approximately 100 good specimens plus many **M. polygnathiformis** fragments Few unidentifiable blade fragments age: Late Triassic, Late Ladinian – Late Karnian – abundance of this form suggests a Late Karnian age may be preferable	93436 B.E.B. Cameron
TOM-75-442B	61°17.2'N, 131°44'W few spines few pyritized bivalves and spheres nodosarid? foraminifer age: indeterminate, Carboniferous to Triassic	93437 B.E.B. Cameron
TOM-75-509A	61°14.2'N, 131°34.9'W sponge spicules small pyritized bivalves radiolaria 1 small fragment – possibly conodont foraminifers – **Ammodiscus**? **Nodosaria**? age: no definite age available from these fossils, however, radiolaria are similar to assemblages from dated Late Triassic rocks.	93438 B.E.B. Cameron
TOM-75-517A	61°14.3'N, 131°34.9'W spines pyritized bivalves radiolaria age: no definite age available from these fossils, but as in 93438 the radiolaria are similar to assemblages from dated Late Triassic rocks	93439 B.E.B. Cameron

Field no.	Location, Fauna & Age	G.S.C. loc. no. Identified by:
TOM-75-518A	61°14.9'N, 131°34.9'W spines pyritized bivalves conodonts: **Neogondolella navicula navicula** (Huckriede) – 1 specimen 2 juvenile **Neogondolella** sp. nodosarid foraminifer few radiolaria (as in previous sample) age: Late Triassic, Karnian or Norian	93440 B.E.B. Cameron
TOM-75-535A	61°14.9'N, 131°37.4'W conodonts: **Neogondolella** or **Metapolygnathus** sp. fragment age: probably Late Triassic	93442 B.E.B. Cameron
TOM-75-536A-2	61°14.1'N, 131°37'W silicified spheres conodonts: **Neogondolella navicula navicula** (Huckriede) – 10 good specimens many juvenile **Neogondolella** sp. and **N. navicula navicula** fragments **Enantiognathus** sp. Some conodont bars and blade fragments fish tooth age: Late Triassic, Karnian or Norian	93443(b) B.E.B. Cameron
TOM-75-537A	61°14.6'N, 131°37'W pellets bivalves ammodiscoid foraminifers 2 radiolaria rare fish? debris age: indeterminate; approximately same assemblage as G.S.C. loc. 93438; suggested late Triassic age.	93444 B.E.B. Cameron
TOM-76-36-2	61°17.5'N, 131°45.4'W trace of skeletal material foraminifera bivalves conodonts: 2 juveniles – **Neogondolella navicula navicula** (Huckriede)? age: Late Triassic	93527(b) B.E.B. Cameron
TOM-76-36-7	61°17.5'N, 131°45.4'W frosted sand white pellets trace of skeletal material conodonts: **Epigondolella abneptis** (Huckriede) **Epigondolella primitia** (Mosher) – numerous fragments age: Late Triassic, Lower Norian	93527(g) B.E.B. Cameron