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EVOLUTION OF THE NORTHERN CORDILLERAN MIOGEOCLINE, NAHANNI MAP AREA (105I), YUKON AND NORTHWEST TERRITORIES

S.P. Gordey and R.G. Anderson

1993

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Cover Description

Southwest-verging overturned folds in sandstone and shale of the Hyland Group (Yusezyu Formation) in southwest Nahanni map area, formed during regional Jura-Cretaceous deformation. These Late Proterozoic and earliest Cambrian turbiditic clastics, locally more than 3 km thick, form the oldest exposed strata of the Sewlyn Basin.

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Preface

The well-exposed late Precambrian to Triassic strata and mid-Cretaceous plutonic rocks of Nahanni map area record a large segment of the evolution of the western North American continental margin. Through much of the early and middle Paleozoic, deposition of two contrasting facies predominated: shale, chert, and turbiditic sandstone on the southwest were flanked by coeval shelf carbonate on the northeast. The former facies, constituting the Selwyn Basin, is well known for its stratiform shale-hosted lead-zinc deposits. The latter, the Mackenzie Platform, has in the past been the focus of exploration for lead-zinc deposits hosted in carbonate rocks. This shelf-basin configuration is overlapped by chert-rich clastic rocks of Devono-Mississippian age. These were deposited during active extensional tectonism that also led to the formation of important exhalative deposits of stratiform lead-zinc-silver-barite. Mid-Cretaceous plutonic rocks in the region are associated with large deposits of tungsten.

This memoir presents a detailed account of the tectonic evolution, stratigraphy, structure, and igneous history of Nahanni map area; mineral deposits are summarized and described in terms of their regional geological setting. It provides basic geological data and a geological framework critical to the appraisal of and search for mineral deposits, and to other geological studies in the region.

Elkanah A. Babcock
Assistant Deputy Minister
Geological Survey of Canada

Préface

Les strates bien exposées de la fin du Précambrien jusqu'au Trias ainsi que les roches plutoniques du milieu du Crétacé dans la zone observée de Nahanni enregistrent un grand segment de l'évolution de la marge continentale nord-américaine. Pendant la plus grande partie du début et du milieu du Paléozoïque, la mise en place de deux faciès contrastants a prédominé: des grès schisteux, cherteux et turbuditiques au sud-ouest étaient flanqués par du carbonate de plate-forme contemporain au nord-est. L'ancien faciès, constituant le bassin de Selwyn, est bien connu pour ses gisements de plomb-zinc encaissés dans des schistes argileux stratiformes. Le second, la plate-forme de Mackenzie, a autrefois fait l'objet de travaux d'exploration visant à déceler des gisements de plomb-zinc encaissés dans des roches carbonatées. Cette configuration de plate-forme-bassin est recouverte de roches clastiques à forte teneur en chert d'âge dévono-mississippien. Ceux-ci ont été déposés au cours d'une phase tectonique active et prolongée qui a aussi mené à la formation d'importants gisements exhalatifs de plomb-zinc-argent-barytine stratiformes. Les roches plutoniques du milieu du Crétacé que l'on trouve dans la région sont associées à de gros gisements de tungstène.

Le mémoire donne un compte rendu détaillé de l'évolution tectonique, de la stratigraphie, de la structure et de la séquence magmatique de la zone représentée sur la carte de Nahanni; les gisements de minéraux sont résumés et décrits du point de vue de leur cadre géologique régional. Le mémoire fournit des données géologiques de base ainsi qu'un cadre géologique essentiel à l'évaluation des gisements minéraux et à la recherche de ceux-ci, ainsi qu'à d'autres études géologiques menées dans la région.

Elkanah A. Babcock, sous-ministre adjoint,
Commission géologique du Canada

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EVOLUTION OF THE NORTHERN CORDILLERAN MIOGEOCLINE, NAHANNI MAP AREA (105I), YUKON AND NORTHWEST TERRITORIES

Abstract

Late Precambrian to Triassic weakly metamorphosed sedimentary rocks that underlie most of Nahanni map area form three sequences:

1.) From the late Precambrian to Middle Devonian two northwest-trending facies belts developed consisting of shallow water carbonate and sandstone (Mackenzie Platform) on the northeast and time-equivalent turbiditic sandstone, deep water limestone, shale, and chert (Selwyn Basin) on the southwest. Euxinic shale of Early Silurian age is host to important stratiform lead-zinc deposits. The aggregate thickness of Lower Cambrian to Middle Devonian rocks ranges from 4200 m for platform and near-platform strata to 1600 m for outer basin strata.

2.) In the Late Devonian and Mississippian, shale was deposited across the Mackenzie Platform, whereas to the southwest, turbiditic quartz-chert sandstone and chert-pebble conglomerate (900+? m) were deposited, derived from elevated fault blocks of Selwyn Basin strata. Stratiform barite and lead-zinc-barite deposits occur within siliceous shale of Middle to Late Devonian age.

3.) Early Mississippian to Triassic sedimentation was dominated by shale, chert, minor sandstone, and siltstone (1700 m) deposited on a shallow marine shelf.

Regional Jura-Cretaceous deformation resulted in decollement style northwest-trending folds and minor thrust faults. Competent strata of Mackenzie Platform formed large-scale open folds. The incompetent strata of the Selwyn Basin area were deformed into small- to large-scale, open to tight folds with associated axial-plane cleavage.

Granitic intrusions of the mid-Cretaceous (100 Ma) Selwyn Plutonic Suite crosscut the regional structure. Tungsten skarn deposits are preferentially associated with biotite-muscovite-bearing plutons where they contact argillaceous limestone of various ages.

Résumé

Les roches sédimentaires peu métamorphisées, du Précambrien supérieur au Trias, qui constituent le sous-sol de la majeure partie de la région cartographique de Nahanni, forment trois séries:

1.) Du Précambrien supérieur au Dévonien moyen, il y a eu formation de deux zones de faciès, de direction nord-ouest, constituées de roches carbonatées et de grès mis en place en eau peu profonde (plate-forme de Mackenzie) au nord-est, et de grés turbiditiques, de calcaire d'eau profonde, schiste argiteux et de chert (bassin de Selwyn) contemporains, au sud-ouest. D'importants dépôts stratiformes de plomb et de zinc logent dans des schistes argileux euxiniques datant du Silurien inférieur. L'épaisseur totale des couches qui couvrent la période du Cambrien inférieur au Dévonien moyen varie de 4200 m pour les couches de la plate-forme et celles qui se trouvent près de la plate-forme, à 1600 m pour les couches situées à l'extérieur du bassin.

2.) Du Dévonien supérieur au Mississipien, des schistes argileux ont été mis en place sur la plate-forme de Mackenzie, alors qu'au sud-ouest avaït lieu la mise en place de grès à quartz et chert turbiditiques et des conglomérats à galets de chert (900+ ? m), provenant de blocs faillés suréléves appartenant aux couches du bassin de Selwyn. Des dépôts stratiformes de barytine et de plomb-zinc-bar ytine se trouvent dans des schistes argileux de nature silicence datant du Dévonien moyen au Dévonien supérieur.

3.) Les roches sédimentaires couvrant la période du Mississipien inférieur au Trias sont surtout constituées de schistes argileux, de cherts, de petites quantités de grès et de microgrès (1700 m) mis en place sur un haut-fond marin.

La déformation régionale survenue au Jurassiaque et au Crétacé a donné des plis de décollement de direction nord-ouest et des failles chevauchantes secondaires. Des couches compétentes de la plate-forme de Mackenzie ont donné naissance à des plis ouverts à grand rayon de courbure. Les couches incompétentes de la région du bassin de Selwyn ont été déformées et ont donné des plis ouverts à serrés à rayon de courbure faible à grand, associés à une schistosité parallèle au plan axial.

Des intrusions granitiques de la série ploutonique de Selwyn du Crétacé moyen (100 Ma) traversent la structure régionale. Des dépôts de skarn à tungstène sont plutôt associés à des plutons à biotite et à muscovite aux endroits où ils sont en contact avec des calcaires argileux d'âges variés.

SUMMARY

Late Precambrian to Triassic weakly metamorphosed sedimentary rocks underlie most of Nahanni map area and likely were deposited above unevenly rifted and thinned older sediments and continental crust of the North American craton. The stratigraphic succession has been subdivided into three assemblages of distinct tectonic affinity.

Late Precambrian to Middle Devonian platform-basin assemblage

From the late Precambrian to Middle Devonian the area was segmented into two contrasting facies belts. On the northeast were deposited shallow water sandstone, dolostone, and limestone that define the Mackenzie Platform. To the southwest, time-equivalent rocks comprise turbiditic sandstone, deep water limestone, shale, and chert of the Selwyn Basin. Within the Selwyn Basin, euxinic black shale of Early Silurian age is host to important stratiform lead-zinc deposits. The platform-basin boundary shifted with time so that in the northeastern half of the map area formations of basin and platform affinity are interstratified. Numerous fossil collections, particularly conodonts, allow accurate correlation between platform and basin facies. Important unconformities occur beneath the Upper Cambrian, middle Lower Devonian, and lowermost Middle Devonian. The aggregate thickness of Lower Cambrian to Middle Devonian platform and thick basinal near-platform strata is about 4200 m, while that of equivalent outer basin strata is about 1600 m.

The oldest exposed strata within Selwyn Basin consist of latest(?) Precambrian turbiditic quartz sandstone at least 3000 m thick. They are younger than the Windermere Supergroup of Mackenzie Mountains with which they have previously been correlated. They may represent a younger Eocambrian rift event, as has been interpreted for similar strata in the southern Cordillera (Bond and Komînz, 1984).

SOMMAIRE

Des roches sédimentaires peu métamorphisées datant du Précambrien supérieur au Trias constituent le sous-sol de la majeure partie de la région cartographique de Nahanni; ces roches out probablement été mises en place sur la croûte continentale et sur des sédiments plus anciens, inégalement fissurés et amincis du craton nord-américain. La succession stratigraphique a été divisée en trois ensembles d'affinité tectonique caractéristique.

Ensemble de la plate-forme et du bassin du Précambrien supérieur au Dévonien moyen

Entre le Précambrien supérieur et le Dévonien moyen, cette région a été segmentée en deux zones de faciès très différentes. Au nord-est, il y a en sédimentation en milieu d'eau peu profonde des grès, des dolomies et des calcaires qui constituent la plate-forme de Mackenzie. Au sud-ouest, des roches, mises en place à la même période, se composent de grès turbiditiques, de calcaires d'eau profonde, schistes argileux et de cherts qui constituent le bassin de Selwyn. D'importants dépôts stratiformes de plomb et de zinc logent dans des chistes argileux noirs de nature euxinique datant du Silurien inférieur, que l'on trouve à l'intérieur du bassin de Selwyn. La limite entre la plate-forme et le bassin s'est déplacée dans le temps, de sorte que dans la moitié nord-ouest de la région cartographique les formations ayant une affinitié avec le bassin et celles ayant une affinitié avec la plate-forme sont interstratifiées. De nombreuses collections de fossiles, particulièrement des conodontes, permettent de corréler d'une façon précise les faciès de la palte-forme avec ceux du bassin. Des discordances importantes se manifestant sous le Cambrien supérieur, sous la partie intermédiaire du Dévonien inférieur, et sous la partie inférieure du Dévonien moyen. L'épaisseur totale des couches de la plate-forme datant du Cambrien inférieur au Dévonien moyen et des couches épaisses du bassin situées près de la plate-forme est de l'ordre de 4200 m, alors que des couches équivalentes situées à l'extérieur du bassin atteignant une épaisseur de l'ordre de 1600 m.

Les couches les plus anciennes qui affleurent au sein du bassin de Selwyn sont constituées de grès quartzeux turbiditiques du sommet du Précambrien, et mesurent au moins 3000 m d'épaisseur. Elles sont plus jeunes que celles du supergroupe de Windermere des monts Mackenzie avec lesquelles on les avait corrélées antérieurement. Elles peuvent représenter un fossé d'effondrement d'âge éocambrien plus jeune, comme dans le cas des couches similaires de la région sud de la Cordillère, (Bond et Komînz, 1984).

Devono-Mississippian turbidite basin assemblage

In late Devonian time there was an abrupt change in depositional regime. Shale was deposited across the older Mackenzie Platform to the northeast, while to the southwest turbiditic quartz-chert sandstone and chert-pebble conglomerate were deposited in a number of submarine fan complexes. The coarse clastics, 900+(?) m in thickness, are derived from elevated fault blocks of older Selwyn Basin strata at least 170 km to the northwest of the map area. In particular, most detritus seems to be derived from late Precambrian gritty quartzose clastic rocks and Ordovician-Silurian chert. Compressional deformation of Devono-Mississippian age is lacking. This and local synsedimentary steep, normal, or reverse faults within the map area and near the proposed source suggest an extensional or transtensional event may have elevated the source area. Regional unconformities occur beneath lower Upper Devonian and uppermost Devonian strata. Stratiform barite and barite-lead-zinc deposits, associated with local faulting, form important deposits within black siliceous shale of Middle to Late Devonian age.

Mississippian to Triassic clastic shelf assemblage

Devono-Mississippian turbiditic clastics were succeeded by mid-Mississippian quartz sandstone and shale interpreted as bar finger sands deposited on a muddy, shallow marine shelf. The quartz sand may have been derived from the east but chert in the sand suggests possible west or northwest source areas similar to those for the previous sequence. Shale, chert, minor sandstone, and siltstone compose strata of Early Permian and Triassic age. Regional unconformities occur beneath the Lower Mississippian, Lower Permian, and Lower Triassic. Aggregate thickness for this sequence is about 1700 m.

In the Early Cretaceous, the area was subject to northeast-southwest compression leading to the development of northwest-trending decollement style folds and minor thrust faults. Competent carbonate strata defining Mackenzie Platform formed large-scale open folds (Mackenzie Fold Belt). The largely incompetent strata of the Selwyn Basin area formed small- to large-scale, open to tight folds with pervasive axial-planar slaty cleavage (Selwyn Fold Belt). Folds and faults in both Mackenzie and Selwyn fold belts, by analogy with the structure of the northern and southern Canadian Rocky Mountains, may root in a detachment that extends beneath Nahanni map area and across the entire deformed belt of the Mackenzie Mountains.

Ensemble du bassin de turbidites du Dévonien et Mississipien

Au Dévonien supérieur, il y a eu un changement brusque du régime de sédimentation. Au nord-est, schistes argileux se sont déposés sur la plate-forme de Mackenzie plus ancienne, alors qu'au sud-ouest avait lieu la mise en place de grès quartzeux et cherteux de nature turbiditique et de conglomérats à galets de chert qui ont formé un certain nombre de cônes de déjection sous-marins complexes. Les roches détritiques à grain grossier, mesurant 900+ (?) m d'épaisseur, proviennent de blocs faillés projetés vers le haut appartenant aux couches anciennes du bassin de Selwyn, situées au moins à 170 km au nord-ouest de la région à l'étude. La majeure partie du matériel détritique semble provenir en particulier de roches détritiques, gréseuses et quartzeuses du Précambrien supérieur et de cherts de l'Ordovicien-Silurien. Les déformations de compression du Dévonien-Mississipien sont absentes. Cet événement, ainsi que la présence par endroits de failles synsédimentaires abruptes de type normal ou inverse se trouvant dans la région à l'étude et à proximité de la source proposée, semblent indiquer qu'un événement d'extension peut avoir élevé la région source. Des discordances régionales se manifestent sous des couches de la partie inférieur du Dévonien supérieur et celles du sommet du Dévonien. D'importants dépôts stratiformes de barytine et de barytine, plomb et zinc, associés à des failles locales, logent au sein de schistes argileux noirs de nature siliceuce dantant du Dévonien moyen à supérieur.

Ensemble de roches détritiques de la plate-forme continentale, du Mississipien au Trias

Des grès quartzeux et des schistes argileux ont succédé aux roches détritiques, turbiditiques, du Dévonien-Mississipien, et, d'après l'auteur, sont des bancs de sable étroits et allongés, déposés sur un haut fond marin vaseux. Le sable quartzeux a pu venir de l'est, mais le chert qui se trouve dans le sable semble indiquer qu'il existait des régions sources possibles à l'ouest ou au nord-ouest, similaires à celles de la séquence précédente. Les couches du Permien inférieur et du Trias se composent de schistes argileux, de cherts, et de petites quantités de grès et de microgrès. Des discordances régionales se manifestant sous la partie inférieure du Mississipien inférieur, sous la partie inférieure du Permien inférieur et sous le Trias inférieur. L'épaisseur totale de cette séquence est d'environ 1700 m.

Au Crétacé inférieur, la région a subi une compression de direction nord-est-sud-ouest qui a donné naissance à des plis de décollement de direction nord-ouest et à des failles chevauchantes secondaires. Des couches compétentes carbonatées, qui caractérisent la plate-forme de Mackenzie, ont donné des plis ouverts à grand rayon de courbure (zone de plissement de Mackenzie). Les couches, en grande partie incompétentes, de la région du bassin de Selwyn ont donné des plis ouverts à serrés, à rayon de courbure faible à grand, associés à une schistosité omniprésente parallèle au plan axial (zone de plissement de Selwyn). Les plis et les failles des zones de plissement de Mackenzie et de Selwyn, par analogie avec la structure des secteurs septentrional et méridional des Rocheuses du Canada, peuvent prendre racine dans un décollement qui s'étend en-dessous de la région cartographique de Nahanni et qui traverse toute la zone déformée.

Granite and granodiorite intrusions of the mid-Cretaceous Selwyn Plutonic Suite underlie about seven percent of the map area. Generally circular in plan, and from less than 1 km to 20 km in diameter, they intrude and hornfels strata as young as Triassic (aureoles to 3 km across). As well, they crosscut regional folds and locally, faults. Isotopic ages (mineral K-Ar and whole rock-mineral Rb-Sr isochrons) for the suite range from 88 to 114 Ma. Two major pluton types can be distinguished by the presence of hornblende, or alternatively, the presence of biotite plus muscovite. Each type also possesses clear differences in major, minor, and trace element abundances, as well as radiogenic and stable isotope ratios. Together, the radiogenic and stable isotopes indicate a significant contribution of old, radiogenic, metasedimentary, sialic crust in the petrogeneses of both varieties of pluton. Tungsten showings are associated with skarns developed next to two-mica plutons that intrude argillaceous limestone.

Regional metamorphic grade is subgreenschist facies. Conodont colour alteration indices and metamorphism of organic matter indicate maximum temperatures of about 300°C, probably associated with above normal heat flow related to Cretaceous deformation and intrusion.

Des intrusions de granite et de granodiorite faisant partie de la série plutonique de Selwyn du Crétacé moyen constituent environ 7% de la région à l'étude. De forme généralement circulaire en surface et de diamètre variant de moins d'un kilomètre à 20 kilomètres, ces intrusions traversent les couches sédimentaires, dont les plus récent3es sont triasiques, et métamorphisme (auréoles atteignant 3 km de large). Elles traversent aussi des plis régionaux et par endroits des failles. Les âges obtenus par méthode radiochronologique (isochrones du système K-Ar et de la roche entière-système Rb-Sr) pour la série varient de 88 à 114 Ma. On peut distinguer deux types importants de plutons par la présence de la hornblende ou bien par la présence de la biotite et de la muscovite. Chaque type présente en outre des différences nettes dans les abondances d'éléments majeurx, mineurs et à l'état de traces, ainsi que dans les rapports des isotopes stables et des isotopes radiogéniques. Ces deux types d'isotopes indiquent que la croûte sialique ancienne, radiogénique et métasédimentaire a beaucoup contribué à la pétrogenèse des deux types de pluton. Des manifestations de tungstène sont associées à des skarns formés à proximité de plutons à deux micas qui ont pénétré des calcaires argileux.

Le métamorphisme régional a atteint un sous-faciès des schistes verts. Des indices d'altération de la couleur de conodontes et le métamorphisme de matières organiques indiquent des températures maximales d'environ 300°C, associées probablement à un flux de chaleur au-dessus de la normale, lié aux déformations et aux intrusions du Crétacé.

INTRODUCTION

Nahanni map area (latitude 62-63°N, longitude 128-130°W; NTS 105 I) includes well-exposed sedimentary, plutonic, and minor volcanic rocks of late Precambrian to Cretaceous age that record a large part of the evolution of the northwestern North American margin. Previously, the stratigraphy of the map area was only vaguely known, and its structural evolution poorly understood. Knowledge of the setting of important tungsten and stratiform lead-zinc occurrences was correspondingly inadequate. This memoir establishes a formal stratigraphic nomenclature and correlations for 31 formations, 11 of them new. The granitic rocks, important for their associated tungsten mineralization, are described in detail. The memoir also outlines the sedimentary, structural, and tectonic development of this part of the Cordilleran orogen.

The area was mapped mainly during the 1977 to 1980 field seasons. In 1980 the bedrock mapping was incorporated within a larger project of the Geological Survey of Canada known as the "Nahanni Integrated Multidisciplinary Pilot Project." Its aim was to provide reconnaissance coverage of the area in bedrock geology, geochemistry, and surficial geology, and to include site specific and detailed studies of the plutonic rocks and of certain important mineral deposits. Reports by other officers of the Geological Survey of Canada on topics other than bedrock geology are presented elsewhere.

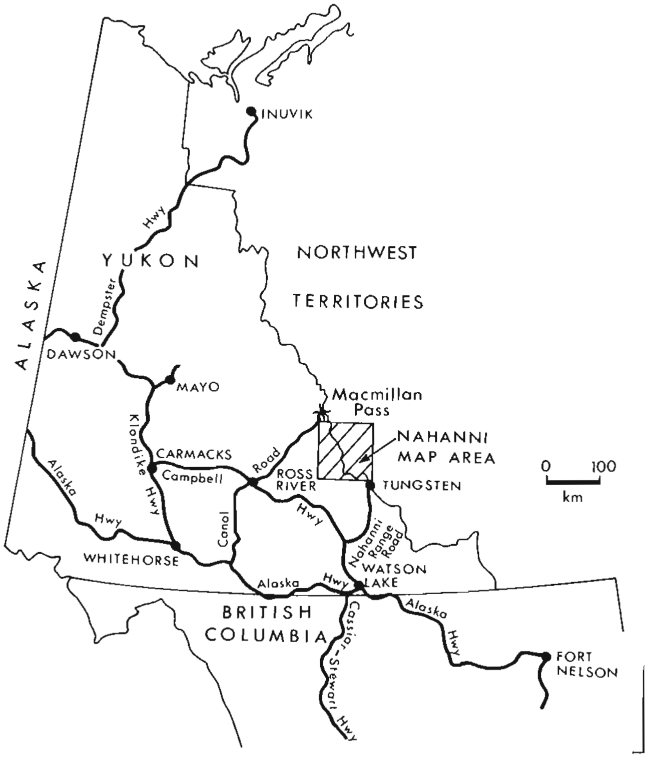

Figure 1. Location and access to Nahanni map area.

Location and access

Nahanni map area straddles the Yukon Territory-Northwest Territories border in the remote Mackenzie and Selwyn mountains. Access to the southeastern corner of the map area (Fig. 1) is provided by an all-weather gravel road (Nahanni Range Road) that extends from Watson Lake to the mine site of Tungsten. However, since closure of the mine in May 1986, maintenance of the road has been irregular. A dirt road constructed by Placer Development Ltd. in 1977 and 1978 for access to their Howards Pass mining property connects with the Nahanni Range Road near Tungsten. This extends to near the centre of the map area, but washouts render it impassable even to four-wheeled drive vehicles. A gravel road maintained during summer months (North Canol Road) extends from Ross River to Macmillan Pass, within 13 km of the northwestern corner of the map area.

Float-equipped aircraft may land on many of the lakes in the region and also on the lower reach of the South Nahanni River (Fig. 2) if conditions of weather and water level are favourable. A 520 m long gravel airstrip on Placer Development's Howards Pass property near the centre of the map area (Morganti, 1979) and a 400(?) m strip on their Anniv property some 21 km to the northwest (Morganti, 1979, Plate III) are not maintained. For most of the region the only rapid access is by helicopter. Except for a few areas of exceptionally rugged terrain, ridge landings and travel by foot are unimpeded.

During the present study the towns of Watson Lake and Ross River were used as bases for supplies and communications.

Physiography

Nahanni map area is mostly mountainous; it includes parts of Mackenzie and Selwyn mountains and Yukon Plateau (Fig. 2 and 3). Mackenzie Mountains are underlain by resistant carbonate strata that tend to form sharp-crested ridges and in places, rugged topography. The less rugged but equally high Selwyn Mountains are underlain by recessive clastic strata that weather to round-shouldered felsenmeer and scree-covered ridges and slopes. The highest peaks and most rugged areas, largely impassable on foot, are underlain by granitic rocks. Sheer granite walls and spires characterize the extremely rugged northwestern end of the Ragged Range, areas southeast of O'Grady Lake and north of Margaret Lake, and the northeastern end of the Itsi Range. In these higher areas, small permanent ice fields, alpine glaciers, and deeply incised cirques form a spectacular landscape. Glaciation of the area during the Wisconsin-age McConnell advance produced diverse glacial features including eskers and kame terraces in many of the large valleys, meltwater channels, and streamlined bedrock ridges (Jackson, 1982). Rock glaciers are abundant and locally spectacularly developed within a large area of Lower Cambrian slate in the southeastern quarter of the map area.

In west-central Nahanni map area, the headwaters of Pelly River drain a broad upland region, part of the Yukon Plateau, of low rolling hills separated by wide flat-bottomed valleys with shallowly incised streams. In Selwyn Mountains (east of Mount Pike), peaks rise from remnants of a wide plateau (at 5000-5500 foot elevation (1524-1676 m)) scattered with lakes and deeply incised by streams. West of Moose Lake a conspicuous flat-topped ridge (at 6500 foot elevation (1981 m)) is the result of incomplete headward stream or glacial erosion of a remnant plateau surface.

Several major drainage systems have their headwaters in the area. A major drainage divide defines the Northwest Territories-Yukon Territory border and separates the South Nahanni River on the northeast from the Pelly, Ross, and Hyland rivers to the southwest. Valley profiles range from narrow and U-shaped to broad and flat-bottomed. Most major stream valleys are incised to 3500 feet (1067 m) above sealevel and most peaks and ridges range from 5000 to 6500 feet (1524-1981 m). Elevations reach a low of 2500 feet (762 m) in the deeply incised South Nahanni River and a high of 8500+ feet (2591+ m) in the granite-cored Ragged Range. Timberline is at 4500 to 5000 feet (1372-1524 m), below which bedrock exposure is sparse.

Climate during June, July, and August is pleasant, with daytime temperatures in the low 20's (°C) and moderate precipitation. Temperatures at night may go below freezing in early June. By early to mid-June snow cover has receded to allow work in many parts of the area, and by late June snow ceases to be a hindrance. Cold spells with light snowfall may occur in August, but usually do not delay field operations for more than a few days. Field work can usually continue into early September about which time snow and cold can be a hindrance.

Previous geological work

The earliest geological exploration of the area was Keele's (1910) reconnaissance along the Ross and Gravel (now Keele) rivers, which includes brief descriptions of the area northwest of Mount Wilson. Kindle (1945) mapped this same area at a scale of one inch to four miles as part of a geological traverse along Canol Road from Teslin to Macmillan Pass.

The first systematic geological mapping was in 1960 by the Geological Survey of Canada as part of "Operation Pelly". In one month about three fourths of Nahanni map area was mapped at a scale of one inch to four miles (Green and Roddick, 1961). Blusson (Blusson et al., 1968) completed the northeastern quarter at the same scale and made minor revisions elsewhere.

Blusson (1968) described the geological setting of the tungsten deposits at Tungsten, Northwest Territories. His map, at a scale of one inch to one mile, covers an area straddling Flat River and extending south from the southern boundary of the Nahanni area (Fig. 4).

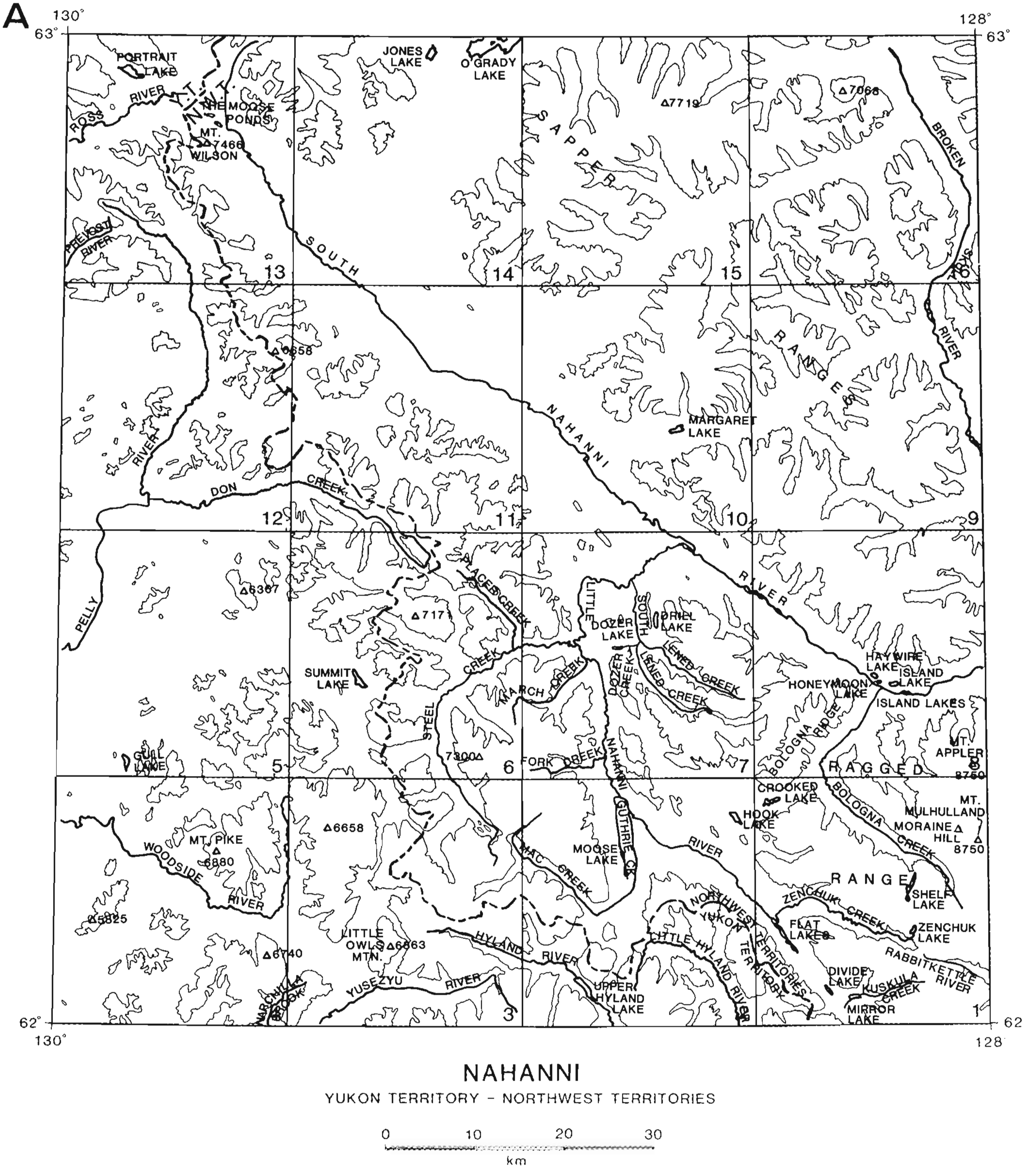

Figure 2. Place names referred to in text. Shown for reference are 5000 foot (1524m) topographic contours and 1:50 000 NTS map areas (labelled 1 to 16). **A.** Named topographic features in Nahanni map area. All names shown (many not yet on any published maps) are sanctioned by the Canadian Permanent Committee on Geographical Names and will appear on future editions of the Nahanni topographic sheet (105I).[1] **B.** Named structural and plutonic features commonly referred to in text.

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[1] Edition 2 (metric) of the topographic base for this area was published as Little Nahanni River (105I) (1:250 000) subsequent to preparation of text figures. The edition 2 map is used as a topographic base for map 1762A (in pocket).

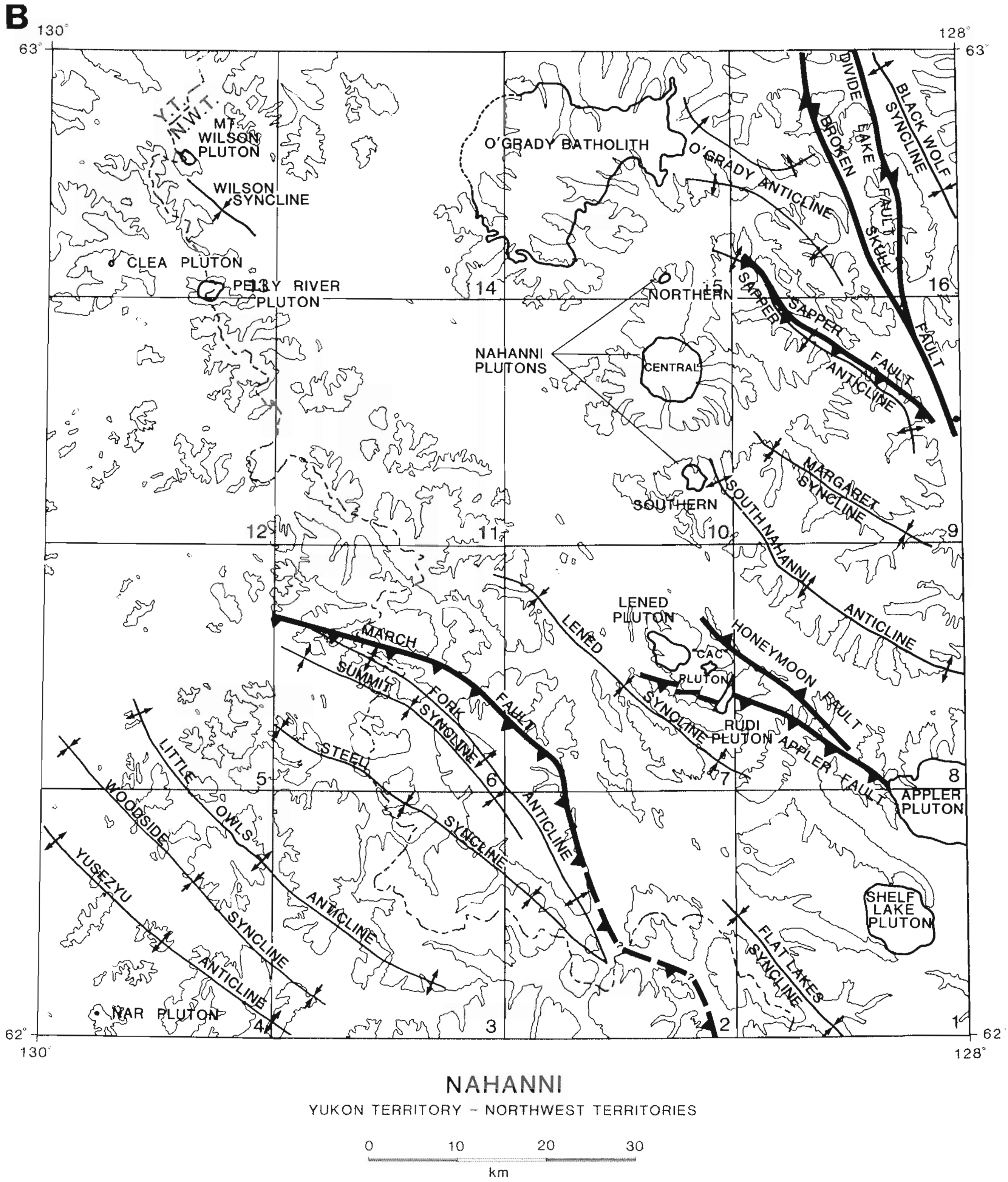

Figure 2. Continued.

Gabrielse et al. (1973) completed geological reconnaissance mapping at a 1:250 000 scale of Flat River (95E)[1], Glacier Lake (95L), and Wrigley Lake (95M) map areas to the east. Their comprehensive memoir established a stratigraphic nomenclature that has been adopted wherever possible in this report.

Preliminary reconnaissance geological maps at 1:250 000 scale, some with marginal notes, are available for nearby map areas (Fig. 4) including Frances Lake (105H) (Blusson, 1966), Finlayson Lake (105G) (Tempelman-Kluit, 1977a), Niddery Lake (105O) (Blusson, 1974), and Sheldon Lake (105J) (Roddick and Green, 1961a). Blusson's (1971) report on Sekwi Mountain (105P) map area includes a map at 1:250 000 scale and brief descriptions of many formations that continue into the Nahanni area. Cecile (1984a,c, 1986a,b) completed remapping of Niddery Lake map area (105O); preliminary maps at 1:50 000 scale are available for most of that area.

Several detailed studies have also been undertaken in the region. Godwin et al. (1980) described briefly the Clea tungsten skarn property 15 km southwest of Mount Wilson, and determined K-Ar and Rb-Sr isotopic ages for the Clea stock. Ludvigsen (1982) and Landing et al. (1980) described the trilobite and conodont biostratigraphy, respectively, of the Rabbitkettle Formation, District of Mackenzie. Both of these publications describe in detail a measured section in northeastern Nahanni map area. Abbott's (1982, 1983) investigations into the setting of important lead-zinc deposits at Macmillan Pass involve 1:50 000 scale mapping and detailed stratigraphic investigations that extend to the northern border of Nahanni map area.

Theses on the geology and mineral deposits within Nahanni map area are numerous. Morganti (1979) described the character and origin of the large stratiform lead-zinc deposits at Howards Pass (see section on Mineral Deposits for location of properties). His thesis includes a geological map at 1:32 160 scale of a large part of central Nahanni map area, as well as 1:4800 scale property maps (see also Morganti, 1981). Mako (1981; see also Mako and Shanks (1984)) described the lead-zinc-barite mineralization of the Vulcan property in southeastern Nahanni map area; Tompson (1978) examined the Clea tungsten deposit. Scott (1974) did a geochemical analysis of black shale on the Han property. Dick (1980) did a comparative study of contact metasomatic mineral deposits in eastern Yukon, several of which (Clea, Omo, Lened) occur in Nahanni map area (see also preliminary published accounts by Dick (1979) and Dawson and Dick (1978)).

Current geological work

This memoir draws from four field seasons from 1977 to 1980 that encompassed nine and one-half months of field work. In the first three seasons one half of the area was mapped at 1:50 000 scale. The detailed mapping was accomplished

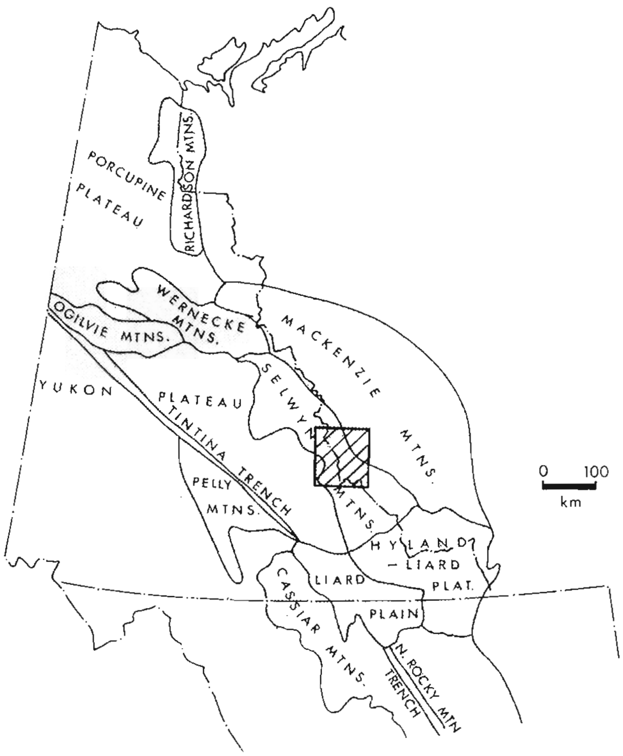

Figure 3. Physiographic subdivisions of the project area and adjacent parts of the northern Cordillera (shaded pattern) (from Douglas et al., 1970, map 1254A). Location of Nahanni map area shown by diagonal line pattern.

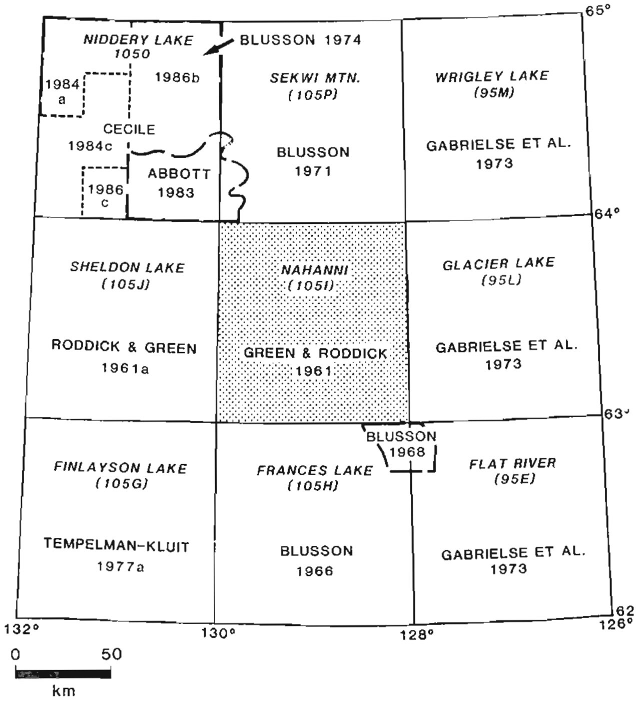

Figure 4. Index map showing references to previous regional geological studies in and adjacent to Nahanni map area.

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[1] Codes in brackets refer to maps of the National Topographic System of Canada.

using casual helicopter charter to support a two to three person field party. In 1980 the remaining area was mapped at 1:250 000 scale at a more rapid rate using a contract helicopter from a fixed base camp. Sixty stratigraphic sections were measured at reconnaissance scale to establish type sections, regional variations in thickness, and stratigraphic control for paleontological determinations. Despite mountainous terrane, well-exposed stratigraphic sections in the western part of the area are rare. Most include cleaved strata that probably contain structural complexities affecting true thickness estimates. Long intervals of scree are also common. Over 400 fossil determinations, about 180 of which are for conodont microfossils, provide control on age and correlation. Figure 5 shows the traverse routes and spot localities visited that provide ground control for the geological maps.

The boundaries of plutonic bodies and small areas of well-exposed carbonate strata in the northeastern part of the map area are amenable to photogeological interpretation. Elsewhere, ground control and an intimate knowledge of the stratigraphy are essential to geological mapping.

Reports of progress that summarize the present work include Gordey (1978, 1979, 1980, 1981a) and Gordey et al. (1981, 1982). Several stratigraphic sections through Cambrian strata were measured by Fritz (1979a, 1981, 1982) and are incorporated in this memoir.

Concurrent with this work, other studies in Nahanni map area by Geological Survey of Canada geologists were undertaken and are published separately. These include examinations of Quaternary geology (Jackson, 1982, 1987), regional geochemistry (Goodfellow, 1982, 1983), geochemistry and origin of the Howards Pass lead-zinc deposits (Goodfellow and Jonasson, 1986), and petrology of Cretaceous granitic rocks (Anderson, 1982, 1983, this memoir).

Acknowledgments

Assistance in the field was provided by L. Unrau in 1977, K.B. Heather in 1978, D.H. Wood and P.F. Coleman in 1979, R.G. Anderson, D.H. Wood, J.G. Beekmann, and J.K. Boulter in 1980, and T.J. Frakes in 1982. W.H. Fritz provided Cambrian biostratigraphic control by measuring several stratigraphic sections in 1978, 1979, 1980, 1981, and 1982 as did B.S. Norford in 1979 and 1980 for the Ordovician to Devonian and M.J. Orchard in 1980 for the Devonian. In 1980 excellent food preparation by cooks N. Anderson and J. Pemberton kept camp moral high. Many other Geological Survey of Canada personnel with diverse fields of study worked in or near Nahanni map area in 1980. These included L. Jackson (Quaternary geology of Nahanni map area), M.P. Cecile (stratigraphy of northeastern Niddery Lake (105O) map area), K.M. Dawson (mineral showings of the Nahanni map area), I.R. Jonasson and W.D. Goodfellow (regional geochemistry of Nahanni map area; Howards Pass lead-zinc deposits, Nahanni map area), J.W. Lydon (Tom lead-zinc deposit, Niddery Lake (105O) map area), and K.M. Dawson, D.F. Sangster, W.H. Fritz, and I.R. Jonasson (mineral showings of the Sekwi Formation in Nadaleen River (106C), Bonnet Plume Lake (106B), and Sekwi Mountain (105P) map areas). Discussions with all of these individuals, as well as H. Gabrielse, D.J. Tempelman-Kluit, R.I. Thompson, and particularly J.G. Abbott has clarified many aspects of regional bedrock geology.

Excellent helicopter service was provided by pilots A. Leiter (Frontier Helicopters) in 1977 and 1978, C. Guichon (Northern Mountain Helicopters) and G. Drzymala (Quasar Helicopters) in 1979, and T. Protheroe, J. Webb, and L. Dean (Kenting-Klondike Helicopters) in 1980. B.C.-Yukon Air Service provided efficient fixed-wing support in 1977, 1978, and 1979.

Enthusiastic co-operation and logistical help came from many individuals from several mining and exploration companies. Particular mention is deserved for J.M. Kowalchuk and J.M. Morganti (Placer Development Ltd.), G. Artmont (Riocanex Exploration Ltd.), C.N. Forster, M. Burson, and K. Glover (Union Carbide Exploration Corp.), and P. Risby and J. Crawford (Welcome North Mines Ltd.).

Bev Vanlier demonstrated superb secretarial skills in preparation of the manuscript. Preparation of diagrams was very capably done by Tonia Oliveric.

The research on the Selwyn Plutonic Suite undertaken by R.G. Anderson was supported by the Geological Survey of Canada and by a Natural Sciences and Engineering Research Council Visiting Postdoctoral Fellowship in 1981-1983. The co-operation, hospitality, and invaluable assistance of Dorothy Atkinson (AMAX) at MacTung and Mike Burson and Keith Glover (Union Carbide) at the Lened camp facilitated the research. Joerg Beekmann, Lyle Duschene, Susie Gareau, Mike Gunning, Dave Humer, and Darren Mathison provided conscientious field assistance and useful contributions to the mapping. Tonia Oliveric, Christine Davis, and Steve Friday aided in initial compilation and/or drafted crisp clear diagrams.

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REGIONAL SETTING

Introduction

Nahanni map area is underlain by unmetamorphosed strata that form part of the Cordilleran miogeocline, a term herein used for the westward thickening wedge of sedimentary rocks of mid-Proterozoic to mid-Jurassic age deposited along the continental margin of western North America. During its long history the miogeocline experienced several periods of extension or rifting that resulted in renewed subsidence and sedimentation and in irregularly stretched and thinned crust. Areas of thick crust subsided relatively little and supported broad platforms or arches with thin sedimentary veneer; areas of more crustal thinning underwent marked subsidence and became sites of thick sedimentary accumulation. Miogeoclinal sedimentation was terminated in the mid-Jurassic, when collision of an island-arc terrane with the continental margin led to imbrication and folding of the miogeoclinal succession, and intrusion of widespread

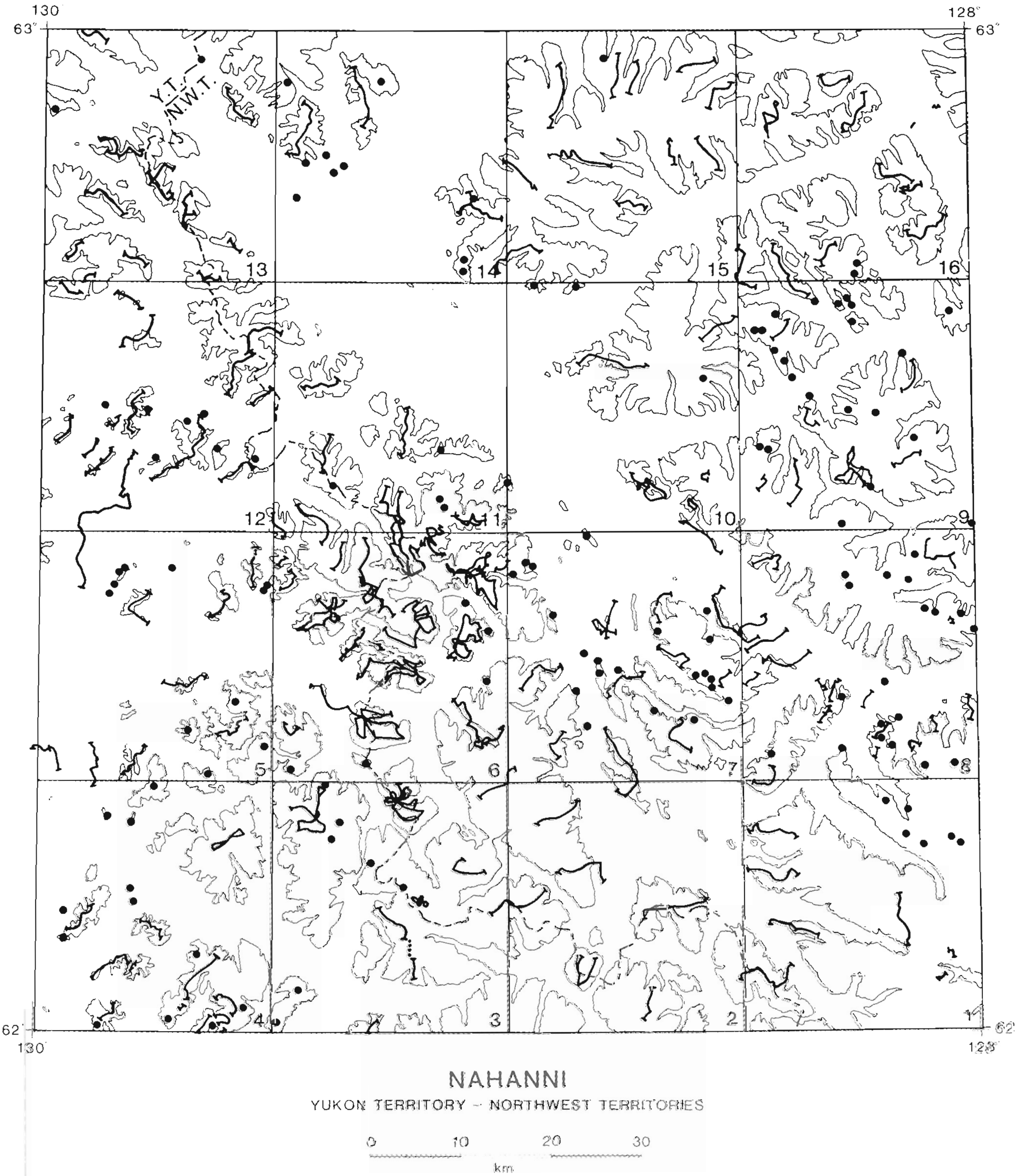


Figure 5. Traverse routes and helicopter spot landings during the present work in Nahanni map area. These are located relative to 5000 foot (1524 m) topographic contours and 1:50 000 map areas (labelled 1 to 16).

post-tectonic plutons. The limit of preservation of the miogeocline is a truncated structural boundary defined by the eastern limit of allochthonous terranes accreted in the Mesozoic (Fig. 6). During this accretion, or earlier, the outer distal parts of the miogeocline were removed. Alternatively, they may have been made unrecognizable by structural disruption and incorporation into the allochthonous terranes. In the following descriptions, the terms "extension" or "rift" are used interchangeably to signify stretching or thinning of the crust. Their use does not imply crustal separation and the formation of intervening oceanic crust.

In Nahanni map area, well-exposed strata record much of the later history of the miogeocline and include an Eocambrian rift sequence, the Paleozoic facies belts of Mackenzie Platform and Selwyn Basin, a thick Devono-Mississippian rift succession, and a late Paleozoic to Late Triassic clastic shelf sequence. The diverse structural styles of the Mesozoic Selwyn and Mackenzie fold belts and intrusive bodies of the mid-Cretaceous Selwyn Plutonic Suite are also well displayed. The following outline summarizes the evolution of the northern Cordilleran craton margin, and describes the aforementioned features of Nahanni map area in a regional context.

Evolution of the northern Cordilleran craton margin

Mid-Proterozoic to late Precambrian

At about 750 Ma, rifting of the craton margin led to dyke intrusion, synsedimentary faulting, and the progradation of a thick wedge of clastic rocks, the Windermere Supergroup (Eisbacher, 1981). At this time the Cordilleran basin showed the first clear indication along most of its length of a consistent westward-deepening basin polarity. This rifting event was preceded by at least two periods of epicratonic sedimentation of about 400 Ma each, separated by major regional deformation (Eisbacher, 1981). Deposition during these earlier periods (Wernecke assemblage (12+ km); Pinguicula Group/Mackenzie Mountains Supergroup (5 to 7+ km) (Young et al., 1979; Eisbacher, 1981)), each probably initiated by an extension or rift event, may have been in an intracratonic basin rather than along a continental margin. The extent of the older strata and the Windermere rift assemblage beneath much of the western part of the younger miogeocline is unknown.

Late Precambrian to Middle Devonian

Extension or rifting in the late Precambrian led to the formation of two facies belts in the miogeocline, which persisted until Middle Devonian time. On the north and east developed a broad expanse of shallow water carbonate and clastic rocks (shelf facies) composing a shallow unevenly subsiding shelf called the Mackenzie Platform (Lenz, 1972) (Fig. 6). Thinning of individual formations and convergence of unconformities within the platform strata define the loci of Ogilvie and Redstone arches (Fig. 7). Greater subsidence northeast of Redstone Arch led to the accumulation of thick carbonate strata defining Root Basin (Fig. 6). On the south and west of Mackenzie Platform is a succession of shale, basinal limestone, chert, and turbiditic clastics (offshelf facies) deposited in an area of relatively deeper water called the Selwyn Basin (Gabrielse, 1967, 1976; Gabrielse et al., 1973; Department of Indian Affairs and Northern Development, 1981). An outboard shallow water carbonate-clastic platform, the Cassiar Platform, developed along the southwestern side of the Selwyn Basin in the Late Silurian to Middle Devonian. The late Precambrian rift(?) clastics at the base of the Selwyn Basin succession compose

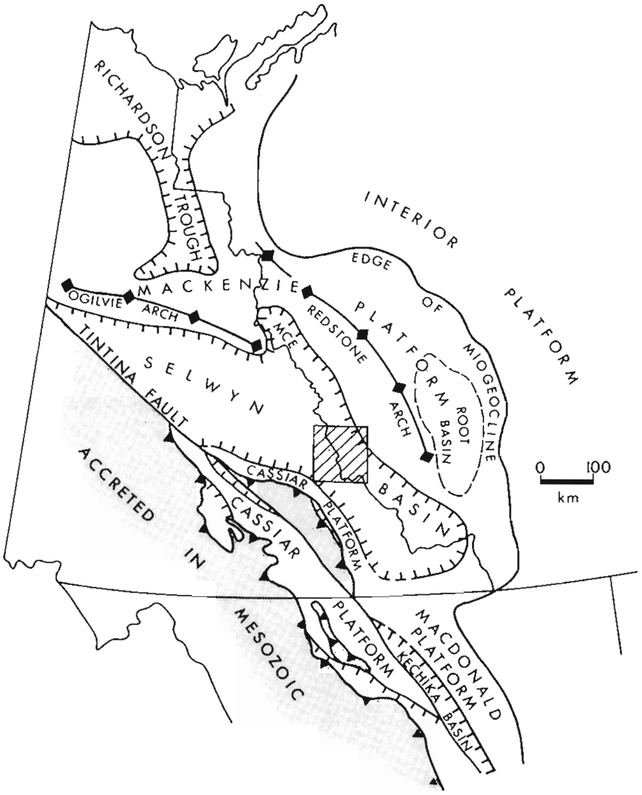


Figure 6. Location of Nahanni map area (diagonal lines) with reference to major late Precambrian to Middle Devonian tectonic and depositional elements of the northern Cordilleran miogeocline (Gabrielse, 1967). Shaded area represents island arc and oceanic terranes accreted to the miogeocline in the Mesozoic (Tempelman-Kluit, 1979). Mackenzie Platform and contiguous Macdonald Platform are regions of latest Precambrian to Middle Devonian shallow water carbonate and clastic sedimentation. Selwyn Basin, Misty Creek Embayment (MCE), Kechika Basin, and Richardson Trough represent coeval deeper water shale, chert, and basinal limestone. Cassiar Platform is outlined by the extent of Siluro-Devonian shallow water carbonate strata. Redstone and Ogilvie arches are loci of erosional and depositional thinning and represent paleobathmetric highs within the miogeocline. Root Basin, within Mackenzie Platform, contains thick shallow water carbonate strata. The edge of the miogeocline is defined at a hinge line west of which sedimentary thicknesses increase abruptly. To the east the Interior Platform comprises a thin veneer (<2 km thick) of Cambrian to Upper Devonian cratonic sediment cover. Cretaceous-Tertiary dextral offset along Tintina Fault (450+ km) (Roddick, 1967; Tempelman-Kluit, 1979; Gabrielse, 1985) is not restored.

the oldest strata exposed in the basin, consisting of at least 3 km of gritty turbiditic sandstone of uncertain, but possibly western derivation. Similar-age but easterly-derived thick quartz sandstone (Backbone Ranges Formation) forms the basal strata of western Mackenzie Platform.

The position of the boundary between Selwyn Basin and Mackenzie Platform migrated laterally over a few tens of kilometres. The sharp margins of Misty Creek Embayment (Cecile, 1982) and Richardson Trough, and the abrupt change to an east-west facies trend in southern Yukon (Fig. 7) may have resulted from fault offset of basement. The likelihood that faults directly controlled the position of this boundary elsewhere is uncertain.

Late Devonian to Early Mississippian

In Late Devonian time the facies distribution outlining Mackenzie Platform, Selwyn Basin, Richardson Trough, and Cassiar Platform was destroyed. A sudden influx of marine, turbiditic, chert-rich clastic rocks spread to the south and east from a source area in northern Yukon and to the east from uplifted western portions of the Selwyn Basin (Fig. 8). In south-central and southeastern Yukon coarse turbiditic clastics occur as far east as the old platform-basin boundary; shale spread to the continental interior. Uplift in northernmost Yukon was related to the Ellesmerian orogeny, a compressional event that produced pre-Early Mississippian folding, a marked Early Mississippian angular unconformity, and granitic intrusions of broadly Devonian age (Bell, 1973; Norris and Yorath, 1981). Uplift of source areas in Selwyn Basin and more southern portions of the Canadian Cordillera was related to a rift event that produced local block faults, local felsic volcanics, and widespread barite and barite-lead-zinc mineralization (Gordey et al., 1987).

Mid-Mississippian to mid-Jurassic

Following the influx of Devono-Mississippian clastics, normal marine shelf sedimentation resumed across the old platform-basin transition and as far to the west as the miogeocline is preserved. In the late Paleozoic to Late Triassic of northern British Columbia and southern Yukon, clastics dominate the sedimentary record (Bamber et al., 1968; Gibson, 1975; Bamber and Mamet, 1978), but in northern Yukon carbonates are also important (Bamber and Waterhouse, 1971; Graham, 1973). In both regions important unconformities occur within the succession, cutting out large parts of the stratigraphic record. Because of this and recent erosion, preservation is regionally discontinuous. Lower Jurassic strata in the miogeocline of the northern Cordillera are unknown except for shale and

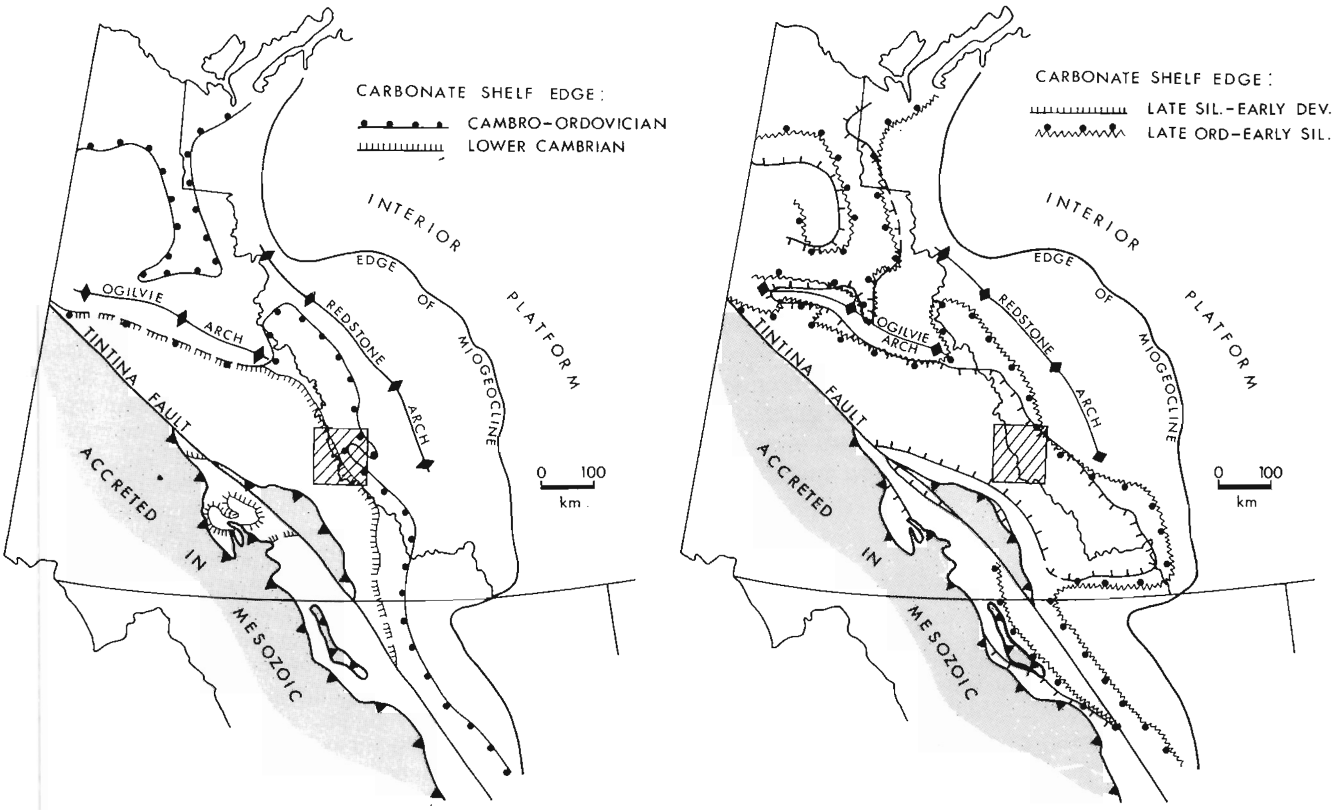


Figure 7. Location of Nahanni map area (diagonal lines) with respect to the position of the carbonate shelf edge at various times in the lower Paleozoic. The average position of the shale-out defines the major tectonic elements as shown in Figure 6. Preservation of Middle Cambrian strata is fragmentary; the position of the Middle Cambrian shelf edge is largely unknown. Cretaceous-Tertiary dextral offset along Tintina Fault (450+ km) (Roddick, 1967; Tempelman-Kluit, 1979; Gabrielse, 1985) is not restored. (Compiled from Lenz (1972), and published as open file 1:250,000 scale maps and reports of the Geological Survey of Canada).

sandstone in northernmost Yukon (Poulton et al., 1982). Middle and Upper Jurassic clastics occur in this same area and in a narrow belt across central Yukon (Tempelman-Kluit, 1970).

Mesozoic structural evolution

The end of continental margin sedimentation and the beginning of widespread compressional deformation was signalled by the collision of a Mesozoic island arc with the miogeocline in the mid-Jurassic (Tempelman-Kluit, 1979). The outer or western part of the miogeocline was overthrust by allochthons of mylonite, ophiolite, and granitic rocks and was itself imbricated and folded during decollement-style deformation (Fig. 9). Widespread mid-Cretaceous granitic rocks (Fig. 10), possibly formed by crustal thickening and heating as a result of collision, intruded the already deformed strata of the outer miogeocline. Deformation of the inner miogeocline in eastern and northern Mackenzie Mountains occurred later as it involves molasse as young as Turonian (Late Cretaceous; Paleocene coarse clastic strata are also gently deformed (Aitken et al., 1982)). Right-lateral transcurrent movement along Tintina Fault, Northern Rocky Mountain Trench Fault, and related structures, in latest Cretaceous or early Tertiary time was at least 450 km judging from offset of earlier formed structural elements (Tempelman-Kluit, 1979), and as much as 650 km as indicated by possible offset facies (Gabrielse, 1985).

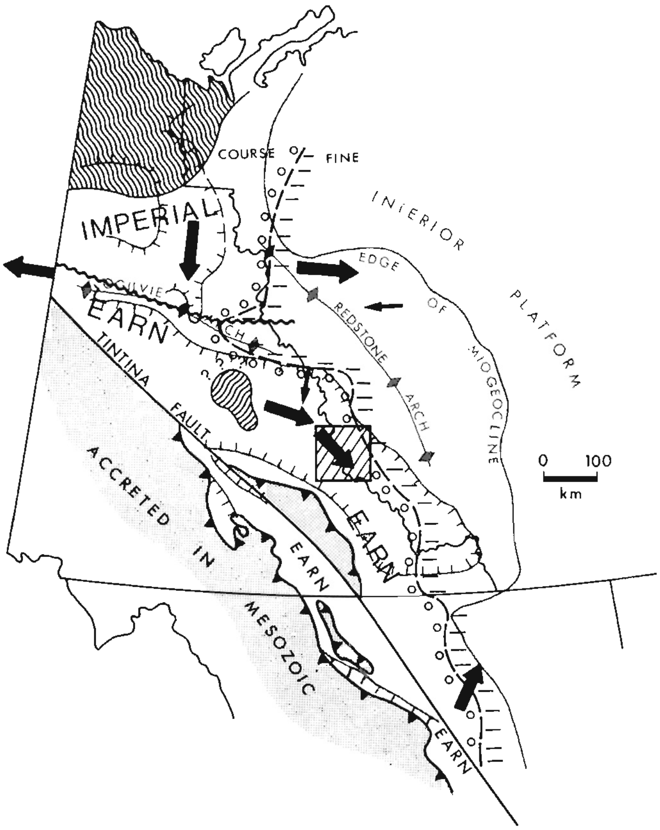


Figure 8. Regional distribution of coarse and fine clastic strata of Devono-Mississippian age in Yukon and Northwest Territories and northern British Columbia (from Gordey et al., 1987). Nahanni map area is indicated by diagonal lines. The wavy line subdivides the clastics into those derived from northern Yukon, largely the Imperial Formation, and those derived from the west, largely the Earn Group. The facies line (labelled coarse (circles) to fine (dashes)) shows the eastern limit of sandstone and conglomerate. Large arrows indicate regional paleoflow from noncratonal source areas (wavy line pattern). Small arrows show local paleoflow, possibly from east or northeast cratonal source. Older Paleozoic tectonic elements are shown in subdued tone (see Fig. 6 and 7). Cretaceous-Tertiary dextral offset along Tintina Fault (450+ km) (Roddick, 1967; Tempelman-Kluit, 1979; Gabrielse, 1985) is not restored.

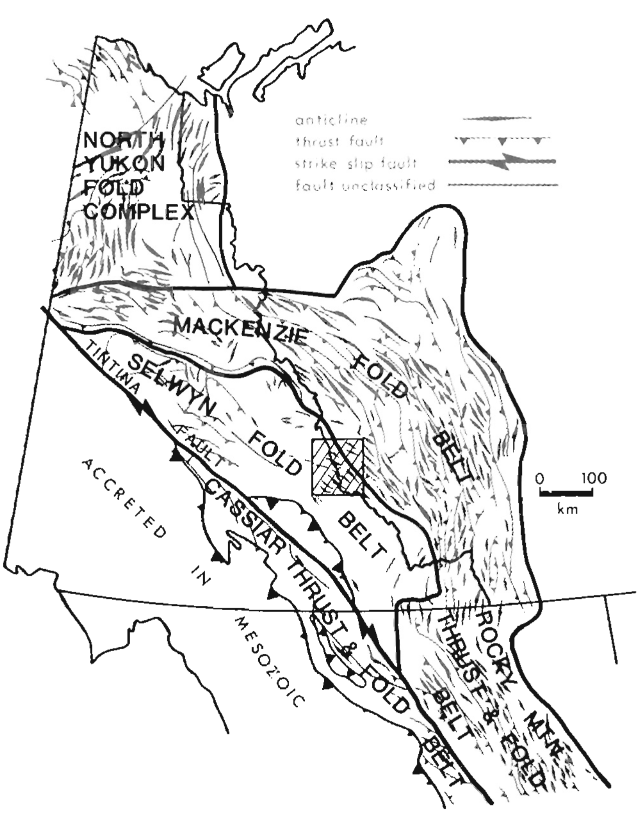


Figure 9. Location of Nahanni map area (diagonal lines) with respect to structural subdivisions of the northern Cordillera (modified from Gabrielse, 1976). Mackenzie Fold Belt (and contiguous Northern Rocky Mountain Thrust and Fold Belt) is an area of thrust faults and concentric folds, lacks slaty cleavage, and corresponds largely to competent strata of Mackenzie Platform (Fig. 6). Selwyn Fold Belt is characterized by slaty cleavage, thrust faults, and tight folds. It represents the largely incompetent strata of Selwyn Basin. Cretaceous-Tertiary dextral offset along Tintina Fault (450+ km) (Roddick, 1967; Tempelman-Kluit, 1979; Gabrielse, 1985) is not restored.

Structural style is greatly influenced by the distribution of lower and middle Paleozoic facies. Incompetent strata in the Selwyn Basin area are intensely folded and have well-developed slaty cleavage (Selwyn Fold Belt) (Fig. 9); the competent strata of Mackenzie Platform area are imbricated by large thrust faults, lack slaty cleavage, and are thrown into relatively open folds (Mackenzie Fold Belt). Structural trends vary from north-south to east-west around a great arc defined by Mackenzie and Ogilvie mountains that parallels Paleozoic facies boundaries (Fig. 9). In northern Yukon (Northern Yukon Fold Complex) there is a sharp bend from an east-west to a north-south structural trend. Mackenzie Fold Belt (Gordey, 1981c) and Northern Yukon Fold Complex (Norris, 1980) by analogy of their structural style with the northern (Thompson, 1979) and southern (Price, 1981) Canadian Rocky Mountains, have been interpreted as thin-skinned detachment terranes. All thrust faults and folds are presumed to root into or die out above a basal decollement below which the basement and/or underlying strata remain undeformed.

Use of the term "Selwyn Basin" - a historical perspective

The term "Selwyn Basin" has changed considerably in meaning since first introduced by Gabrielse (1967). Since it has been used by different authors in different ways, it seems pertinent to outline how its meaning has evolved and to reiterate its definition as used here.

The original use (Gabrielse, 1967) of "Selwyn Basin" was to delimit a sedimentary basin evidenced by a thick wedge of sediments of Precambrian to Middle Devonian age that thinned eastward to a hinge line at the position of Redstone Arch (Fig. 11). The intent of the original definition (H. Gabrielse, pers. comm., 1984) was to include shallow water clastics and carbonates on the western side of Redstone Arch as well as time-equivalent deeper water clastics and chert to the west. Root Basin was used to refer to thick carbonate strata east of Redstone Arch.

Unfortunately the term "Selwyn Basin" was used by Gabrielse (1967) only as part of a framework for a broad discussion of tectonic evolution, and was not rigorously defined. The inclusion of shallow water strata within Selwyn Basin was not specifically stated. Also, the limits of the basin as originally figured (Gabrielse, 1967, Fig. 1) correspond to the carbonate-shale (shelf-offshelf) boundary (compare with Fig. 6-9, Gabrielse, 1967) implicitly excluding the shallow carbonate strata from the basin. In common usage "Selwyn Basin" increasingly came to mean a "shale basin" (e.g. Blusson, 1976; Tempelman-Kluit, 1977b; Tempelman-Kluit and Blusson, 1977; Department of Indian Affairs and Northern Development, 1981). With rare exception (e.g. Aitken et al., 1982), the original intent of including the fringing shallow water strata was forgotten.

Tempelman-Kluit and Blusson (1977) considered the Selwyn Basin not as a sedimentary basin evidenced by a vertical accumulation of thick strata (as did Gabrielse, 1967), but as a depositional entity. They considered that for a depositional feature to be a "basin" it must be at least partly enclosed during sedimentation. By their definition Selwyn Basin only existed from about the Early(?) Cambrian to Middle Devonian when there was evidence of an outboard platform (Cassiar Platform) or at least a restriction along the southwestern margin. Shallow water carbonate strata to the east of Selwyn Basin were referred to as Mackenzie Platform (Department of Indian Affairs and Northern Development, 1981), a term coined earlier by Lenz (1972).

A third but geographical use of the term has been adopted in some informal usage and in some literature (e.g. Douglas et al., 1970). In this use "Selwyn Basin" refers to a geographical area, roughly delineated by the Paleozoic carbonate-shale boundary, but which includes all rock types of any age found within that area.

The definition of "Selwyn Basin" presented here follows partly that of Tempelman-Kluit and Blusson (1977), and reflects the most common current usage. It refers to a region of deeper water offshelf sedimentation that persisted from

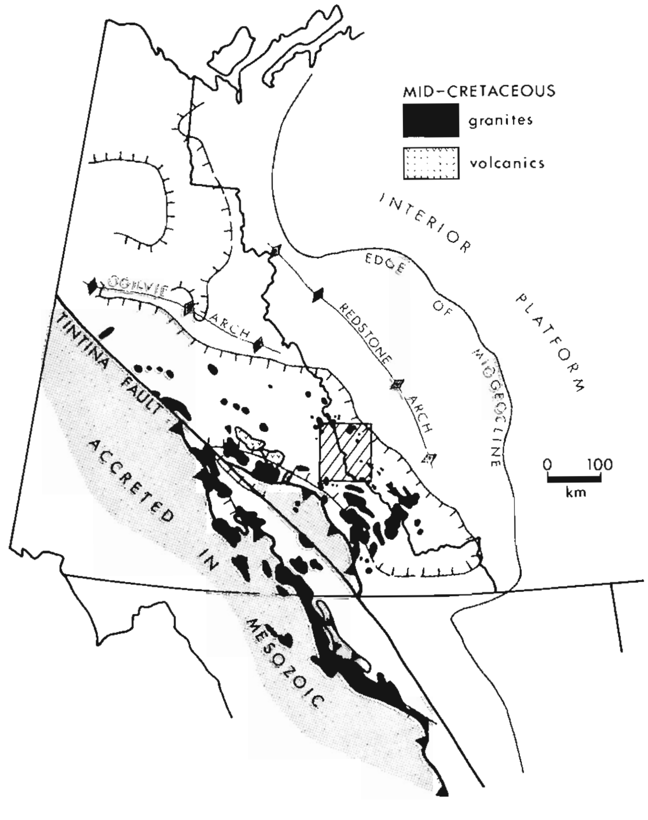


Figure 10. Distribution of mid-Cretaceous plutonic rocks (and related volcanics) intruding the miogeocline and easternmost accreted terrane. Plutons in Nahanni map area (diagonal lines) and other areas northeast of Tintina Fault compose the Selwyn Plutonic Suite. Paleozoic tectonic elements are shown in subdued tone for reference (see Fig. 6 and 7). Cretaceous-Tertiary dextral offset along Tintina Fault (450+ km) (Roddick, 1967; Tempelman-Kluit, 1979; Gabrielse, 1985) is not restored.

late Precambrian to Middle Devonian time. Its basal deposits consist of thick late Precambrian rift(?) clastics; it is overlain by rift clastics of Late Devonian age. On its northeastern side are time-equivalent shallow shelf strata of Mackenzie Platform. Along its southwestern margin there developed in the Siluro-Devonian a carbonate-clastic shelf, the Cassiar Platform, although a restriction to circulation may have existed at this locus before Late Silurian time. Its southwestern limit is essentially the limit of the miogeocline as presently preserved. When a geographical meaning is intended the word "area" will be appended (e.g. in the Selwyn Basin area).

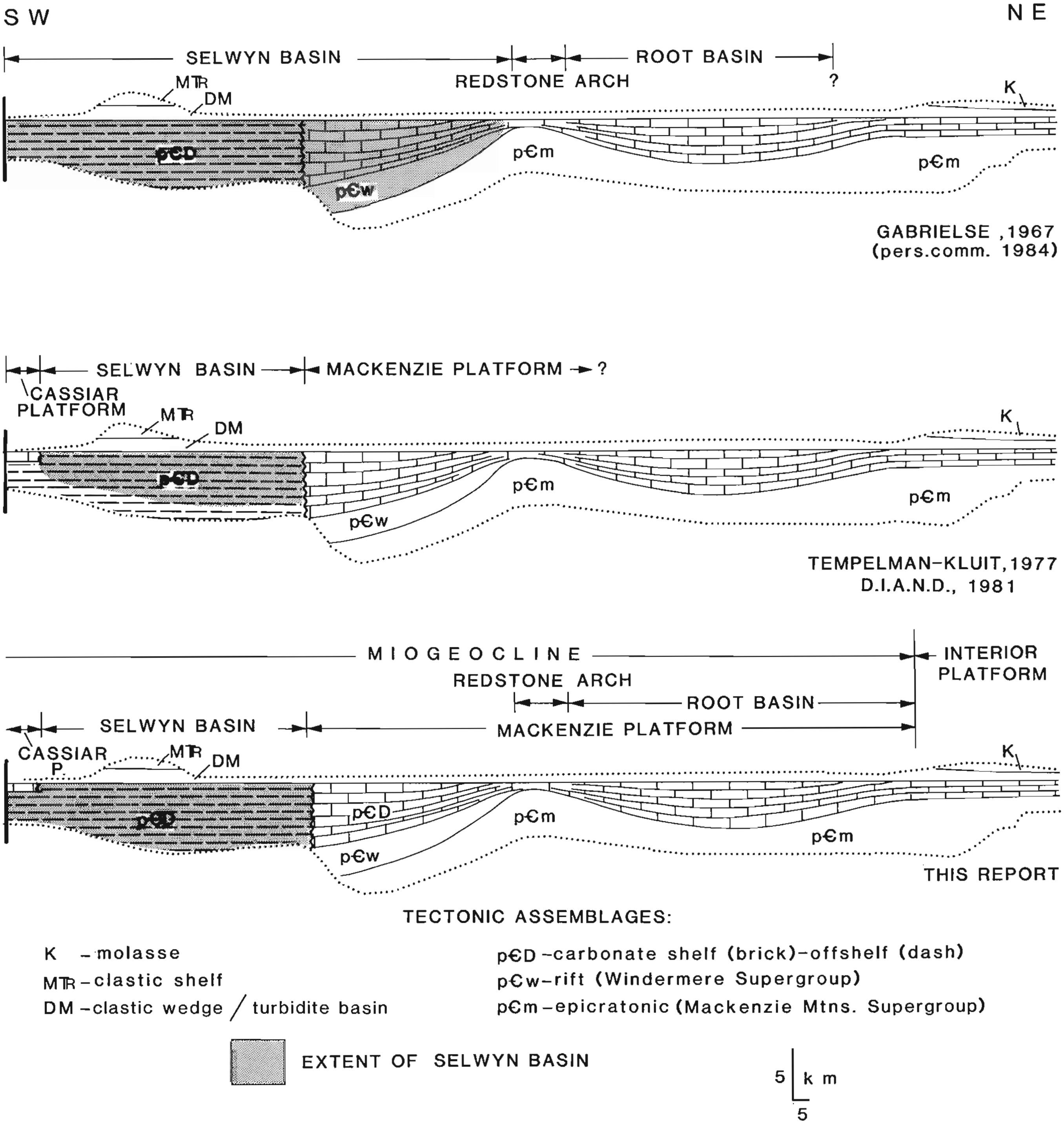


Figure 11. Evolution in terminology applied to the miogeocline, particularly the term "Selwyn Basin", as illustrated by a cross section from northeastern Finlayson Lake map area (105G), through Nahanni map area, and extending east-northeast across Mackenzie Mountains to Mackenzie River. (pЄ-Precambrian; pЄD-late Precambrian to Devonian; DM-Devono-Mississippian; MTR-Mississippian to Triassic; K-Cretaceous; section is not compensated for structural shortening).

STRATIGRAPHY

Stratified rocks in Nahanni map area are grouped into assemblages that reflect three broad stages in the development of the miogeocline (see Regional Setting): (I) a late Precambrian to Middle Devonian stable platform (Mackenzie Platform) sequence flanked to the southwest by a deeper water sequence of equivalent age (Selwyn Basin); (II) a Late Devonian to mid-Mississippian assemblage of marine turbiditic clastics; and (III) a mid-Mississippian to Triassic assemblage of clastics, chert, and minor carbonate deposited on a shallow marine shelf.

These three assemblages comprise 31 formations (Fig. 12; Table of Formations) of which 11 are described for the first time. The lithological descriptions and environmental interpretations that follow are largely field based; supplementary petrographical work was done on a few selected clastic units. Paleontological descriptions, a list of faunal zones and geological time chart, and a key to map area names mentioned in the text are presented in the appendices.

Assemblage I: Mackenzie Platform-Selwyn Basin

Mackenzie Platform strata consist mostly of shallow water dolostone, with lesser amounts of limestone, and minor quartz sandstone and shale. These shallow water lithologies, termed shelf facies, are represented in the late Precambrian to Middle Cambrian (Backbone Ranges, Sekwi, and Avalanche formations), Cambro-Ordovician (Haywire and Broken Skull formations), and Siluro-Devonian (Delorme, Camsell, Sombre, and Arnica formations). Selwyn Basin strata consist of shale, limestone, chert, and grit, termed offshelf facies deposited in relatively deeper water. They are represented in the Precambrian (Yusezyu and Narchilla formations), Lower Cambrian (Gull Lake Formation), Cambro-Ordovician (Rabbitkettle Formation), Ordovician-Silurian (Duo Lake and Steel formations), and Siluro-Devonian (Sapper, Grizzly Bear, Natla, and Funeral formations). The boundary between shelf facies (shallow platform) and flanking offshelf facies (relatively deeper basin) migrated through time across a northwest-trending zone 50 km wide covering the northeastern half of the map area. In this region formations of the Mackenzie Platform and Selwyn Basin are interstratified.

For purposes of description the formations of Assemblage I are grouped basinward (i.e. southwesterly) into three facies belts:

1) northeastern belt: shelf facies of Mackenzie Platform northeast of Broken Skull River;

2) central belt: interstratified shelf (Mackenzie Platform) and offshelf (Selwyn Basin) facies between South Nahanni and Broken Skull rivers; and

3) southwestern belt: offshelf facies of Selwyn Basin southwest of South Nahanni River.

Table of Formations

Period or Epoch	Formation	Map unit and Lithology	Thickness (m)
Pleistocene to Recent		Q: unconsolidated glacial and alluvial deposits	
unconformable			
Cretaceous	Selwyn Plutonic Suite*	KS: granite, quartz monzonite, granodiorite	
intrusive			
Clastic Shelf (mid-Mississippian to Triassic)			
Triassic	Jones Lake Formation*	TJ: shale, siltstone, sandstone	750 +
unconformable			
Permian	Mount Christie Formation*	CPMC: shale, chert	690
unconformable			
Mississippian	"Tsichu" formation	MT: quartz sandstone, shale	175-270
unconformable?			
Turbidite Basin (in part) (Devonian to mid-Mississippian)			
EARN GROUP (PPORTRAIT LAKE AND PREVOST FORMATIONS)			
Devono-Mississippian	Prevost Formation*	DMP: shale, sandstone, conglomerate DMP1: sandstone, conglomerate, minor shale DMP2: shale, minor sandstone	900 +
unconformable			
Lower to Upper Devonian	Portrait Lake Formation*	DP: shale, chert, sandstone, conglomerate DP1: sandstone, conglomerate DP2: shale, chert, minor sandstone	40-880
conformable to unconformable on Selwyn Basin and Mackenzie Platform			
Selwyn Basin (Offshelf Facies) - Mackenzie Platform (Shelf Facies) (Precambrian to Middle Devonian **Southwest of S. Nahanni River (Offshelf Facies)**			
ROAD RIVER GROUP (OSR) DUO LAKE AND STEEL FORMATIONS			
Upper Silurian	Steel Formation*	SS: wispy laminated mudstone	95-145
conformable			
Ordovician and Silurian	Duo Lake Formation	OSD: shale, chert OSD1: shale, minor chert OSD2: chert, minor shale	225-310
conformable			
Cambro-Ordovician	Rabbitkettle Formation	ꞒOR: silty limestone, limestone ꞒOR1: white weathering (SW of S. Nahanni R.)	250-990 +
unconformable on Gull Lake and Narchilla Formations			
Lower and? Middle Cambrian	Gull Lake Formation*	ꞒG: shale, siltstone, minor sandstone, limestone, conglomerate ꞒG1: limestone, conglomerate mbr ꞒG2: shale mbr (shale, siltstone, minor sandstone) ꞒG3: grey mudstone mbr	1050 0-20? 665 390
conformable			

* Denotes formations or groups that are named and described for the first time

Table of Formations. cont'd.

Period or Epoch	Formation	Map unit and Lithology	Thickness (m)
HYLAND GROUP* (YUSEZYU AND NARCHILLA FORMATIONS)			
Precambrian to Lower Cambrian	Narchilla Formation*	ⱣЄN: shale, minor sandstone ⱣЄN1: shale, minor sandstone ⱣЄN2: sandstone mbr (sandstone, shale)	830
conformable			
Precambrian	Yusezyu Formation*	ⱣY: shale, sandstone, quartz-pebble conglomerate, minor limestone ⱣY1: limestone mbr	3000 + ? 0-20
base not exposed			
Between S. Nahanni and Broken Skull Rivers (Mixed Shelf and Offshelf Facies)			
Middle Devonian	Funeral	DF: limestone	500
conformable?			
Lower	Grizzly Bear Formation	DGB: limestone	0-200
unconformable			
Silurian to Lower Devonian	Sapper Formation*	SDS: silty limestone, limestone SDS1: limestone mbr SDS2: silty limestone mbr SDS3: dark limestone mbr	80-850 0-295 90-585 50 +
conformable			
Upper Cambrian to Lower Silurian	Haywire Formation*	ЄSH: dolostone, minor shale, sandstone ЄSH1 : sandy carbonate mbr (sandstone, shale, dolostone) ЄSH2: dolostone (includes resistant and banded dst mbrs) ЄSH3: volcanic mbr (basalt, tuff) ЄSH4: white dolostone mbr ЄSH5: massive dolostone mbr	45-885 + 0-100 45-885 + 0-336 + 0-300 200 + ?
conformable on Broken Skull Formation; in part lateral equivalent of Broken Skull and unconformable? on Rockslide and Avalanche formations			
Upper Cambrian to Lower Ordovician	Broken Skull Formation	ЄOBS: dolostone, limestone, minor sandstone ЄOBS1: sandy carbonate mbr (sandstone, dolostone, limestone) ЄOBS2: dolostone mbr ЄOBS3: limestone mbr	490-770 0-130 340-490 20-585
conformable			
Upper Cambrian	Rabbitkettle Formation	ЄOR: limestone, silty limestone ЄOR2: buff weathering (NE of S. Nahanni R.)	440-550
conformable on Rockslide Formation			
Middle Cambrian	Avalanche Formation	ЄA: dolostone	0-325
conformable on and in part lateral equivalent of Rockslide Formation			
Middle Cambrian	Rockslide Formation	ЄR: limestone	100-453
conformable			

* Denotes formations or groups that are named and described for the first time

Table of Formations. cont'd.

Period or Epoch	Formation	Map unit and Lithology	Thickness (m)
Lower Cambrian	Sekwi Formation	ЄS: limestone, dolostone, sandstone, siltstone, shale ЄS1: carbonate mbr (limestone, dolostone) ЄS2: sandy carbonate mbr (sandstone, siltstone, shale, dolostone)	405-675 200-365 205-310
conformable			
Lower Cambrian	Vampire Formation	ⱣЄV: shale, siltstone, sandstone	830
conformable			
Precambrian	Backbone Ranges Formation	ⱣB: dolostone	100 +
base not observed			
Northeast of Broken Skull River (Shelf Facies (except Natla Formation))			
Middle Devonian	Nahanni Formation	DN: limestone	30-90
conformable			
Middle Devonian	Headless Formation	DH: limestone	215
conformable			
Middle Devonian	Landry Formation	DL: limestone	220-390
conformable			
Middle Devonian	Natla Formation	DNA: limestone	330-465
conformable			
Lower Devonian	Arnica Formation	DA: dolostone	40
conformable			
Lower Devonian	Sombre Formation	DS: dolostone DS1: white dolostone mbr DS2: black dolostone mbr DS3: striped dolostone mbr	575-635 195 110 275
conformable on Sapper and Camsell formations			
Lower Devonian	Camsell Formation	DC: dolostone	324
conformable (relations seen northeast of Nahanni map area)			
Upper Silurian Lower Devonian	Delorme Formation	SDW: dolostone, (cross section only)	690
conformable (relations seen northeast of Nahanni map area)			
Upper Ordovician to Lower Silurian	Whittaker Formation	OSW: dolostone, limestone (cross section only)	350
base not seen in map area			

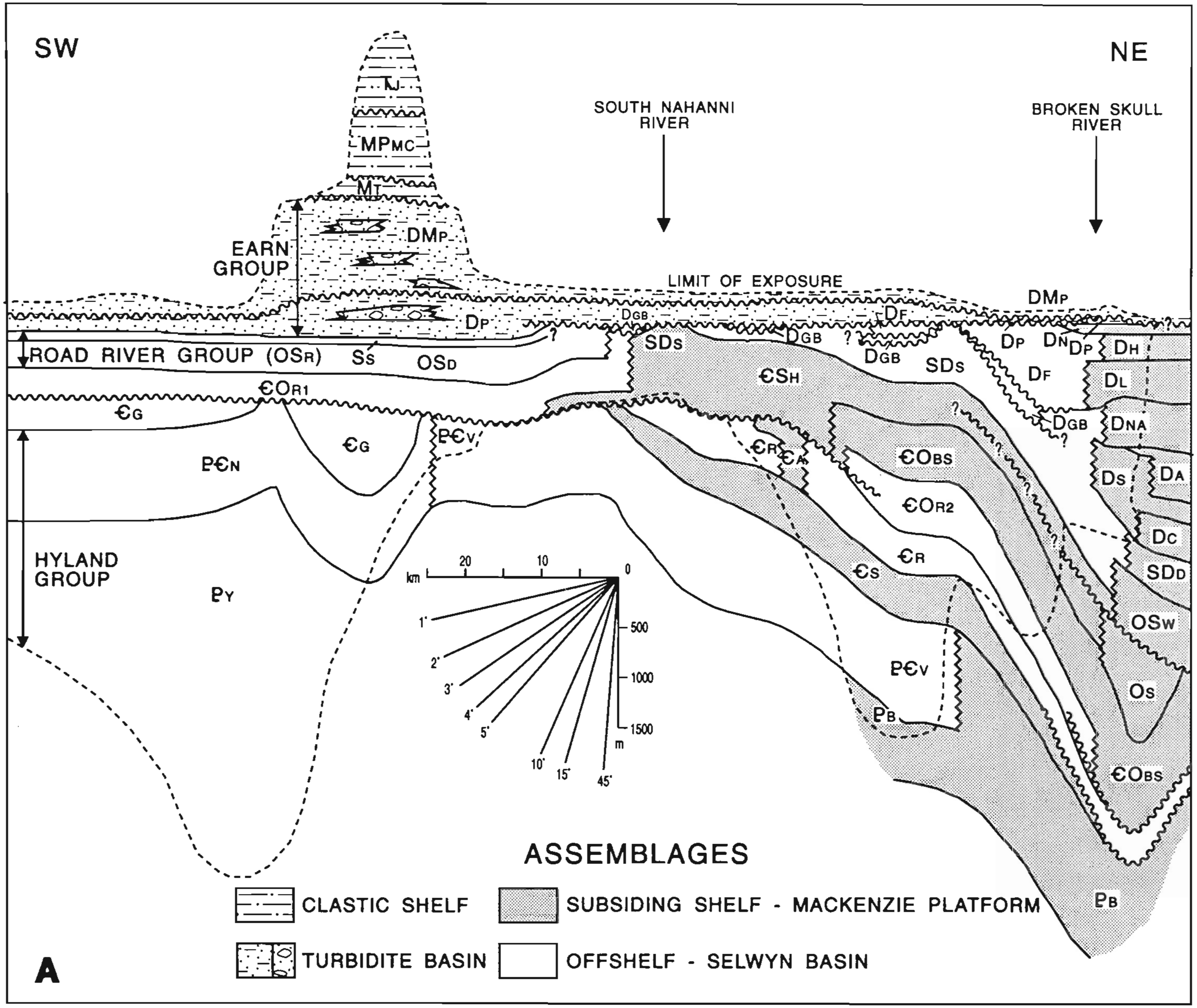
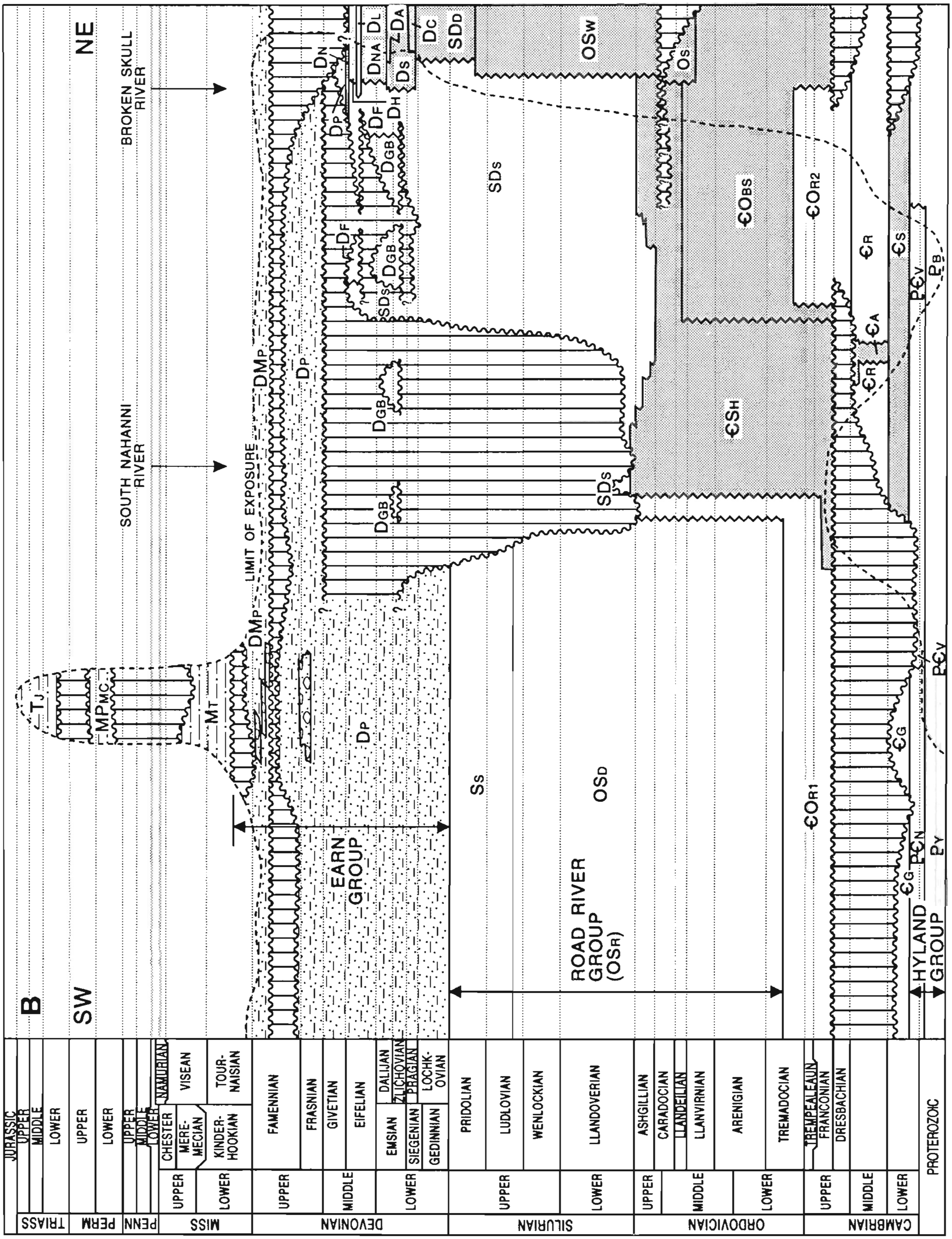


Figure 12. Rock- **(A)** and time-stratigraphic **(B)** cross sections across Nahanni map area. Vertical sawtooth line indicated facies change. Wavy line and vertical ruling indicates unconformity.


B
SW
NE
SOUTH NAHANNI RIVER
BROKEN SKULL RIVER
LIMIT OF EXPOSURE
EARN GROUP
ROAD RIVER GROUP (OSR)
HYLAND GROUP
TJ
MPMC
MT
DMP
DP
DGB
SDS
SS
OSD
€OR1
€G
P€N
PY
P€V
€SH
€R
€A
€S
PB
€OR2
€OBS
OSW
OS
DC
SDD
DA
DL
DN
DNA
DS
DF
DH
JURASSIC
UPPER
MIDDLE
LOWER
TRIASS
PERM
PENN
MISS
CHESTER
MERE-MECIAN
KINDER-HOOKIAN
NAMURIAN
VISEAN
TOUR-NAISIAN
DEVONIAN
FAMENNIAN
FRASNIAN
GIVETIAN
EIFELIAN
EMSIAN
SIEGENIAN
GEDINNIAN
DALIJAN
ZLICHOVIAN
PRAGIAN
LOCHK-OVIAN
SILURIAN
PRIDOLIAN
LUDLOVIAN
WENLOCKIAN
LLANDOVERIAN
ORDOVICIAN
ASHGILLIAN
CARADOCIAN
LLANDEILIAN
LLANVIRNIAN
ARENIGIAN
TREMADOCIAN
CAMBRIAN
TREMPEALEAUN
FRANCONIAN
DRESBACHIAN
PROTEROZOIC

Northeastern belt - shelf facies of Mackenzie Platform

Northeast of the upper reaches of Broken Skull River is a thick succession of Late Ordovician to Middle Devonian carbonate strata. The Late Ordovician to Early Devonian Whittaker, Delorme, Camsell, Sombre, and Arnica formations consist of medium- and thick-bedded, mostly poorly fossiliferous dolostone and minor limestone. The dolomite composition, local cryptalgal lamination and mudcracks, and sparse faunas suggest deposition and/or lithification under restricted marine conditions and high salinity. The succeeding Middle Devonian Landry, Headless, and Nahanni formations consist of thin- to thick-bedded commonly fossiliferous limestone. The limestone composition and abundant and diverse fauna suggest open marine deposition. The Natla Formation (described under the section on the central belt) also occurs in this area, but represents an incursion of offshelf facies into the platform; it separates the Arnica and Landry formations. All of these formations are of regional extent, occurring over large parts of Mackenzie Mountains. Southwest of Broken Skull River the Whittaker, Delorme, Camsell, Sombre, and Arnica change facies to their offshelf equivalents (see Table of Formations and Fig. 12).

Upper Ordovician to Lower Devonian

Whittaker Formation (**OS**W). The Whittaker Formation (Douglas and Norris, 1961; Gabrielse et al., 1973) does not crop out in Nahanni map area, but its uppermost beds which are exposed east of the northeastern corner of the map area (near section 57, Appendix 3) were examined and sampled for conodonts for correlation purposes. The uppermost part of Whittaker Formation consists of dark grey to black weathering bioclastic dolostone and limestone. It is medium to dark grey on fresh surfaces, and medium to thick bedded. The contact with the overlying Delorme Formation is conformable and delineated by a sharp change in weathering colour from dark grey to orange.

Age and correlation. Conodont fauna from the uppermost Whittaker and overlying Delorme formations at the above locality have wide age ranges, but collectively tightly constrain the contact to within the *eosteinhornensis* Zone (late Late Silurian) (see Appendix 4). The base of the Whittaker Formation is known from elsewhere in Mackenzie Mountains to be of Late Ordovician age (Tipnis et al., 1978).

The Whittaker Formation is widespread in southern Mackenzie Mountains (Gabrielse et al., 1973) and correlates with the similar Mount Kindle Formation of northern Mackenzie Mountains (e.g. Aitken et al., 1982). In Nahanni map area it is equivalent to the Haywire Formation, and in the offshelf facies to parts of the Sapper Formation and Road River Group.

Delorme Formation (**SD**D). Conspicuous orange weathering dolostone and limestone of the Delorme Formation (Douglas and Norris, 1961; Gabrielse et al., 1973) outcrop immediately northeast of Nahanni map area where it was examined and sampled for conodonts. There (section 57, Appendix 3) the Delorme Formation consists of 687 m of orange weathering, grey, very fine to fine crystalline dolostone in medium to thick beds. In the lower 192 m there is an equal proportion of blue-grey to buff-orange weathering, very fine to fine crystalline limestone. Above 405 m the dolostone is very finely laminated, and contains thin rare beds of pale green mudcracked shale and mudchip conglomerate. The lower contact of the Delorme Formation is conformable and placed at an abrupt change in weathering colour from orange to grey of the underlying Whittaker Formation. The upper contact, also conformable, is picked at a sharp upward colour change from orange to black weathering dolostone of the basal Camsell Formation.

Age and correlation. Conodont faunas (Appendix 4) indicate an age range for the Delorme Formation of Late Silurian (*eosteinhornensis* Zone) to Early Devonian (late Lochovian).

The Delorme Formation is widespread in Mackenzie Mountains (Gabrielse et al., 1973). In the offshelf facies it correlates with the Sapper Formation in northeastern Nahanni map area, and farther to the southwest it is partly correlative with the Steel Formation (upper Road River Group).

Camsell Formation (**D**C). The Camsell Formation (Douglas and Norris, 1961; Gabrielse et al., 1973) outcrops only in the northeastern corner of the map area. There (section 57) it consists of 324 m of grey, yellowish white, and lesser black weathering, grey to black, fine crystalline dolostone in medium to thick beds. Near the middle of the formation are two 1 m thick intervals of yellow, very rubbly, and cavernous weathering massive dolostone. The lower contact of the Camsell Formation is sharp but conformable and defined by a colour change to the underlying orange weathering dolostone of the Delorme Formation. The upper contact is conformable and defined at the top of the highest black weathering, black dolostone bed. An overlying thick interval of white weathering dolostone marks the lower Sombre Formation.

Age and correlation. No fossils were found in the Camsell Formation. Conodont faunas from overlying and underlying units (Appendix 4) bracket its age as middle Early Devonian, probably Pragian.

The Camsell Formation is a widespread unit in southern Mackenzie Mountains (Gabrielse et al., 1973). To the southwest in the offshelf facies it correlates with part of the Sapper Formation, and farther to the southwest with the lowest part of the Earn Group.

Sombre Formation (**D**S). The Sombre Formation (Douglas and Norris, 1961; Gabrielse et al., 1973) is a thick succession of well-bedded dolostone best exposed on the limbs of Black Wolf Syncline.

On the northeastern limb of the syncline (section 58) the Sombre Formation can be subdivided into three members with a total thickness of 575 m. The lowest member (194 m) consists of white to grey weathering, very fine to medium crystalline dolostone in medium beds that are internally massive or finely laminated. The middle member (108 m) consists of fetid, bioclastic, grey to black weathering, dark grey, fine to medium crystalline dolostone in thick beds. Except for crinoid stem fragments most of the bioclastic debris is not identifiable. The upper Sombre Formation (273 m) consists of yellow-white, white, and dark grey to black fine, crystalline dolostone that weathers to similar colours. The dolostone is medium to thick bedded, and beds may be massive or laminated. The lower third of the member is predominantly light coloured, the proportion of black weathering dolostone interbeds increasing upward in the top two thirds of the unit, to give a markedly striped appearance. Black dolostone at the top of the upper member is commonly riddled (to 30-40%) with amphipora-like tubes filled with white carbonate. The Sombre Formation conformably overlies the Camsell Formation, the basal contact being defined at the top of the highest black to dark grey dolostone bed of the latter. The upper contact of the Sombre Formation is defined above the uppermost, white weathering dolostone bed and beneath black weathering, cherty dolostone of the Arnica Formation.

On the southwestern limb of Black Wolf Syncline, near the northern boundary of the map area (section 55), the Sombre Formation consists of 635 m of light grey, weathering, light grey fine crystalline dolostone. The dolostone is locally crinoidal or vuggy and occurs in medium to thick beds. In its upper part, the Sombre Formation contains interbeds of dark grey to reddish weathering cherty limestone. The limestone is fine crystalline; on fresh surfaces it is black. The three members recognized on the northeastern limb of the syncline are not present on the western limb. Overlying and underlying formations are also different. In this area the Sombre Formation conformably(?) rests above the Sapper Formation, the contact being picked at the lower limit of dolostone above thick-bedded Sapper limestone. The upper contact is at an abrupt conformable(?) change from dolostone to dark grey weathering, black fine, crystalline limestone of the Natla Formation.

Environment, age, and correlation. The dolostone composition, dearth of fossils, and local delicate cryptalgal lamination suggest a peritidal, restricted (above normal salinity) depositional setting for the Sombre Formation. The bioclastic middle member may have been deposited under less restricted conditions. The age of the Sombre Formation is poorly bracketed by conodont faunas to be middle Early Devonian (Pragian-Zlichovian) (Appendix 4).

The Sombre Formation is widespread in Mackenzie Mountains (Gabrielse et al., 1973) where the tripartite subdivision based on a middle, dark weathering member is widely recognized. Its western offshelf equivalents include parts of the Grizzly Bear and Sapper formations and in more western exposures, the lowest part of the Portrait Lake Formation.

Arnica Formation (**DA**). The Arnica Formation (Douglas and Norris, 1961; Gabrielse et al., 1973) is only recognized northeast of the Broken Skull River. It consists of 40 m (sections 57, 59) of dark grey to black weathering black, fine crystalline, vuggy dolostone in medium to thick beds. Its contact with the underlying Sombre Formation is placed at the top of the uppermost white weathering dolostone bed of the latter. Its upper contact with the Natla Formation is placed at a sharp upward change from thick-bedded dolostone to thin and evenly bedded, cherty dolostone.

Environment, age, and correlation. Like the underlying Sombre Formation the Arnica Formation, with its dolomite composition and sparse fauna, probably represents deposition in a peritidal restricted setting. Its age is well bracketed by conodonts (Appendix 4) as being within the *inversus/laticostatus* conodont Zone of late Early Devonian age.

The Arnica Formation is found throughout Mackenzie Mountains (Gabrielse et al., 1973), where it ranges up to 500 m thick. Its thinness in the Nahanni area may be attributed to facies change to the Natla Formation. Also, the striped interval here composing the upper member of the Sombre Formation may be included elsewhere in Mackenzie Mountains with the Arnica Formation. Offshelf facies of Arnica age include the Sapper and Grizzly Bear formations and farther southwest, the lower part of the Portrait Lake Formation.

Middle Devonian

Landry Formation (**DL**). The Landry Formation (Douglas and Norris, 1961; Gabrielse et al., 1973) is exposed in Black Wolf Syncline where it consists of cliff-forming, grey weathering limestone exposed between underlying and overlying recessive limestone of the Natla and Headless formations, respectively. On the northeastern limb of the syncline it consists of at least 389 m (section 56) of thin- to thick-bedded grey limestone, with abundant rugose and tabulate corals. Echinoderm debris, brachiopods, and trilobites are common locally. Near the base of the formation is a 15 m thick interval of biostromal limestone with about 8 percent vuggy porosity, containing large clumps of colonial rugose corals, some not in growth position. The base of the formation is picked at resistant, light grey weathering limestone that conformably overlies thinly bedded, recessive, greyish-black weathering limestone of the Natla Formation. The top of the Landry Formation is conformable with overlying thin-bedded limestone of the Headless Formation, this contact being defined at a sharp upward change in weathering colour from grey to buff-brown. The Landry Formation can be easily traced on aerial photographs because of its resistant character. To the southeast, at the eastern boundary of the map area (with Glacier Lake (95L) map area), the Landry Formation pinches out and there is no resistant limestone unit separating the Natla and Headless (or Funeral) formations.

Immediately north of the map area on the southwestern limb of Black Wolf Syncline (section 55) basal beds of the Landry Formation (222+m thick) consist of medium-bedded, very fine crystalline limestone that weathers dark grey with minor orange and pink. There the Landry Formation rests conformably above dark grey to buff weathering, thin-bedded, silty limestone assigned to the Natla Formation.

Environment, age and correlation. The Landry Formation's abundant fossils and lack of dolomitization indicate a well-aerated open marine environment. Its age, based on contained and bracketing conodont faunas, is late Eifelian (probably within the *australis* to *kockelianus* zones) (Appendix 4).

The Landry Formation is a widespread unit in Mackenzie Mountains where it is a prominent ridge-former (Douglas and Norris, 1961; Gabrielse et al., 1973). Where it pinches out at the eastern margin of the map area, age control is not sufficient to tell whether equivalent strata belong to the underlying Natla or overlying Headless formations. However, the latter is suspected because medium to thick beds of the basal Landry Formation are tan-brown to orange weathering in this region, a weathering colour characteristic of the overlying Headless Formation. To the southwest in Nahanni map area, beds of the offshelf facies that are equivalent to the Landry Formation belong to the Funeral, and possibly Sapper formations. Farther, basinward equivalent shale and chert form the lower Portrait Lake Formation.

Headless Formation (**D**H). The Headless Formation (Douglas and Norris, 1961, Gabrielse et al., 1973) is an interval of recessive weathering limestone between resistant limestone of the Nahanni and Landry formations. It is exposed on the northeastern limb of Black Wolf Syncline. Judging from sections described by Gabrielse et al. (1973, sections 46 and 47) the Headless Formation in this area is about 212 m thick. The predominant lithology is dark grey, fine crystalline limestone that weathers orange to tan-brown and occurs in thin to medium beds. The formation is rich in fossils including an abundance of echinoderm debris, corals, bryozoa, brachiopods, and trilobites. The basal contact is conformable and placed at a sharp upward change in weathering colour from grey to buff-brown. Toward the southeast where the underlying Landry Formation pinches out, the contact is picked at the highest recessive thin-bedded dark weathering limestone of the Natla Formation. The conformable upper contact is picked at the base of the lowest, resistant, grey weathering thick limestone rib of the Nahanni Formation.

Environment, age and correlation. The diverse and abundant fauna of the Headless Formation is compatible with deposition in an open marine shelf setting. Few fossil collections were made during its brief examination and its age therefore cannot be bracketed more closely than late Eifelian (Appendix 4).

The Headless Formation occurs widely in southern Mackenzie Mountains (Gabrielse et al., 1973). In northern Mackenzie Mountains it correlates with the lithologically similar Hume Formation (e.g. Aitken et al., 1982). On the southwestern limb of Black Wolf Syncline in Nahanni map area, and along strike to the southeast in Glacier Lake (95L) map area (Gabrielse et al., 1973), equivalent offshelf strata constitute the Funeral Formation. To the southwest, black shale and chert of about the same age form the lower part of the Portrait Lake Formation.

Nahanni Formation (**D**N). Resistant grey limestone of the Nahanni Formation (Hage, 1945; Douglas and Norris, 1960, 1961; Gabrielse et al., 1973) overlies the recessive, orange to tan-brown weathering Headless and Funeral formations along Black Wolf Syncline. It also occurs above the Funeral Formation along the unnamed syncline northeast of Sapper Anticline, but there it is too thin and discontinuous to be mapped separately. The top of the Nahanni Formation marks the end of Mackenzie Platform carbonate deposition.

On Black Wolf Syncline (section 59), the Nahanni Formation consists of about 31 m of grey weathering, grey to black, fine crystalline limestone (Fig. 13). It weathers into a succession of 3 m thick ribs separated by about the same thickness of recessive beds. An irregular 0.2 m thick parting is best developed in the more resistant beds. Crinoid ossicles and brachiopods occur locally.

Northeast of Broken Skull Fault (section 35) the Nahanni Formation comprises about 90 m of sparsely fossiliferous limestone in grey weathering, medium to thick beds. Fresh surfaces are dark grey.

The Nahanni Formation overlies the Headless and Funeral formations conformably. The contact is defined below the lowest resistant limestone rib resting on recessive rubbly weathering limestone. Its upper contact along Black Wolf Syncline is marked by an abrupt change from resistant

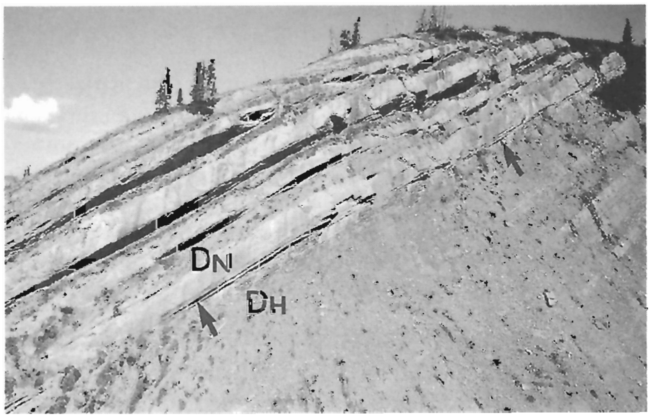


Figure 13. The Nahanni Formation (**D**N; 31 m thick) on the northeastern limb of Black Wolf Syncline (section 59). The contact with underlying thin-bedded and recessive limestone of the Headless Formation (**D**H) is marked by arrows. GSC 204922.

weathering carbonate to recessive overburden- or vegetation-covered shale of the Prevost Formation. This contact is presumed to be unconformable as the expected intervening Portrait Lake Formation is not present, or too thin to be recognized along the poorly exposed contact (see Fig. 12). Northeast of Broken Skull Fault (section 35), the Nahanni Formation is sharply overlain with assumed conformity by silver-grey weathering siliceous shale and chert of the Portrait Lake Formation. To the southwest along the southwestern limb of Sapper Anticline, the Nahanni Formation is absent. Regional stratigraphic relationships suggest that there it was removed by pre-Portrait Lake Formation erosion, although this cannot be proved with present fossil control.

Environment, age, and correlation. The regional extent and composition of the Nahanni Formation and sparse faunal data indicate deposition on an open marine shelf. Its age is probably latest Eifelian (Appendix 4). Its upper age limit, although not constrained in the Nahanni area, appears elsewhere in Mackenzie Mountains to be no younger than Eifelian (Chatterton, 1978).

The Nahanni Formation extends as far as the eastern margin of Franklin Mountains (Douglas and Norris, 1961). In northern Mackenzie Mountains equivalent strata form the upper part of the Hume Formation (e.g. Aitken et al., 1982). To the southwest, siliceous shale and chert of the Portrait Lake Formation may be partly equivalent, but fossil determinations of Nahanni age are lacking in the offshelf facies. Noble and Ferguson (1973) describe an abrupt southwestward shale-out of the Nahanni Formation in southwesternmost Northwest Territories (about 61°N; 125°W).

Central belt - Interstratified shelf (Mackenzie Platform) and offshelf (Selwyn Basin) facies

The region between the South Nahanni and Broken Skull rivers is underlain by late Precambrian to Middle Devonian strata of mixed shelf and offshelf facies. Formations of offshelf facies include the Vampire (late Precambrian to Lower Cambrian), Rockslide (Middle Cambrian), Rabbitkettle (Cambro-Ordovician), Sapper (Siluro-Devonian), Grizzly Bear (Devonian), and Funeral (Devonian) formations. Each of these is characterized by one or more of siltstone, fine grained quartz sandstone, and thin-bedded limestone. Interstratified with these formations are the Backbone Ranges (late Precambrian), Sekwi (Lower Cambrian), Avalanche (Middle Cambrian), and Broken Skull and Haywire (Cambro-Ordovician to Silurian) formations. These are composed of shelf facies comprising mostly shallow water dolostone, quartz sandstone, and shale. In gross aspect the boundary between offshelf (Selwyn Basin) and shelf (Mackenzie Platform) facies shifted northeast with time. The Lower Cambrian shelf edge occurs along the valley of Flat Lakes, and that of the Cambro-Ordovician occurs roughly along the South Nahanni River. The Siluro-Devonian shelf edge occurs along the upper Broken Skull River. In detail, however, formations grouped with the shelf facies may contain members of offshelf affinity, indicating complexities in the advance and retreat of the shelf margin.

Precambrian to Lower Cambrian

Backbone Ranges Formation (PB). The Backbone Ranges Formation (Gabrielse et al., 1973) is the oldest exposed platform unit in Nahanni map area. It consists of medium- and thick-bedded dolostone, sandy dolostone, and minor quartz sandstone that weather light grey, cream, and light orange. Exposures are limited to lower valley walls of the South Nahanni River where it deeply dissects South Nahanni Anticline. There the formation is at least 400 m thick. The Backbone Ranges Formation is abruptly and conformably overlain by dark brown weathering siltstone, shale, and sandstone of the Vampire Formation.

Environment, age, and correlation. The sandy dolostone and quartz sandstone lithologies suggest deposition on a shallow marine shelf. Trace fossils in the overlying Vampire Formation suggest that the Precambrian-Cambrian boundary may lie above but close to the top of the formation (Fritz et al., 1983).

The Backbone Ranges Formation and its equivalents extend over much of western Mackenzie Mountains. They are known from Glacier Lake (95L) and Wrigley Lake (95M) (Gabrielse et al., 1973), Sekwi Mountain (105P) (Blusson, 1971, unit 12), Nadaleen River (106 C) and Bonnet Plume Lake (106B) (Blusson, 1974), and Upper Ramparts River (106 G) (Aitken et al., 1982) map areas. Exposures in Nahanni map area correlate with the middle carbonate member of the Backbone Ranges Formation at the type section 44 km to the east (Gabrielse et al., 1973; Fritz, 1982). To the southwest in Selwyn Basin it may correlate with a thin limestone member at the top of the Yusezyu Formation (Fritz et al., 1983).

Vampire Formation (PЄV). The Vampire Formation (Fritz, 1982) is a dark brown weathering clastic succession up to 830 m thick found between light grey weathering carbonates of the underlying Backbone Ranges and overlying Sekwi formations. Its best exposures are along South Nahanni Anticline. It also cores the Sapper Anticline and is extensive in the southeastern quarter of the map area. The Vampire Formation is of fairly uniform composition. The following summary is based on Fritz's (1982) description of the type section located on South Nahanni Anticline immediately east of the map area. His observations typify exposures throughout the region.

The Vampire Formation consists of siltstone and very fine to fine grained, quartz sandstone that weather dark brownish grey. Beds are thin to thick, and planar laminae are visible in some, especially the thinner ones. Cross-bedding is rare. Load casts, ball and pillow structures, and penecontemporaneous folds are present at some levels. The siltstone is generally interbedded with the quartz sandstone, but at several levels within the formation, the sandstone forms resistant medium- to thick-bedded members. Fresh quartz sandstone surfaces are medium grey, greenish grey, or light brownish grey. The base of the Vampire Formation is defined at the top of the highest orange weathering dolomitic sandstone bed in the predominantly dolomitic Backbone

Ranges Formation. The Vampire Formation is abruptly but conformably overlain by maroon and orange weathering limy nodular siltstone of the basal Sekwi Formation.

Environment, age, and correlation. The fine clastic facies of the Vampire Formation represent deposition in an offshelf, possibly slope (e.g. penecontemporaneous folds) environment. Its trace fossils (Fritz et al., 1983) indicate an earliest Early Cambrian age for at least the upper two thirds of the formation. The lower part belongs to the Precambrian.

The Vampire Formation correlates with the upper member of the Backbone Ranges Formation at its type section to the east in Glacier Lake (95L) map area (Fritz, 1982). The latter consists of fine to very coarse, locally pebbly quartz sandstone. In Sekwi Mountain (105P) map area topmost beds of the upper Backbone Ranges Formation are replaced by a tongue of fine clastics belonging to the Vampire Formation (unit 13 of Blusson, 1971). The tongue separates sandstone of the upper Backbone Ranges Formation (unit 12 of Blusson, 1971) from the overlying Sekwi Formation. In southwestern Nahanni map area scant trace fossils suggest that the Vampire Formation is equivalent to maroon to dark grey weathering fine clastics of the Narchilla Formation (Fritz et al., 1983).

Sekwi Formation (Ꞓs). The Sekwi Formation (Handfield, 1968; Gabrielse et al., 1973; Fritz, 1976, 1978, 1979a, 1979b, 1981) is a widespread, lithologically varied Lower Cambrian succession of carbonate, quartzite, and shale. Its grey to bright orange weathering colour distinguishes it from underlying dark weathering shale of the Vampire Formation and from overlying dark grey to black weathering limestone of the Rockslide Formation. In Nahanni map area the Sekwi Formation is exposed in South Nahanni Anticline, in Sapper Anticline, and in O'Grady Anticline. At the first two localities it comprises a lower carbonate member of limestone and dolostone (300 m), and an upper sandy carbonate member characterized by quartz sandstone but also including shale and dolostone (300 m).

The lower part of the carbonate member on South Nahanni Anticline (see sections 21, 23) is characterized by orange to grey weathering, dark grey, fine crystalline limestone in thin beds. Wavy bedding and nodules of dark blue-grey, fine crystalline limestone several centimetres across are common. The nodules are elliptical and can be widely separated or are locally abundant enough to coalesce along bedding (Fig. 14A). They commonly weather more recessively and are darker than the more silty matrix. Interstratified with the limestone are rare intervals of slump conglomerate from a few metres to up to twenty metres thick (Fig. 14B). The conglomerates are predominantly orange weathering. They consist of rounded to angular, black to dark blue-grey, fine crystalline limestone clasts set in a sandy, fine crystalline limestone matrix. These fragments may be isolated within the matrix or clast supported. Up to 5 percent of them are oolitic limestone or medium to coarse grained quartzarenite. Clast size is predominantly 0.1 m or less but more tabular clasts may be up to 0.3 m long. The clasts have their long axes at variable angles to regional bedding and

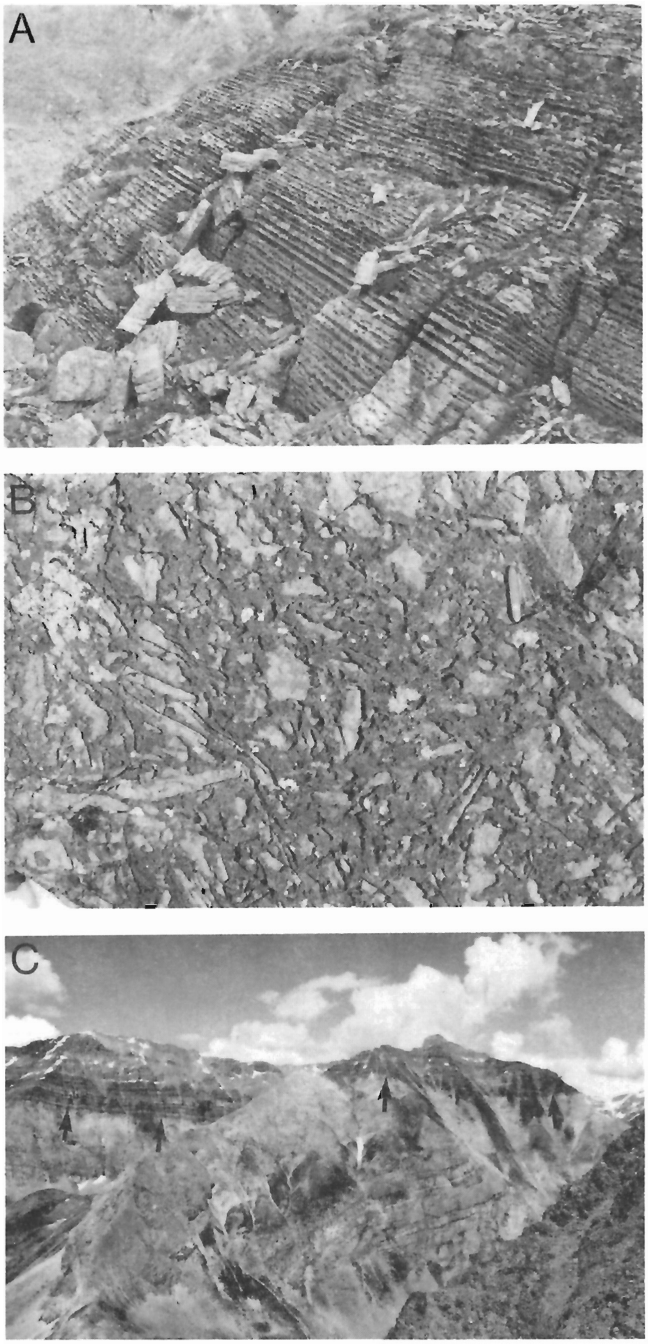


Figure 14. The Sekwi Formation along the southwestern limb of South Nahanni Anticline. **A.** Thin-bedded nodular bedded limestone characteristic of the lower Sekwi Formation (photo near section 21). GSC 204922-A. **B.** Limestone conglomerate, common in the lower Sekwi Formation, consisting of light coloured fine crystalline limestone clasts in a dark coloured argillaceous to sandy limestone matrix (photo near section 21). GSC 204922-B. **C.** Sharp contact, marked by arrows, of lower carbonate and upper clastic members of the Sekwi Formation. View is to the northeast from section 21. GSC 204922-C.

show no imbrication. The upper part of the carbonate member comprises massive white weathering, grey, fine crystalline dolostone. A fine lamination on weathered surfaces in shades of grey and white can be discerned, with a variable attitude on outcrop scale. Presumably this rock is a dolomitized breccia containing clasts at various orientations; the lamination is not continuously preserved so that original clast outlines are not visible.

The sandy carbonate member of the Sekwi Formation in South Nahanni Anticline is a succession of interstratified quartzarenite, siltstone, mudstone, dolostone, and limestone (Fig. 14C). For descriptive purposes it can be divided into three main units. The lower unit (161.5 m in section 21) comprises thick-bedded, planar laminated, or massive, mature, quartzarenite with minor interbedded shale and siltstone. In its upper part the unit contains thin to thick interbeds of orange weathering fine crystalline dolostone, commonly with suspended sand grains. Small-scale scour, ripple cross-lamination, and oscillation ripple marks are locally developed. The middle unit (108 m in section 21) consists of interbedded purple mudstone, and yellow, fine crystalline limestone and dolostone in beds 0.5 to 1.0 m thick. The purple mudstone is commonly finely laminated and has floating quartz sand and local mudcracks. The upper unit (94 m in section 21) comprises brilliant orange weathering, thick-bedded, grey to white, very fine crystalline dolostone.

On Sapper Anticline (section 22) the lower member of the Sekwi Formation comprises orange-brown weathering siltstone, and thin-bedded, wavy bedded, cream weathering dolostone in subequal proportions. This is overlain by thick-bedded, fine crystalline, grey dolostone. The upper member comprises dolostone and orange weathering siltstone. Mature quartz sandstone in thick beds occurs about 16 to 20 m above the base of the upper member. As in South Nahanni Anticline the upper member contains purple, maroon, and light brown siltstone and is capped by brownish-grey to orange weathering siltstone and dolostone. In Sapper Anticline the designation of upper and lower members in measured section probably corresponds closely with that as mapped in South Nahanni Anticline, the contact between members placed below an influx of quartz sand. In Sapper Anticline, however, mapping of the two members is hindered by their similar orange weathering colour.

On O'Grady Anticline, the Sekwi Formation was only briefly examined. There it consists of undivided orange weathering dolostone, sandy dolostone, and quartz sandstone.

The Sekwi Formation conformably overlies the Vampire Formation along a gradational contact a few metres thick. The formational boundary was selected at a change in lithology from clastic to carbonate composition. The upper contact of the Sekwi Formation with the Rockslide Formation is sharp and apparently conformable, corresponding to a lithological change from dolostone to limestone and to a marked change in weathering colour from white to dark grey or black. On southeastern South Nahanni Anticline the Sekwi Formation is overlain conformably by dolostone of the Avalanche Formation, a lateral equivalent of the Rockslide Formation. There is no marked compositional difference across the contact and the boundary is mapped at the base of red weathering beds that are included within the Avalanche Formation.

Environment, age, and correlation. The presence of thin-bedded limestone with interstratified slump(?) conglomerate suggests that the lower part of the Sekwi Formation was deposited below wave base in a relatively deep water slope(?) environment. This part of the formation represents a shoaling upward sequence above the underlying Vampire Formation. Mudcracks and floating windblown(?) quartz sand within the upper member suggest a shallow subtidal to intertidal depositional setting. The age of the Sekwi Formation is well known on the basis of a prolific and diversified trilobite fauna. In Nahanni map area the upper Lower Cambrian *Fallotaspis, Bonnia-Olennelus*, and *Nevadella* zones are represented (Appendix 4).

The Sekwi Formation is a widespread Lower Cambrian unit that outcrops over most of western Mackenzie Mountains in Flat River (95E), Glacier Lake (95L), Wrigley Lake (95M) (Gabrielse et al., 1973), Sekwi Mountain (105P) (Blusson, 1971), Bonnet Plume Lake (106B), Nadaleen River (106C) (Blusson, 1974), and Niddery Lake (105O) (Blusson, 1974; Cecile, 1981) map areas. Fritz (1976, 1978) presents detailed measured sections of the Sekwi Formation from most of these places. In Nahanni map area the Sekwi Formation is apparently replaced to the west in the offshelf facies of Selwyn Basin by shale of the Gull Lake Formation. A thin limestone conglomerate at the base of the Gull Lake is of Early Cambrian age and lithologically like the conglomerates within the lower Sekwi Formation.

Middle Cambrian

Rockslide Formation (**ЄR**). The Rockslide Formation (Gabrielse et al., 1973) comprises recessive, dark grey to black weathering limestone which is well exposed along South Nahanni Anticline (Fig. 15), Sapper Anticline, and east of O'Grady Batholith. At the first locality it is easily distinguished from overlying and underlying light coloured carbonates of the Haywire (or Avalanche) and Sekwi formations, respectively. In the latter areas it is underlain by the Sekwi Formation but is overlain by the similar weathering Rabbitkettle Formation.

Along South Nahanni Anticline the Rockslide Formation varies up to 450 m in thickness and comprises dark grey weathering, commonly planar laminated limestone in thin to medium beds (Fig. 15). Medium grey to brownish-grey weathering nodular siltstone, oolitic limestone, and silty limestone are abundant lithologies at some places. Penecontemporaneous breccias and slump folds also occur locally. The contact with underlying dolostone of the Sekwi Formation is sharp, but conformable. The upper contact with Avalanche Formation thick-bedded dolostone is gradational through several to a few tens of metres and is expressed by an increase in bed thickness and proportion of dolostone. The contact is defined at the lowest dolostone bed.

Along Sapper Anticline the Rockslide Formation consists of about 430 m of tan weathering, dark grey, fine crystalline, thin-bedded, platy limestone. Orange-brown weathering beds, limy siltstone with limestone nodules, thin wavy beds, and penecontemporaneous slump structures are present. The base of the Rockslide Formation is defined at an abrupt change from medium grey weathering limestone to orange weathering siltstone and dolostone of the underlying Sekwi Formation. The upper contact is defined at the base of very fine to fine grained quartz sand marking the bottom of the Rabbitkettle Formation.

East of O'Grady Batholith the Rockslide Formation is similar to that in Sapper Anticline. The contact with the underlying Sekwi Formation occurs at an abrupt change from orange weathering dolostone upward to dark weathering limestone. The upper boundary of the Rockslide Formation was not examined, and the presence of the quartz sand which marks the overlying basal Rabbitkettle Formation on Sapper Anticline was not confirmed. East of O'Grady Batholith the mapped location of the Rockslide/Rabbitkettle contact is inferred by assuming the same thickness for the Rockslide Formation as occurs in Sapper Anticline.

Avalanche Formation (**ЄA**). The Avalanche Formation (Gabrielse et al., 1973) consists of grey to white weathering dolostone. It is exposed along South Nahanni Anticline above dark weathering limestone of the Rockslide Formation, and beneath basal redbeds of the Haywire Formation (Fig. 15). At the southeastern end of the anticline it overlies the Sekwi Formation.

Avalanche dolostone is medium to thick bedded, medium to light grey weathering, fine to coarse crystalline, and commonly vuggy. Locally there are beds that weather pink, maroon, or tan, and locally the dolostone may contain a few percent floating, medium to coarse, quartz sand. In the middle of the formation is 20 to 30 m of oncolitic, dark grey weathering, medium- to thick-bedded dolostone. The oncolites are up to 2 cm in diameter and set in a medium to coarse crystalline dolostone matrix. The basal contact of the Avalanche Formation is gradational. Medium grey weathering limestone of the Rockslide Formation in thin, wavy, beds changes upward over a few metres to a few tens of metres to medium- to thick-bedded Avalanche dolostone. Nodular texture typical of the underlying limestone may persist upward as ghost-like relicts in the dolostone. The formational boundary is defined at the base of the lowermost dolostone beds. At the southeastern end of South Nahanni

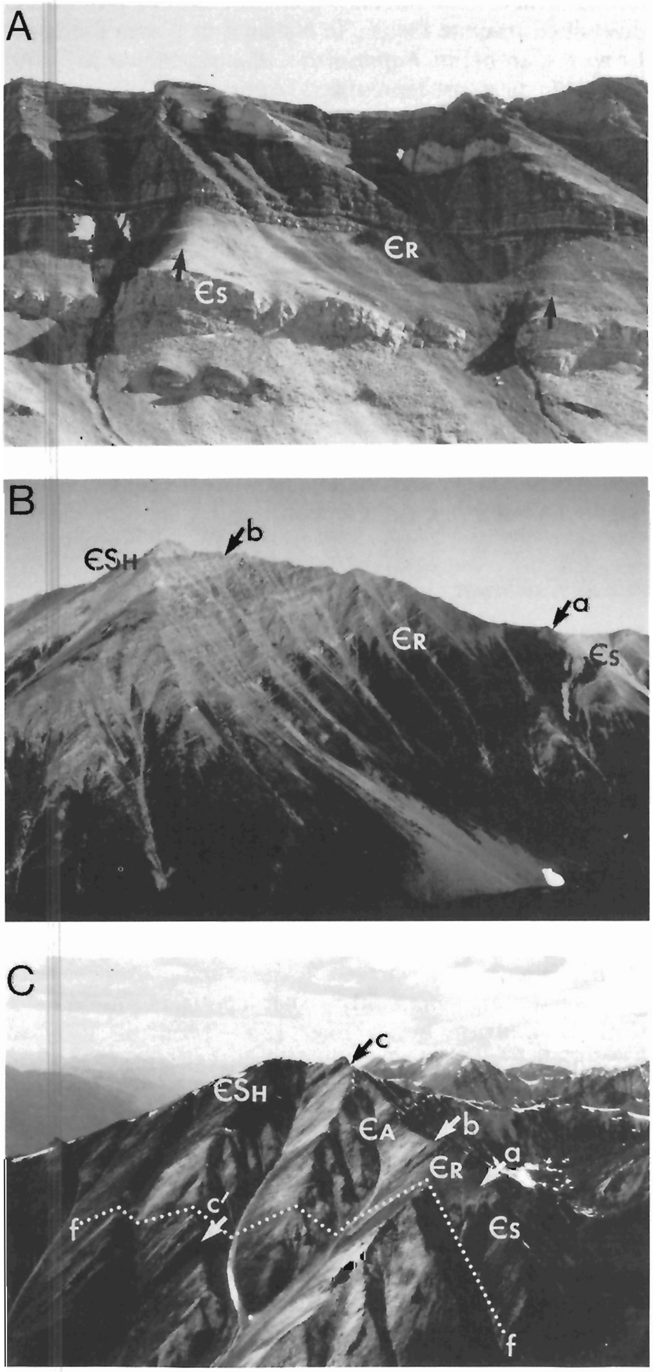


Figure 15. The Rockslide and Avalanche formations along the southwestern limb of South Nahanni Anticline. **A.** Arrows mark the scree-covered contact between the Sekwi Formation (ЄS) dolostone and the dark coloured limestone of the Rockslide Formation (ЄR). The white patches within the Rockslide Formation are mounds of massive, fine crystalline limestone. View to the southwest, from 3 km northwest of section 40. GSC 204922-D. **B.** "a" marks the contact of the Sekwi Formation (ЄS) with the Rockslide Formation (ЄR). The approximate top of the Rockslide Formation, and contact with the overlying Haywire Formation (ЄSH) is at "b". Northwest view from near section 40 toward section 21. GSC 204922-E. **C.** The base of the Rockslide Formation (ЄR), and contact with underlying Sekwi Formation (ЄS) is at "a". The upper contact of the Rockslide Formation with the overlying Avalanche Formation (ЄA) is at "b". The base of the Haywire Formation (ЄSH) is at "c". Displacement across a steeply-dipping fault "f-f" is shown by offset of the base of the Haywire Formation (i.e. "c" to "c'"). Note that the Avalanche and Rockslide formations are lateral equivalents (compare photos B and C) occupying the same stratigraphic position between the Sekwi and Haywire formations. View to the northwest from section 25 toward section 23. GSC 204922-F.

Anticline, the Avalanche Formation rests on the Sekwi Formation. There, red weathering beds are present and included within the Avalanche Formation. The base of the redbeds serves to delineate an otherwise inconspicuous formational contact. The upper contact of the Avalanche Formation is placed at the base of the first appearance upward of red weathering dolostone or grey, pink, or buff weathering quartz sandstone that mark the basal redbed sequence of the Haywire Formation.

Environment, age, and correlation of the Rockslide and Avalanche formations. Compared to dolostones of the overlying and underlying formations (Avalanche and Sekwi formations) the Rockslide Formation was deposited in relatively deep water; perhaps on a slope as indicated by local slump structures. It contains abundant trilobite fossils which collectively represent all Middle Cambrian trilobite zones (Appendix 4). The Avalanche Formation is a lateral equivalent of the Rockslide Formation, gradually replacing it toward the southeastern end of South Nahanni Anticline (Fig. 16). Its oncolites, floating quartz sand, and dolomite composition suggest a shallow subtidal or peritidal environment. The Avalanche Formation is not well dated, but faunas collected indicate a Middle Cambrian age (Appendix 4). Its diachronous basal contact with the Rockslide Formation indicates it locally may span all or only a small part of the time represented by that formation (see Fig. 16).

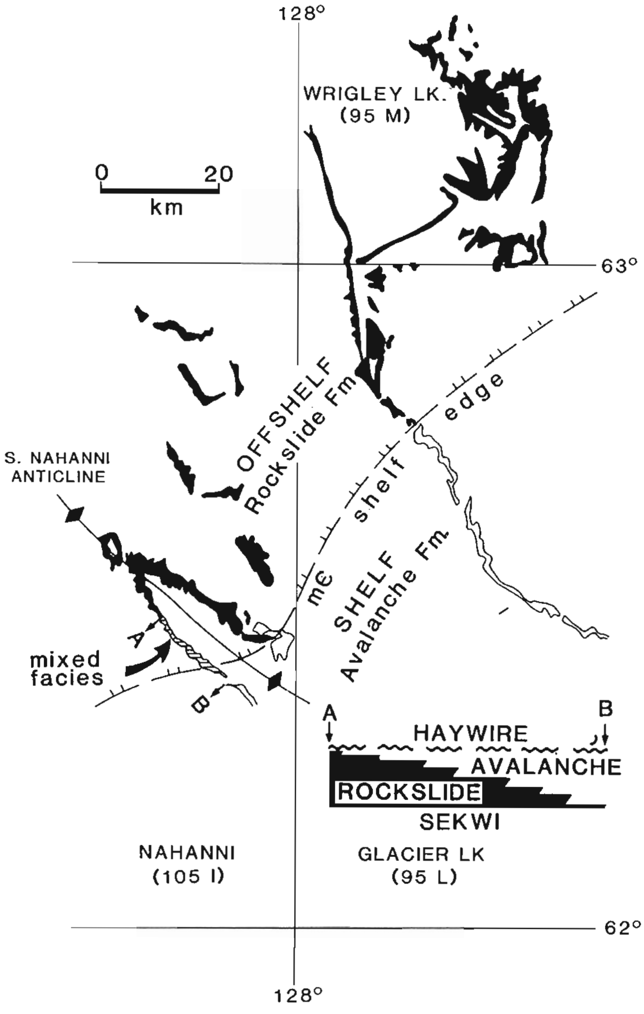


Figure 16. Regional distribution of Avalanche (dolostone) (unpatterned) and Rockslide (limestone) black formations delineate the approximate position of the Middle Cambrian shelf edge. The Avalanche Formation replaces the Rockslide Formation laterally to the southeast along the southwest limb of South Nahanni Anticline (horizontal rule) as shown diagrammatically in longitudinal section AB. The position of the Middle Cambrian shelf edge is at a high angle to earlier and later facies changes which trend dominantly northwest.

In Mackenzie Mountains the Rockslide Formation occurs extensively in northwestern Flat River (95E) and Glacier Lake (95L) map areas (Gabrielse et al., 1973). In these areas it represents an incursion of offshelf facies far onto Mackenzie Platform (Fig. 16). In these areas also, not all trilobite zones are present in all sections, suggesting depositional breaks within and at the base of the formation (Gabrielse et al., 1973, p. 32, 38). In Bonnet Plume (106B) map area shale and calcareous shale of Middle Cambrian age, locally containing thick quartz sandstone flysch, is assigned to the Hess River Formation by Cecile (1982). In Sekwi Mountain (105P) map area unit 15 of Blusson (1971) is lithologically similar and equivalent to the Rockslide Formation. The Avalanche Formation has limited exposure in Glacier Lake map area where it rests unconformably above Precambrian to earliest Cambrian quartz sandstone of the Backbone Ranges Formation. Over much of Mackenzie and Selwyn mountains (including southwestern Nahanni map area), Middle Cambrian strata have been entirely removed by pre-Upper Cambrian erosion. Regional distribution of Avalanche (dolostone) and Rockslide (limestone) formations (Fig. 16) delineate the position of the Middle Cambrian Mackenzie Platform edge. The platform edge trends northeast, at right angles to earlier and later dominantly northwest trends (Fig. 7; see section on Tectonics).

Cambro-Ordovician to Silurian

Haywire Formation (ЄSH)(new). The Haywire Formation comprises medium- and thick-bedded light grey to white weathering dolostone exposed mostly northeast of the South Nahanni River. A basal tongue of the formation (sandy carbonate member) extends southwest to Lened Syncline and to the southeast of the Shelf Lake pluton. South of Haywire Lake, the formation contains interstratified basalt flows and tuffs (volcanic member). The Haywire Formation has complex stratigraphic relations with overlying and underlying units (Fig. 17). On South Nahanni Anticline, it consists of monotonous shelf dolostone of Cambro-Ordovician to Early Silurian age. To the northeast of Margaret Syncline, partly correlative formations can be mapped (see Fig. 17). In these regions the Haywire Formation spans less time and in most places, is thinner.

Type section - Section 40 - 62°26.8′N; 128°23.9′W. The type section, 639 m thick, is located on the southwestern limb of South Nahanni Anticline about 14 km northwest of Haywire

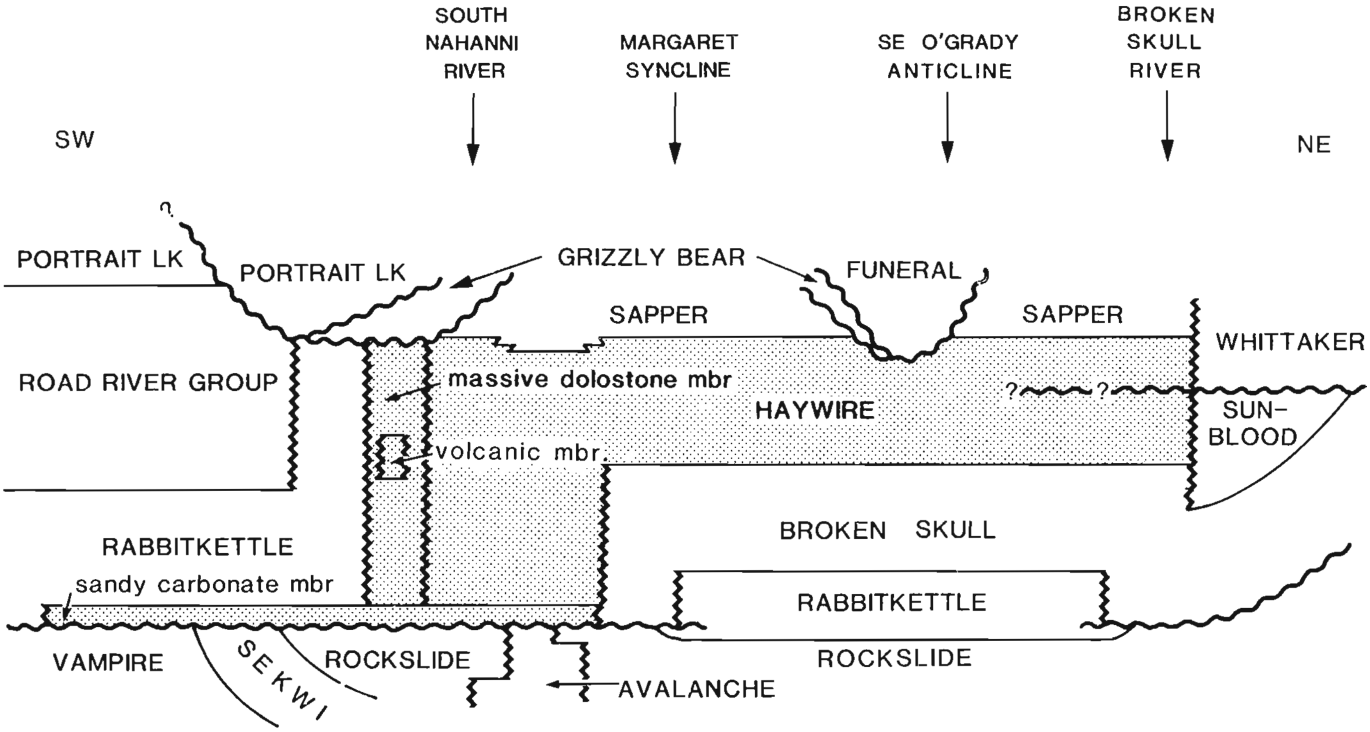


Figure 17. Stratigraphic relationships of the Haywire Formation (patterned). The Haywire Formation is a monotonous dolostone succession equivalent to the Rabbitkettle, Broken Skull, Sunblood, and Whittaker formations of Mackenzie Mountains. The regional sub-Whittaker unconformity may be present, but cannot be recognized within the Haywire, and may account for significant thickness changes in the formation.

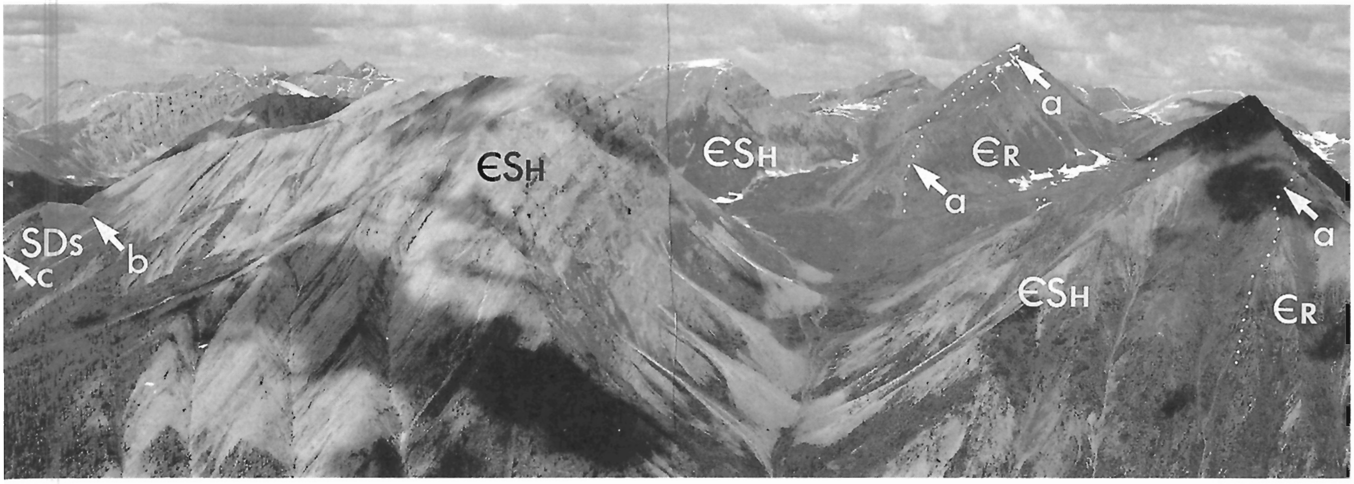


Figure 18. Northwesterly view of the Haywire Formation (**Є**S**H**), southwestern limb of South Nahanni Anticline, about 8 km northwest of the type section. The base of the Haywire Formation is approximated at "a" and marked by a dotted line. Dark weathering beds of the basal sandy carbonate member are difficult to distinguish at a distance from the upper Rockslide Formation (**Є**R). Contact of the recessive Sapper Formation (**SD**s) with the Haywire Formation is at "b". The base of a thin slightly resistant rib of carbonate at "c" marks the contact of the Sapper Formation with limestone of the overlying Grizzly Bear Formation. GSC 204922-G.

Lake after which the formation is named. As the top of the section is faulted, a separate reference section is designated (see below) for the upper formational boundary. Although exposed along a ridge crest, the lower part of the type section is obscured by blocky felsenmeer and rubble. The base of the formation is defined in felsenmeer at the base of light yellow to cream weathering, sandy dolostone. The underlying Avalanche Formation is of similar lithology but lacks sand. An unconformity at the basal contact is assumed from regional evidence for an important, locally angular, unconformity at this level (Gabrielse et al., 1973). The type section contains a basal sandy carbonate member about 86 m thick that consists of yellow or red-to-orange weathering, light grey, sandy dolostone and coarse grained quartz sandstone. Planar lamination and large scale cross-lamination are common. Abundant in the middle, and forming the upper fourth of the member is blue-grey weathering, blue-grey, fine crystalline limestone in beds up to 2 m thick. The top of the sandy carbonate member is marked by the upper limit of orange weathering strata. The remainder of the Haywire Formation at the type locality comprises 553 m of monotonous, thick-bedded, fine to medium crystalline dolostone. Weathering colours range from grey to white, and locally black or yellow. Fresh surfaces are grey to dark grey. Beds in the lower 60 m of this interval are locally sandy. The topmost beds of the Haywire Formation are faulted against the Grizzly Bear Formation, but relations along strike indicate as little as 50 m of Haywire strata may have been thus removed.

Reference section for top of formation. A reference section for the top contact of the formation is designated 14 km northwest of the type section (section 41). There, the uppermost 12 m of the Haywire Formation consists of grey weathering, grey to black, fine crystalline dolostone in thick beds. This is abruptly and conformably overlain by scree of light grey to blue-grey weathering, black limestone of the Sapper Formation that is locally burrowed and variably argillaceous.

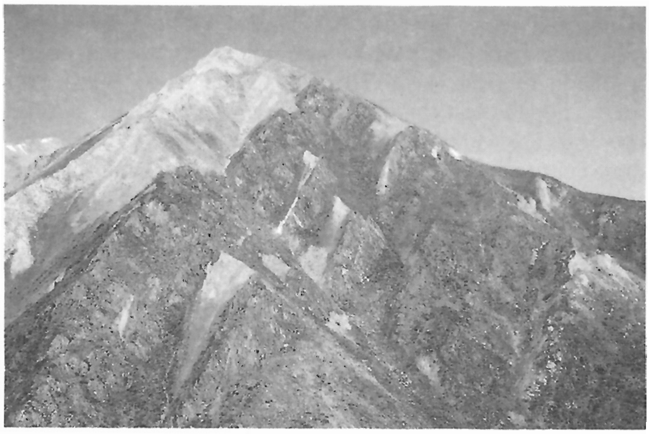


Figure 19. Interbedded basaltic volcanics (dark) and dolostone (light) of the Haywire Formation, on the northwestern side of Bologna Creek near South Nahanni River. View is to the northwest. GSC 204922-H.

Other areas. Elsewhere along the southwestern limb of South Nahanni Anticline the succession is similar to that of the type section. The basal sandy carbonate member was examined 12 km southeast of the type section. There it consists of maroon shale, quartz sandstone, and dolostone (section 25), the shale being locally mudcracked, and showing rare raindrop imprints. The basal contact with underlying thick-bedded, massive dolostone of the Avalanche Formation is sharp and presumably unconformable. Along much of the southwestern limb of the anticline the upper Haywire Formation contains widely separated thick beds of black weathering, black dolostone which impart a striped appearance (Fig. 18). Southwest of Honeymoon Lake the Haywire Formation consists of massive, light to dark grey dolostone (massive dolostone member), which contrasts markedly to its well-bedded character elsewhere. The massive member also occurs 8.7 km south of Margaret Lake but has not been separately mapped there.

Southwest of South Nahanni River the sandy carbonate member of the Haywire Formation forms a tongue(?) that extends to Lened Syncline. There it consists of white to grey weathering, commonly sandy, and locally red weathering dolostone and limestone that rest unconformably on the Vampire Formation. Lower and Middle Cambrian strata (Sekwi and Rockslide formations) were removed by sub-Haywire erosion. Whether the sandy carbonate member in this area is continuous with that on South Nahanni Anticline is uncertain; relationships are obscured by cover of younger strata.

Southeast of Shelf Lake the sandy carbonate member of the Haywire Formation comprises about 50 m of maroon weathering, fine to medium grained quartz sandstone, dolomitic sandstone, and orange weathering, grey dolostone. This in turn is overlain by at least 120 m of grey, fine to medium crystalline dolostone, with minor coarse grained quartz sandstone, sandy dolostone, and minor flat pebble conglomerate. About 15 m above the base of this upper succession, is a thick bed of grey crinoidal limestone; the crinoids indicate an age younger than Cambrian (Eaton, 1960, p. 626).

South of Haywire Lake (section 39), the formation contains a volcanic member comprising up to 300 m of basalt flows and tuff which weather rusty greenish grey to orange (Fig. 19). The flow rocks are dark greenish grey on fresh surface, highly chloritized, and commonly amygdaloidal. The carbonate- and chlorite-filled amygdules vary from 2 to 6 mm in diameter and compose 10 to 15 percent of the rock. The tuffs are dark grey to dark greenish grey, fine grained (maximum fragment diameter 2 cm), and commonly altered to chlorite phyllite. The rusty weathering colour is caused by abundant disseminated pyrite. The volcanics are intercalated with several units, up to 30 m thick, of fine crystalline, thick-bedded dolostone. The carbonate weathers light grey to orange and on fresh surfaces is light grey. The maximum thickness of a basalt interval is about 44 m, and the thickest unit of tuff about 115 m. Individual eruptive units within the lava or tuff could not be distinguished.

Northeast of Margaret Syncline as far as the eastern and northern margins of the map area, the lower and middle parts of the Haywire Formation are replaced by the Broken Skull and Rabbitkettle formations (Fig. 17). The Haywire Formation in this region is generally composed of thick-bedded light grey weathering dolostone. It is overlain sharply and conformably by darker coloured recessive limestone of the Sapper Formation. Thin-bedded dark limestone of the Broken Skull Formation rests sharply and conformably beneath it. The thickness of the Haywire Formation in this region varies remarkably, and at different localities several informal members are recognized (described below). Section 30 is designated a reference section for the Haywire Formation in this area. There, the Haywire Formation comprises 379 m of thick-bedded dolostone. The lower 181 m is dark grey weathering, and dark grey to black on fresh surface. Ellipsoidal chert nodules up to 6 cm in diameter form up to 10 percent of the rock. The upper 198 m comprises alternations from 1 to 4 m thick of grey, black, and white weathering, fine to medium crystalline dolostone. The basal conformable contact of the Haywire Formation with the underlying Broken Skull Formation is marked by an abrupt upward change from thin-bedded limestone to thick-bedded dolostone. The conformable upper contact of the formation is at a sharp change, delimited in scree, from white weathering dolostone to tan weathering limestone of the Sapper Formation.

At section 29, midway along the eastern boundary of the map area, the Haywire Formation consists of 851 m of medium- to thick-bedded dolostone. Grain size varies from fine to medium crystalline, and on fresh and weathered surfaces the rocks are light to dark grey. Two informal members are recognized. A lower or resistant member, 455 m thick, is recognized by its cliff-forming character and predominantly light grey weathering colour. An upper, or banded member is predominantly dark grey weathering. In its upper part the banded member contains thick beds of black dolostone which impart a striped appearance like that of the upper Haywire Formation along South Nahanni Anticline.

Along the northeastern limb of Margaret Syncline (section 33) the Haywire Formation totals 884 m of thick-bedded dolostone. Two members are recognized. A lower or dark dolostone member comprises 585 m of fine to medium crystalline dolostone. Fresh and weathered surfaces are dark grey. The lower member is sharply overlain by 299 m of light grey to white weathering dolostone of the white dolostone member.

Along the southwestern limb of Sapper Anticline the Haywire Formation reaches a minimum thickness of 45 m. There it consists of grey weathering, grey to black, medium to coarse crystalline dolostone. Dark chert nodules up to several centimetres in diameter are abundant. On the northeastern limb of the anticline the formation contains about 140 m of grey, black, or white weathering, medium to coarse crystalline dolostone in thick beds.

East of O'Grady Batholith strata assigned to the Haywire Formation (section 44) comprise at least 239 m of thick-bedded, locally cherty limestone and dolostone. In contrast to other places Haywire strata are predominantly limestone. However, the thick bedding readily separates the Haywire Formation from the thin-bedded limestone of the overlying Sapper and underlying Broken Skull formations.

Environment, age, and correlation. The dolomite composition, mudcracks, and scarcity of fossils in the Haywire Formation suggest a shallow subtidal to intertidal depositional setting. Parts of the basal sandy carbonate member along South Nahanni Anticline represent deposition on a sandy to muddy tidal flat, with mudcracks and raindrop imprints indicating subaerial desiccation. The massive dolostone member near South Nahanni River may represent dolomitized reef(?) facies along the edge of the carbonate shelf.

Conodonts and rare corals from the middle and upper parts of the Haywire Formation in South Nahanni Anticline indicate an age span of Early Ordovician to Early Silurian (Appendix 4). A Late Cambrian (Franconian) age is assigned to unfossiliferous basal beds there and to the southwest by correlation with similar strata in Glacier Lake map area (Gabrielse et al., 1973). Northeast of the anticline, Early and Middle Ordovician strata are represented by the Broken Skull Formation. There, the overlying Haywire Formation is confined to Late Ordovician and Early Silurian age (Fig. 12) (Appendix 4).

The Haywire Formation correlates in the Mackenzie Mountains with the Rabbitkettle, Broken Skull, and Sunblood formations and perhaps part of the Whittaker Formation (see Gabrielse et al., 1973). It represents the outer shelf equivalent of these formations where they lose their distinguishing characteristics and mappability (see Fig. 17). Volcanics west of Honeymoon Lake may correlate with prominent andesite or basalt flows in the Middle Ordovician Sunblood Formation in Glacier Lake (95L) map area to the east. To the southwest the Haywire Formation correlates with the Rabbitkettle Formation and Road River Group in the offshelf facies of Selwyn Basin. The distribution of strata outside the map area that can be assigned to the Haywire Formation (Fig. 20) include parts of map units OSw and Os^2 to Os^5 of Gabrielse et al. (1973) in Glacier Lake (95L) map area, the lower part of map unit 19b of Blusson (1971) in Sekwi Mountain (105P) map area, and all or part of map units 7 and 8 of Blusson (1968) in Frances Lake (105H) and Flat River (95E) map areas. For the last region, Blusson considered unit 8 to be Lower and/or Middle Cambrian. However, near Shelf Lake, strata continuous with Blusson's (1968) unit 8 contain crinoid ossicles and are therefore Ordovician or younger.

Along trend from Shelf Lake to the southeast is the Brintnell Member, an unfossiliferous silty to sandy orange weathering dolostone that Gabrielse et al. (1973) thought Early Cambrian in age, and hence assigned to the Sekwi Formation. This dolostone rests directly on the Vampire Formation (phyllite unit of Gabrielse et al. (1973)), and nodular limestone that is typically found at this stratigraphic position in the Sekwi Formation is apparently absent. The Brintnell Member, instead of being Early Cambrian in age, may represent basal Cambro-Ordovician strata resting unconformably on the Vampire Formation. Local volcanics underlying the Brintnell Member likewise may not be of Early Cambrian age as previously thought.

In Mackenzie Mountains there is an important regional unconformity beneath the Whittaker Formation (Gabrielse et al., 1973). It is uncertain whether this unconformity extends into the Haywire Formation (Fig. 17). Extreme thickness changes of the Haywire Formation northeast of South Nahanni Anticline may reflect this erosional episode, but evidence for this event is obscured by monotonous lithology and dearth of fossils.

Rabbitkettle Formation (northeast of South Nahanni River) (**ЄOR2**). The Rabbitkettle Formation (Gabrielse et al., 1973) comprises thin-bedded tan weathering limestone. It is underlain by the Rockslide Formation of similar weathering colour and lithology, and overlain by white weathering dolostone of the Broken Skull Formation. Best exposures are along and north of Sapper Anticline.

The Rabbitkettle Formation near the southeastern end of Sapper Anticline (section 28) comprises 438 m of orange-tan weathering thin-bedded limestone. The limestone is very fine crystalline and on fresh surfaces is blue-grey. Nodules of grey weathering limestone are common, are as large as several centimetres across, and weather preferentially to form a "swiss-cheese" texture. Grey weathering, thin-bedded, silty limestone is commonly interbedded with the orange weathering limestone. This rock type is also very fine crystalline and is blue-grey on fresh surfaces. It lacks limestone nodules, and locally has an orange weathering parting. The base of the Rabbitkettle Formation is defined at the base of a 33 m thick unit of white weathering, grey, fine grained quartz sandstone. Ripple cross-lamination and herringbone cross-stratification are common in this basal unit. Minor interbeds of orange weathering dolostone and sandy dolostone occur within the sandstone. The unit overlies quartz siltstone with limestone lenses that forms the top of the Rockslide Formation. The top 10 m of the Rabbitkettle Formation comprises orange-tan weathering, blue-grey, thin-bedded silty limestone characterized by red colouration along bedding planes. The upper contact of the formation is defined at a sharp change to grey-tan weathering thick-bedded dolostone of the overlying Broken Skull Formation.

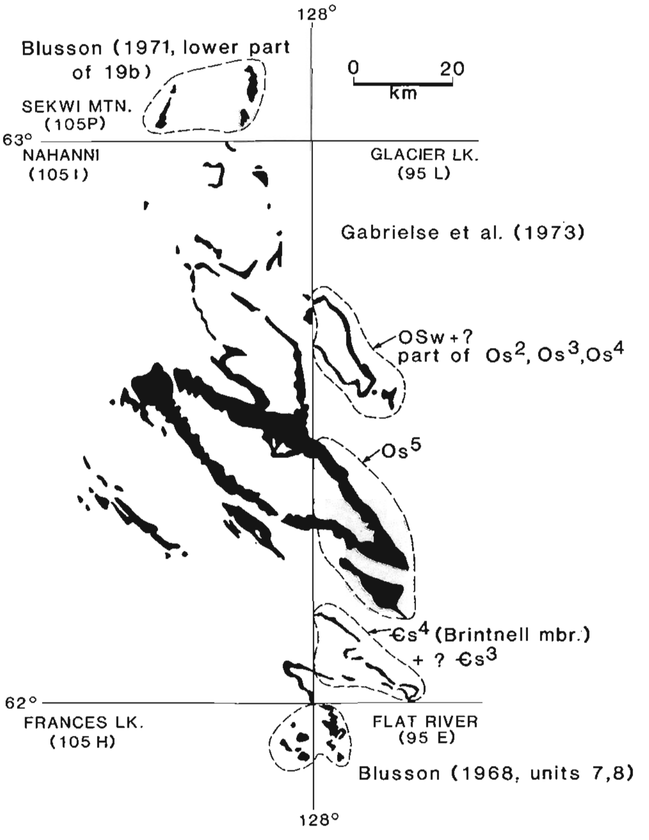


Figure 20. Distribution of the Haywire Formation in Nahanni map area and correlative strata in adjacent map areas that might also be assigned to the Haywire Formation. Acronyms refer to map units of Gabrielse et al., 1973.

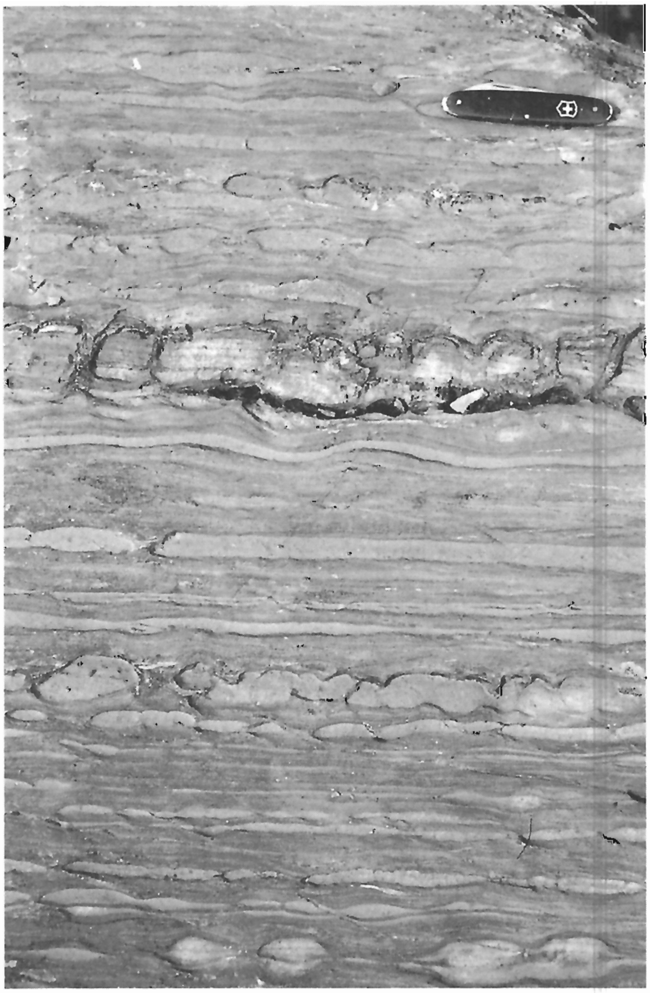


Figure 21. Thin-bedded limestone typical of the Rabbitkettle Formation northeast of South Nahanni River. Thin beds and nodules of blue-grey weathering, fine crystalline limestone occur within a matrix of thin-bedded, orange weathering silty limestone matrix. GSC 204922-I.

Along Sapper Anticline the Rabbitkettle Formation is about 490+ m thick (section 22), and comprises thin-bedded, locally nodular limestone like that described above. Limy siltstone and shale compose thick intervals (tens of metres) in the lower and mid-upper parts of the formation. The base of the formation is defined at the base of a member of quartz sandstone 37 m thick. The grey weathering quartz sandstone occurs in medium and thick beds and is interbedded (25%) with greenish-grey siltstone. The top of the formation is defined by an abrupt change upward to white weathering blocky dolostone of the overlying Broken Skull Formation.

North of Sapper Anticline and east of Broken Skull Fault, the formation also consists of thin-bedded, locally nodular limestone. However, the base of the formation was not examined, and it is not known if the basal quartz sandstone is present. The mapped position of the lower contact is inferred from the thickness of the formation in other places, and from the presence of a slightly more reddish-tan weathering interval that occurs elsewhere near the base. East of O'Grady Batholith at about 62°55'N; 128°25'W, Ludvigson (1982) described a section through the upper part of the Rabbitkettle and lower Broken Skull formations (the latter incorrectly assigned to the Road River Formation), for which he gives a valuable, detailed conodont zonation and environmental interpretation. Lithologies there, like elsewhere, are thin bedded limestone and silty limestone (Fig. 21). The base of the formation was not examined in this area and the Rockslide-Rabbitkettle contact was mapped only approximately.

Environment, age, and correlation. The general scarcity of traction-produced features, thin bedding, silty limestone lithology, and position to the east of flanking, equivalent, shallow water dolostone (Broken Skull Formation - see below) indicate a below wave base, offshelf setting during Rabbitkettle deposition. The ripple cross-laminated and herringbone cross-stratified (intertidal?) basal quartz sandstone near the southeastern end of Sapper Anticline represents a period of shallowing before the relatively deeper water deposition of most of the formation. The age of the Rabbitkettle Formation is well constrained through conodont and trilobite collections to range from Dresbachian (Late Cambrian) through early Tremodocian (Early Ordovician) (Appendix 4).

The Rabbitkettle Formation outcrops extensively in western Flat River (95E) and southwestern Glacier Lake (95L) map areas. As developed there it is largely equivalent to the Broken Skull Formation (Gabrielse et al., 1973). The Rabbitkettle Formation in much of northeastern Nahanni map area can be considered a basal tongue of the formation, overlain by its lateral equivalent, the Broken Skull Formation (see Fig. 17). Only in a small area east of Margaret Syncline is the Rabbitkettle Formation completely replaced by the Broken Skull Formation. The Rabbitkettle Formation is mapped southwest of South Nahanni River (described later), where it has a similar lithology, but is generally white or grey rather than tan to brown weathering. A regional unconformity is recognized beneath the Rabbitkettle Formation southwest of South Nahanni River and beneath the Haywire Formation and the Broken Skull Formation over much of Mackenzie Platform. However in northeastern Nahanni area, a complete sequence of trilobite zones through the Middle and Upper Cambrian indicates little if any erosion. The Rabbitkettle Formation is equivalent to the widespread Kechika Group of Cassiar (Gabrielse, 1963a) and Pelly (Gordey, 1981b) mountains. Cecile (1982) included Cambro-Ordovician silty limestone, limestone, and shale in Bonnet Plume Lake (106B) map area in the Rabbitkettle Formation.

Broken Skull Formation (ЄOBS). White to dark grey weathering dolostone and limestone of the Broken Skull Formation (Gabrielse et al., 1973) are widely exposed northeast of South Nahanni Anticline. The formation overlies dark brown weathering limestone of the Rabbitkettle Formation (and locally Rockslide Formation) and underlies grey weathering dolostone of the Haywire Formation (Fig. 17). Two members are generally recognized. A lower or dolostone member (340-490 m) comprises light grey to white weathering, thick-bedded dolostone. The upper or limestone member (118-583 m) consists of dark grey thin-bedded limestone. A third unit, the sandy carbonate member (0-103 m) occurs at the base of the formation, but only north of the southeastern end of Margaret Syncline.

On the southwestern limb of Sapper Anticline the lower dolostone member consists of 338 m of grey, white, and tan weathering, thick bedded dolostone. The rock is grey to black on fresh surfaces, and fine to medium crystalline. A 20 m thick interval from 278 to 306 m above the base of the formation consists of angular to subrounded blocks of laminated dolostone up to 2 m in diameter randomly oriented within a white, coarse crystalline, dolomite matrix. Above

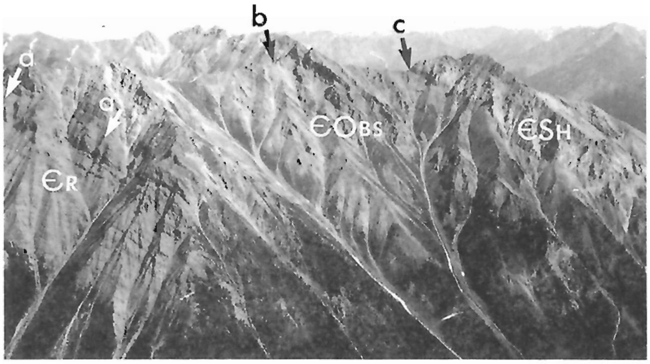


Figure 22. North-looking view of Broken Skull (769 m; ЄOBS) and Haywire (ЄSH) formations, at section 29. Contact of the Broken Skull Formation with the underlying Rockslide (ЄR) Formation is at "a". The base of the Haywire Formation is at "c". "b" marks the contact between the lower or dolostone member, and the upper or limestone member of the Broken Skull. GSC 204922-J.

the breccia, the dolostone is thin to medium bedded. The overlying limestone member consists of 127 m of blue-grey weathering, black, very fine to fine crystalline, thin-bedded limestone. This is overlain by 24 m of tan to dark grey weathering, dark grey dolomitic siltstone. The contact with overlying thick-bedded dolostone of the Haywire Formation is not exposed.

On the northeastern limb of Sapper Anticline (section 30) the dolostone member is 339 m thick and comprises monotonous, black, grey, and white weathering, dolostone in thin to thick beds. The sharply overlying limestone member consists of 200 m of grey weathering thin-bedded limestone. The limestone is fine crystalline. Scattered nodules and thin beds of black chert are common.

East of Broken Skull Fault, at the southern end of O'Grady Anticline (section 34), the top of the lower dolostone member consists of light grey to yellow weathering, very fine crystalline dolostone in medium to thick beds. The overlying limestone member is 118 m thick. Thin-bedded, very fine crystalline limestone that weathers light grey, yellow-grey, and pink is the prominent lithology. Chert nodules are common.

North of O'Grady Anticline (section 38), the limestone member attains a maximum thickness of 583 m. The lower 292 m consists of thin-bedded, fine crystalline, grey to pink weathering, black limestone. The upper 291 m comprises medium to thick bedded, light grey weathering, black, fine crystalline limestone that is locally cherty. The contact with the underlying thick-bedded dolostone member is sharp.

North of the southeastern end of Margaret Syncline the Broken Skull Formation (section 29) can be subdivided into three members (Fig. 22) totalling 769 m. The lowest 103 m of the formation, the sandy carbonate member, consists of white to orange weathering, fine to coarse crystalline, thick-bedded sandy dolostone and interbedded dolomitic quartz sandstone. The overlying dolostone member comprises 487 m of medium- to thick-bedded dolostone. The carbonate weathers grey, is sandy near the base, and is commonly oncolitic. The sharply overlying limestone member consists of 179 m of medium-bedded, very fine crystalline, black limestone. Rouge colouration along bedding planes is characteristic.

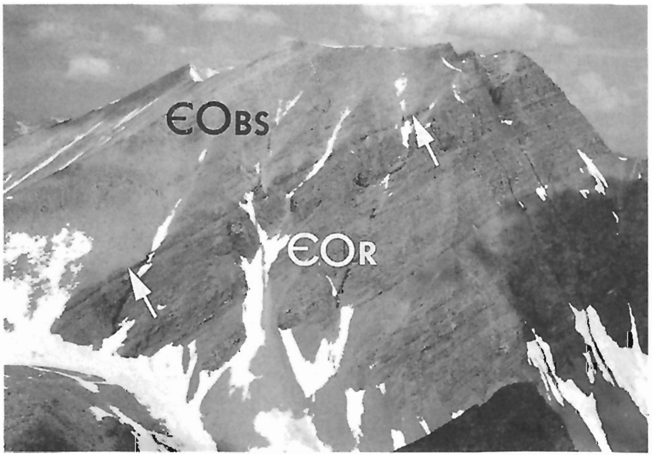


Figure 23. Sharp conformable contact (marked by arrows) between white weathering dolostone of the lower Broken Skull Formation (**€OBS**) and dark tan weathering limestone of the Rabbitkettle Formation (**€OR**). View is to the west, midway along the northeastern limb of Margaret Syncline. GSC 204922-K.

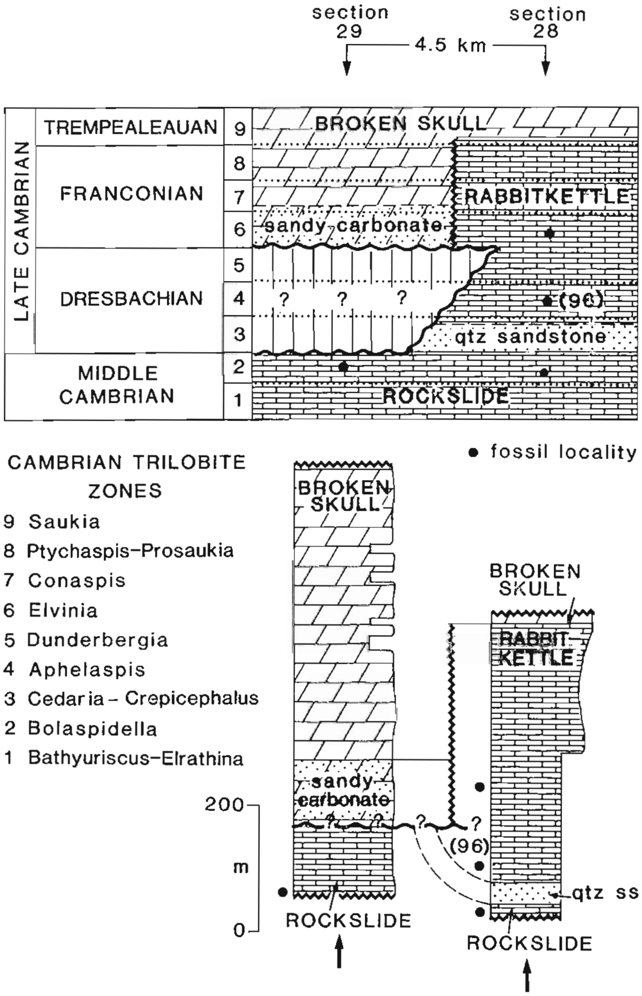


Figure 24. An interpretation of stratigraphic relations between the Broken Skull and Rabbitkettle formations between Sapper Anticline and Margaret Syncline. The sub-Franconian unconformity at section 29 is presumed from regional correlation with Broken Skull strata in Glacier Lake map area (Gabrielse et al., 1973). Rabbitkettle-Rockslide deposition at section 28 is probably continuous as shown by fossil collections of Fritz (this memoir) for the same stratigraphic sequence at section 22. Fossil locality 96 (Appendix 3) collected on a reconnaissance traverse was found an uncertain distance above the quartz sandstone. The Rabbitkettle Formation is partly equivalent to the Broken Skull Formation as well as to the hiatus represented by the sub-Broken Skull (sub-Franconian) unconformity.

Near the southeastern end of Margaret Syncline, limestone of the upper Broken Skull Formation is replaced by dolostone. There the Broken Skull Formation cannot be mapped separately and beds of Broken Skull age are included in the monotonous dolostone sequence of the Haywire Formation (Fig. 17).

Over most of the area the Broken Skull Formation rests sharply and conformably on the Rabbitkettle Formation. Its basal grey or white weathering dolostone contrasts sharply with the dark tan weathering Rabbitkettle limestone (Fig. 23). North of the southeastern end of Margaret Syncline the sandy carbonate member of the Broken Skull Formation unconformably(?) overlies the Rockslide Formation. The contact there is defined at the boundary between thick-bedded silty limestone beneath and thick-bedded sandy dolostone above. Mapping of areas to the east suggests a sub-Franconian unconformity at the base of the Broken Skull Formation (Gabrielse et al., 1973). If the unconformity is present at the above locality, relations between the Broken Skull and Rabbitkettle formations may be as depicted in Figure 24. The Rabbitkettle Formation would be partly equivalent to the Broken Skull Formation and partly equivalent to unrepresented stratigraphic record beneath the unconformity. The basal quartz sandstone of the Rabbitkettle Formation would represent a shoaling related to the unconformity. The contact of dolostone and limestone members of the Broken Skull Formation appears everywhere sharp and conformable. Thin- to thick-bedded limestone of the upper limestone member is abruptly and conformably(?) overlain by thick-bedded dolostone of the Haywire Formation.

Environment, age, and correlation. The dolostone member of the Broken Skull Formation was probably deposited in a shallow subtidal or intertidal setting, as indicated by the dolomite composition, oncolites, and locally, suspended (wind-blown?) quartz sand. The upper limestone member may represent deposition in a slightly(?) deeper water setting. Fauna, largely conodonts, indicate a Tremadocian (Early Ordovician) age for the lower dolostone member where it rests on the Rabbitkettle Formation, and an Arenigian to Llandeilian (late Early to late Middle Ordovician) age for the upper limestone member (Appendix 4). Northeast of the southeastern end of Margaret Syncline basal beds of the Broken Skull Formation rest on the Middle Cambrian Rockslide Formation and may be as old as Late Cambrian (Fig. 24).

The Broken Skull Formation is a Late Cambrian-Early Ordovician dolostone-limestone succession found widely in Glacier Lake (95E) and Wrigley Lake (95L) map areas (Gabrielse et al., 1973, p. 51). Strata mapped as Broken Skull in Nahanni map area encompass this interval, but also range into the Middle Ordovician. This younger limit

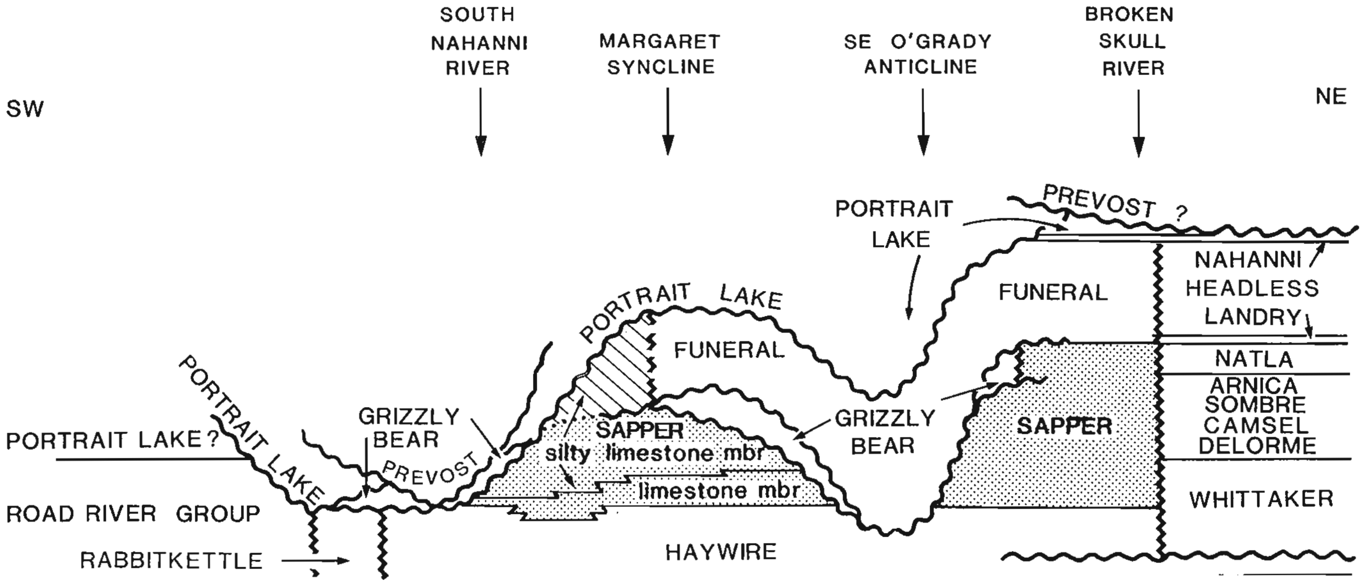


Figure 25. Stratigraphic relations between the Sapper (stippled) and adjacent formations. Near Broken Skull River the Sapper Formation includes Grizzly Bear equivalent strata. The Grizzly Bear Formation is not developed there as a separately mappable formation. On the southwestern limb of Margaret Syncline pinchout of the Grizzly Bear Formation precludes differentiating the Sapper and Funeral formations. Funeral equivalent strata in that area are therefore included within the Sapper Formation (ruled pattern). The contact of the limestone and silty limestone members of the Sapper Formation is diachronous as is the Sapper-Haywire formation boundary. Near South Nahanni River a coalescence of several unconformities leads to the Prevost Formation resting nearly directly on the Haywire Formation. An unconformity underlies the Portrait Lake Formation over most of northeastern Nahanni map area. However, southwest of South Nahanni River and near Broken Skull River beds beneath the unconformity are lithologically like those above it. The continuation of the unconformity in these areas is uncertain (also see Fig. 12).

is the same age as dolostone and limestone of the Sunblood Formation (Gabrielse et al., 1973) in the aforementioned areas. Thick black dolostone which distinguishes the basal Sunblood Formation is not developed in the Nahanni area. The Broken Skull correlates with the similar Franklin Mountain Formation in northern Mackenzie Mountains (Norford and MacQueen, 1975; Aitken et al., 1982). To the west, in the offshelf facies in Selwyn Basin, it is largely equivalent to the Rabbitkettle Formation. The sandy carbonate member likely correlates with similar lithologies at the base of the Haywire Formation and with a widespread sandstone member at the base of the Broken Skull Formation in Glacier Lake (95L) and Wrigley Lake (95M) map areas (Gabrielse et al., 1973). An important regional unconformity, in places angular, occurs beneath Upper Cambrian beds of the Broken Skull, Rabbitkettle, and Franklin Mountain formations over large areas of Mackenzie and Selwyn mountains.

Siluro-Devonian

Sapper Formation (**SD**s)(new). The Sapper Formation comprises recessive, thin-bedded, dark grey to tan-orange weathering limestone and silty limestone exposed northeast of the South Nahanni River. In many areas two members are recognized, a lower limestone member of grey weathering, dark grey thin-bedded limestone and an upper silty limestone member of tan to tan-orange weathering silty limestone. The Sapper Formation is easily distinguished at a distance from underlying light grey to white weathering dolostone of the Haywire Formation and from grey weathering limestone of the overlying Grizzly Bear Formation. On the southwestern limb of Margaret Syncline the Grizzly Bear Formation is absent. There the Sapper Formation cannot be differentiated from the overlying Funeral Formation; Funeral age beds are therefore mapped as the Sapper Formation (Fig. 25).

Type section - section 51 - 62°42′N; 128°25.6′W. The type section (362 m thick) is located on the southwestern limb of Sapper Anticline northeast of central Nahanni pluton (Fig. 26A,B). The name "Sapper" is derived from the Sapper Ranges, over which the formation outcrops extensively. Although exposed along a ridge most of the section is scree-covered. The base of the formation is defined at a sharp conformable contact with underlying grey weathering cherty dolostone of the Haywire Formation. The basal 107 m (limestone member) consists of blue-grey to grey weathering, black, very fine to fine crystalline limestone in locally wavy beds from 0.1-0.5 m thick. Minor orange weathering fine crystalline limestone contains oval blue-grey weathering limestone nodules up to 0.1 m in diameter. From 69 to 71 m

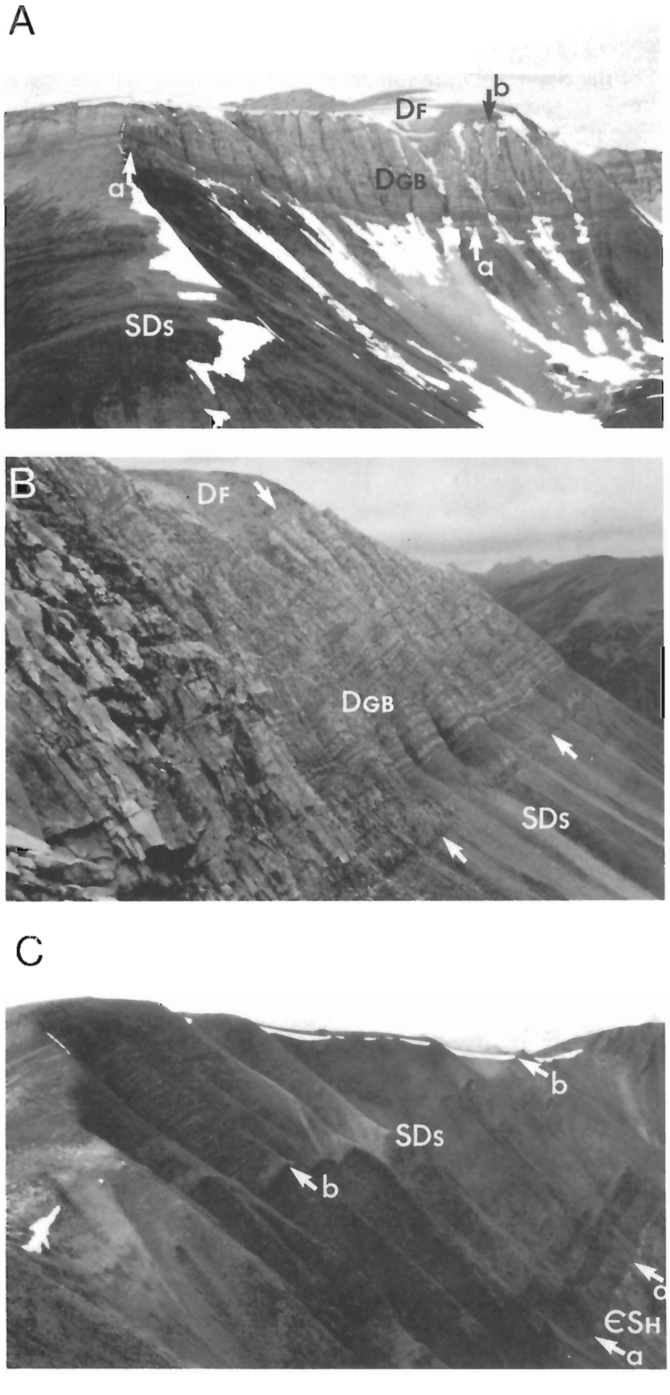


Figure 26. Sapper and Grizzly Bear formations. **A.** The Grizzly Bear Formation (**D**GB) and type section of the Sapper Formation (**SD**s) on the southwestern limb of Sapper Anticline (sections 46, 51). View is toward the southwest. Section 51 follows the crest of the rounded ridge on the left side of photo, and then follows the ridge crest of Grizzly Bear carbonate to the right side of the photo. The contact of the Grizzly Bear Formation with the underlying Sapper Formation is at "a". The contact between the Grizzly Bear and Funeral (**D**F) formations is at "b". GSC 204922-L. **B.** Close-up view of photo "A". Arrows mark unconformable base and top of the Grizzly Bear Formation (**D**GB) with the Funeral (**D**F) and Sapper (**SD**s) formations. GSC 204922-M. **C.** The Sapper Formation on the southwestern limb of O'Grady Anticline. Section 36 is along the ridge crest. "a" marks the contact between the Sapper Formation (**SD**s) and the underlying dolostone of the Haywire Formation (**Є**SH). Points "b" mark the contact of the lower limestone member (here about 94 m thick) with the upper silty limestone member of the Sapper Formation. The top of the Sapper Formation is to the left beyond the field of view. GSC 204922-N.

and 75 to 76 m are intervals of black graptolitic shale. The contact with the overlying silty limestone member is defined at a sharp change to black weathering, black, fine crystalline, platy, argillaceous limestone. This upper member comprises 255 m of mostly buff-orange to tan weathering, grey-black, laminated, argillaceous to silty limestone in thin beds. Locally the limestone weathers pink. The uppermost part of this member is of similar lithology but is resistant and blocky weathering. Resistant outcrop forms ribs on the cliff face beneath the overlying Grizzly Bear Formation. The unconformable upper contact is defined at the change upward to thin bedded, light grey weathering, commonly crinoidal limestone of the Grizzly Bear Formation. The lowest Grizzly Bear lithology is a breccia with scattered black lime-mudstone clasts.

Other areas. On the southwestern limb of O'Grady Anticline (section 36) the formation is about 243 m thick (Fig. 26C). The lower limestone member, 94 m thick, comprises grey to blue-grey weathering, black, fine crystalline limestone in thin beds. The upper member, about 149 m thick, consists of orange to tan weathering, thin-bedded, grey, black, and tan silty limestone. The lower contact with dolostone of the Haywire Formation is abrupt. In this area, the Sapper Formation is directly overlain by the Funeral Formation. The Grizzly Bear Formation, which in other areas separates the two, is presumably removed by sub-Funeral erosion. The Sapper/Funeral contact is defined at a subtle change from silty to shaly limestone. A subtle change in weathering colour from orange to bright orange also occurs at the contact. Southeast of the measured section a pod of light-grey weathering limestone of the Grizzly Bear(?) Formation (not examined) occurs at about this stratigraphic level.

Northeast of Broken Skull Fault (section 35) lower and upper members cannot be mapped separately. There the Sapper Formation consists of 714 m of dark grey, in places buff and pink weathering, thin- to thick-bedded, fine crystalline limestone. The limestone appears to be much less silty and argillaceous than at the type section. The base of the formation rests sharply above orange to grey, thin- to medium-bedded chert of the Haywire Formation. The upper contact is defined at a sharp change upward to buff to orange weathering, black, fine crystalline laminated limestone of the Funeral Formation. The Grizzly Bear Formation, which overlies the Sapper Formation at the type section, is not developed here as a distinct mappable unit. Strata of Grizzly Bear age are represented partly(?) as dark weathering crinoidal limestone included within the upper Sapper Formation. The crinoid ossicles with their twin axial canals, are typical of those in the Grizzly Bear Formation.

East of O'Grady Batholith, both members of the Sapper Formation are well developed. The lower limestone member, at least 295 m thick (section 44), consists of grey weathering, black, very fine crystalline limestone in thin, even beds that commonly have rouge colouration on bedding planes. Black to grey-brown chert forms up to 15 percent of the rock as thin beds, and nodules to 0.15 m in diameter. The sharply overlying silty limestone member consists of 322 m of recessive, generally buff to tan weathering, platy, silty limestone. Distinctive pink weathering silty limestone is common. This is overlain, in turn, by more than 80 m of dark grey weathering, thin- to medium-bedded, resistant fine crystalline limestone (dark limestone member). The base of this uppermost member is defined beneath a 3 m thick bioclastic limestone bed containing abundant crinoid ossicles with twin axial canals. The upper contact of the Sapper Formation in this area is not exposed.

North of O'Grady Batholith the Sapper Formation consists of more than 505 m (section 47) of light grey to buff-orange weathering, grey, very fine crystalline limestone. The strata are thin to medium bedded, and locally wavy bedded. These beds are overlain abruptly and unconformably(?) by light bluish-grey siliceous shale of the Portrait Lake Formation.

On Margaret Syncline (sections 37, 49, 53) both members of the Sapper Formation are recognized, although the lower one is too thin to be mapped separately. The limestone member sharply and conformably overlies the Haywire Formation, and ranges up to about 24 m thick (section 49). It consists of grey weathering, dark grey, fine to medium crystalline limestone in thin beds. The overlying silty limestone member comprises buff to light grey weathering, laminated siltstone, calcareous siltstone, and silty limestone. The Grizzly Bear-Sapper contact was only observed at one locality (section 37), where it is sharp and unconformable. There it is defined by the first appearance upward of light grey weathering, grey crinoidal limestone containing crinoid ossicles with twin axial canals. Along strike, where the Grizzly Bear Formation is absent, the Sapper Formation and the lithologically alike Funeral Formation could not be mapped separately. There, Funeral age beds are included within the Sapper Formation (Fig. 25).

Along South Nahanni Anticline thin, recessive intervals of the Sapper Formation are preserved between underlying Haywire Formation and overlying Grizzly Bear or Portrait Lake formations. In this area the Sapper Formation reaches a maximum thickness of about 159 m (section 41). The lower limestone member (not separately mapped), up to 27 m thick, consists of light grey to blue-grey weathering, black limestone in thin beds. The overlying silty limestone member comprises 132 m of black, brown, or tan, variably calcareous, thin-bedded siltstone that weathers orange to mauve.

Environment, age, and correlation. The flat lamination, lack of wave- or traction-produced structures, and position west of a shallow carbonate shelf suggest a below wave base, offshelf depositional environment for the Sapper Formation. Abundant fossil collections including conodonts, graptolites, and shelly fauna collectively range in age from Late Ordovician (late Caradocian) to Middle Devonian (late Eifelian). They demonstrate a large degree of diachronism of members and of overlying and underlying formations (Appendix 4). The base of the limestone member is locally as old as late Caradoc (e.g. section 54) whereas elsewhere the underlying Haywire Formation contains fossils that are of Silurian age. The top of the limestone member contains fossils as young as mid-Ludlovian (Late Silurian). However along South Nahanni Anticline its youngest beds may be as old as late Llandoverian (Early Silurian), and locally as old as latest Ordovician (Appendix 4). On the southeastern limb of Margaret Syncline, where the Grizzly Bear Formation is not recognized, the Sapper Formation includes lithologically similar beds of Funeral age and they may be as young as Eifelian. East of Broken Skull Fault, the Sapper Formation can be distinguished from the overlying Funeral Formation, but in this area includes beds that are in part Grizzly Bear equivalent, as young as Eifelian. In summary, the Sapper Formation is a diachronous unit including all of the immediately offshelf silty limestone and siltstone facies of Silurian and Devonian age. In some areas, distinctive lithologies or weathering colour permit subdivision into different formations, but in other areas these differences are not apparent, and strata of wide age range constitute a single mappable unit (Fig. 25).

The Sapper Formation is largely equivalent to strata mapped in Flat River (95E) and Glacier Lake (95L) map areas by Gabrielse et al. (1973) as Road River Formation, but may also include parts of their map unit 34 and Funeral formations. Judging from their descriptions, the general two-member subdivision in these equivalent strata was not recognized. On the west boundary of Glacier Lake (95L) map area, strata assigned by Gabrielse et al. (1973) to the Road River Formation also include strata recognized here as the Portrait Lake Formation. The Sapper Formation is a useful and easily delineated formation within Nahanni map area. Further work will be required in adjacent areas before its full regional extent is determined.

Grizzly Bear Formation (DGB). The Grizzly Bear Formation (Gabrielse et al., 1973) is a resistant, light to dark grey weathering, bioclastic limestone characterized by crinoid ossicles with twin axial canals. It forms an excellent marker in northeastern Nahanni map area that allows the separation of buff weathering siltstone and silty limestone of the overlying Funeral and underlying Sapper formations.

On the southwestern limb of Sapper Anticline, the Grizzly Bear Formation is up to 200 m thick (sections 46, 51; Fig. 26). There it comprises mostly grey to blue-grey weathering, dark grey crinoidal limestone in even beds 3 to 10 cm thick. The top and bottom 5 to 10 m of the formation are marked by limestone breccia with subrounded grey limestone clasts up to 0.2 m in diameter and abundant coralline and crinoid fossil debris. The top contact is defined at a sharp, possibly unconformable change upward to orange weathering, blue-grey shaly limestone of the Funeral Formation. The base of the Grizzly Bear Formation comprises a lime-mudchip breccia that overlies buff-orange weathering, laminated silty limestone of the Sapper Formation. About 6.3 km to the northwest (section 60), the Grizzly Bear Formation is only 60 m thick. There it comprises grey weathering, thick-bedded to massive bioclastic limestone. Fossil debris includes corals, pelecypods, and brachiopods, but is characterized by abundant crinoid ossicles with twin axial canals. The upper contact with the overlying Funeral Formation is abrupt and possibly unconformable, as is the basal contact with the underlying Sapper Formation. On the northern limb of the Sapper Anticline, Grizzly Bear lithologies are as above. There the thickness of the formation varies from a few metres to at least several tens of metres.

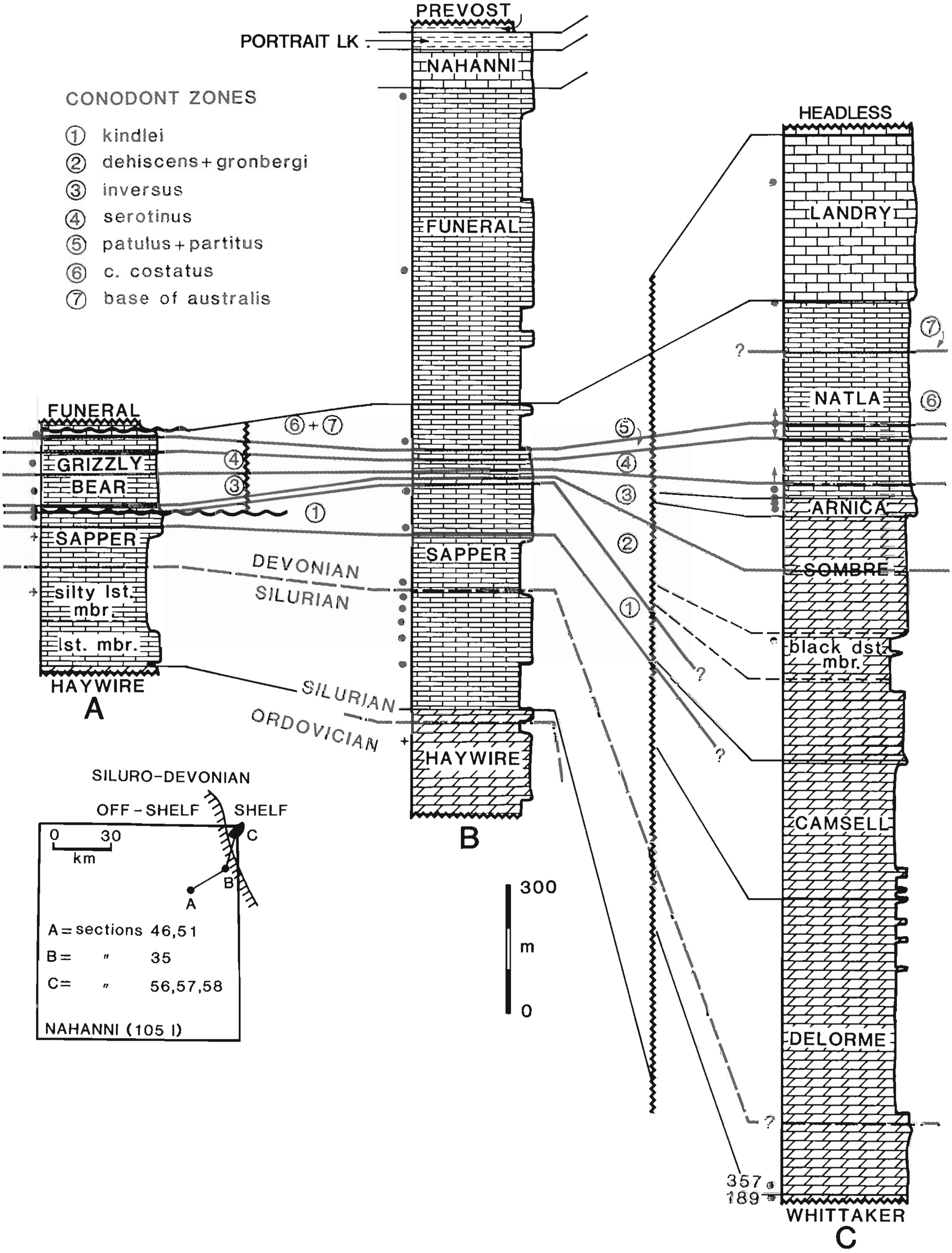
On the southeastern end of O'Grady Anticline the Grizzly Bear Formation is only locally preserved between the Sapper and Funeral formations. At one locality the Funeral Formation apparently directly overlies the Haywire Formation. Isolated float of two-hole crinoidal limestone typical of the Grizzly Bear Formation is found along the contact. It is suspected that an unconformity at the base of the Grizzly Bear Formation has removed the Sapper Formation, and that an unconformity at the base of the overlying Funeral Formation has all but removed the Grizzly Bear Formation.

Along Margaret Syncline the Grizzly Bear Formation is exposed only at the southeastern end but is too thin to be mapped separately. There (section 37) the formation is 40 m thick and consists of the following: 2 m of light grey weathering, grey crinoidal limestone; about 7 m of black weathering, black crinoidal limestone; 6 m of thin-bedded tan-grey weathering platy limestone and laminated limestone; and 25 m of white weathering, black, fine crystalline thin-bedded limestone. The crinoidal limestone is characterized by crinoid ossicles with twin axial canals. The contact with overlying orange weathering, grey, thin-bedded limestone of the Funeral Formation is abrupt, and probably unconformable. The contact with the underlying Sapper Formation is also sharp and unconformable. Along most of the poorly exposed northeastern limb of the syncline, the Grizzly Bear Formation does not outcrop and the contact of Sapper and Funeral formations is extrapolated. Along the southwestern limb of the anticline the Grizzly Bear Formation is not present and the Sapper and Funeral formations cannot be separated. Those beds that would normally be assigned to the Funeral Formation are included in the Sapper Formation.

On the southwestern limb of South Nahanni Anticline the Grizzly Bear Formation is up to 150 m thick. Lithologies include grey-white weathering, dark grey, thin-bedded to massive crinoidal limestone, and local thick stromatoporoid and coralline limestone. The stromatoporoids and corals are preserved in growth position. Along South Nahanni Anticline the Grizzly Bear Formation is unconformity bounded. It rests above a generally thin Sapper Formation, and locally on the Haywire Formation. It is overlain by the Portrait Lake or Prevost formations. The Funeral Formation typically found above the Grizzly Bear Formation elsewhere, is absent.

The Grizzly Bear Formation occurs on the southwestern side of South Nahanni River where it comprises crinoidal limestone a few tens of metres thick. It is unconformably bounded by Cambro-Ordovician limestone of the Rabbitkettle Formation below and by siliceous shale of the Portrait Lake Formation above.

Environment, age, and correlation. The lithology, ubiquitous fossils, and position west of correlative shallow water dolostone suggest deposition in an open marine setting,


PREVOST
PORTRAIT LK
NAHANNI
CONODONT ZONES
① kindlei
② dehiscens + gronbergi
③ inversus
④ serotinus
⑤ patulus + partitus
⑥ c. costatus
⑦ base of australis
FUNERAL
HEADLESS
LANDRY
⑦
?
NATLA
⑥
FUNERAL
⑥ + ⑦
⑤
GRIZZLY
BEAR
④
③
④
③
ARNICA
①
SAPPER
②
SOMBRE
SAPPER
DEVONIAN
SILURIAN
silty lst. mbr.
①
black dst. mbr.
lst. mbr.
?
HAYWIRE
A
SILURIAN
ORDOVICIAN
HAYWIRE
?
SILURO-DEVONIAN
OFF-SHELF
SHELF
C
0 30 km
B
A
B
CAMSELL
300
m
0
A = sections 46,51
B = " 35
C = " 56,57,58
NAHANNI (105 I)
DELORME
?
357
189
WHITTAKER
C

perhaps along shoal(s) developed in the offshelf area immediately to the west of the main carbonate platform. The Grizzly Bear Formation in the Nahanni area is well dated by conodonts, its age ranging from Zlichovian (*gronbergi* Zone - late Early Devonian) to mid-Eifelian (*australis* Zone - early Middle Devonian) (Appendix 4). At two localities (sections 37, 51) where detailed faunal control is established across the base of the formation, an unconformity is demonstrated by missing conodont zones (*dehiscens*, and in section 37 the *gronbergi* and *inversus* zones as well). The base of the formation is also diachronous, ranging in age through these same three conodont zones. Apparently, at some localities Grizzly Bear lithologies were being deposited during a time not represented at other places. An unconformity is suspected beneath the sharply overlying Funeral Formation, although this has not been proven through fossils (see Funeral Formation). East of Broken Skull Fault the Grizzly Bear Formation is not developed as a mappable unit. Equivalent crinoidal limestone (crinoid ossicles with twin axial canals) is found within the upper Sapper Formation.

The Grizzly Bear Formation in its type area in Glacier Lake (95L) map area (Gabrielse et al. (1973)), ranges from 0 to about 260 m thick. It comprises light grey weathering,cliff-forming massive limestone, commonly crinoidal, and locally dolostone. It underlies the Funeral Formation, and overlies undivided Devonian dolostone. The Grizzly Bear Formation is also recognized in northeastern Niddery Lake (105O) map area by Cecile (1981) as a cliff-forming, white-grey limestone characterized by crinoid ossicles with twin axial canals. In Sekwi Mountain (105P) map area, unit 22d of Blusson (1971) has lithologies typical of the Grizzly Bear Formation. Detailed faunal control of the Grizzly Bear Formation in Nahanni map area (Fig. 27) allows correlation with the upper part of the Sombre, Arnica, and most of the Natla formations to the east. To the west, near the head of Don Creek, rare crinoidal limestone in the basal Portrait Lake Formation is correlative. Elsewhere in the far offshelf area of Selwyn Basin, fossil control is poor. Correlative strata comprise siliceous shale and chert of the Portrait Lake Formation.

Figure 27. Correlation of Siluro-Devonian offshelf and shelf strata indicated by detailed conodont zonation. Conodont localities used as control for placement of zone boundaries are indicated by black dots. Arrows indicate that a collection could belong to a zone either younger (arrow pointing up) or older (arrow pointing down) than that in which it has been tentatively placed. Crosses refer to graptolite collections that have been used to locate system boundaries. All fossil collections, except those numbered (357,189), are from the measured sections indicated. The probable stratigraphic position of zones not represented by fossil collections is interpolated; for example, zones 2 to 5 are not represented by collections in column B. Grizzly Bear equivalents are represented in the Sapper Formation in column B (where the Grizzly Bear cannot be separately distinguished). In column C, the Grizzly Bear is equivalent to parts of the Sombre, Arnica, and Natla formations.

Funeral Formation (**DF**). The Funeral Formation (Douglas and Norris, 1961; Gabrielse et al., 1973) is an orange weathering succession of thin-bedded limestone and shaly imestone. The most complete and best exposed sections occur east of Broken Skull Fault, along Sapper Anticline, and east of O'Grady Batholith. The formation is overlain by grey weathering limestone of the Nahanni Formation or by gun-blue to white weathering siliceous shale of the Portrait Lake Formation. Grey weathering crinoidal limestone of the Grizzly Bear Formation underlies the Funeral Formation in most places. Locally, the Grizzly Bear Formation is absent and the Funeral Formation rests directly on the Sapper Formation.

East of Broken Skull Fault the Funeral Formation is about 747 m thick (section 35). It consists of orange weathering, dark grey to black, fine crystalline, silty to argillaceous limestone in thin to thick beds. The contact with the underlying Sapper Formation is conformable(?) and defined at an abrupt upward change in weathering colour from dark grey to buff-orange. Orange-grey weathering argillaceous limestone forms the topmost beds of the Funeral Formation. These contrast with conformably overlying grey weathering limestone of the Nahanni Formation. Both the topmost Funeral and basal Nahanni formations are medium to thick bedded.

Along the southwestern limb of Sapper Anticline, Funeral strata are much like those described above, but are more argillaceous and less calcareous. The thickness of the formation is estimated at 350 m. The Funeral Formation is abruptly and unconformably overlain by gun-blue to white weathering shale of the Portrait Lake Formation, and sharply underlain, probably unconformably, by grey weathering limestone of the Grizzly Bear Formation (Fig. 28).

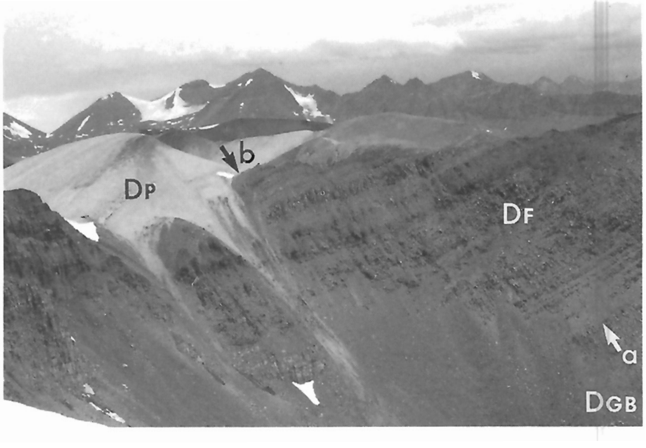


Figure 28. Orange weathering limestone of the Funeral Formation (**DF**) on the southwestern limb of Sapper Anticline, near section 51. View is toward the northwest. The Funeral Formation is unconformably underlain by grey weathering limestone of the Grizzly Bear Formation (**DGB**) (contact at "a"), and unconformably overlain by gun-blue to white weathering, siliceous siltstone and shale of the Portrait Lake Formation (**DP**) (contact at "b"). GSC 204922-O.

Northeast of Sapper Anticline and southwest of Broken Skull Fault, the Funeral Formation overlies the Haywire Formation. Float of Grizzly Bear crinoidal limestone occurs along the scree-covered contact. The absence of the Sapper and Grizzly Bear formations may result from a combination of sub-Grizzly Bear and sub-Funeral erosion (see Grizzly Bear Formation).

In Margaret Syncline the Funeral Formation consists of orange weathering, grey, fine crystalline, thin-bedded limestone. The basal contact is well delineated at the southeastern end of the syncline (section 37) where Grizzly Bear limestone, too thin to be separately mapped, underlies it. On the northeastern limb of the syncline the contact is extrapolated through a poorly exposed area.

Environment, age, and correlation. The lack of current- or wave-produced sedimentary structures, scarcity of fossils, and lateral stratigraphic relations suggest deposition below wave base in an open marine offshelf setting. Relative to its shelf equivalent to the northeast, the richly fossiliferous Headless Formation, the Funeral Formation is poorly fossiliferous, argillaceous, and silty. Fossil ages for the Funeral Formation range widely through the Middle Devonian, but data from the underlying Sapper and Grizzly Bear formations, and overlying Nahanni Formation, bracket its age as mid-Eifelian (*C. costatus* to *australis* conodont zones) (Appendix 4). An unconformity at the base of the Funeral Formation is strongly suspected because of the sharp lithological change at the contact, and rapid thickness changes and local absence of the underlying Grizzly Bear Formation. Unfortunately, proof from detailed faunal control is lacking.

The Funeral Formation correlates with the Funeral Formation as mapped by Gabrielse et al. (1973) in Glacier Lake (95L) map area, which in turn is largely equivalent to the Headless Formation, a carbonate unit widespread in Mackenzie Mountains. The Funeral Formation may also contain beds time equivalent to the Landry Formation, a shelf limestone underlying the Headless Formation (see sections on Headless and Landry formations). In Sekwi Mountain (105P) map area, Funeral-like strata are included by Blusson (1971) in the Headless Formation. In the far offshelf facies of Selwyn Basin to the southwest, strata of Funeral age, if present, comprise siliceous shale and chert within the Portrait Lake Formation.

Natla Formation (**D**NA). The Natla Formation (Gabrielse et al., 1973) is a recessive succession of black, sooty weathering limestone exposed on Black Wolf Syncline. It overlies more resistant Arnica dolostone and is overlain by resistant, grey to grey-brown weathering limestone of the Landry Formation, or thin-bedded brown weathering limestone of the Headless Formation.

On the northeastern limb of the syncline the Natla Formation is 464 m thick (section 56) (Fig. 29) and consists mostly of argillaceous, thin-bedded microcrystalline limestone and minor, poorly fissile calcareous shale. Interbedded dark grey chert makes up to 2 percent of the basal 80 m. Tentaculitids, rugose and tabulate corals, brachiopods, trilobites, and echinoderm debris are common. Crinoid ossicles with twin axial canals are characteristic of the echinoderm debris. The basal 10 m of the formation consists of platy, argillaceous dolostone, dolomitic shale, and bedded chert, which rest conformably above resistant thickly bedded Arnica dolostone. The contact with the Landry Formation is conformable and defined at the base of overlying light grey weathering resistant limestone. Toward the southeast the Landry Formation pinches out (see Landry Formation) and the Natla Formation is overlain directly by the Headless Formation. The upper contact of the Natla Formation is then placed at the upward change to slightly more resistant nonsooty, orange-brown weathering limestone.

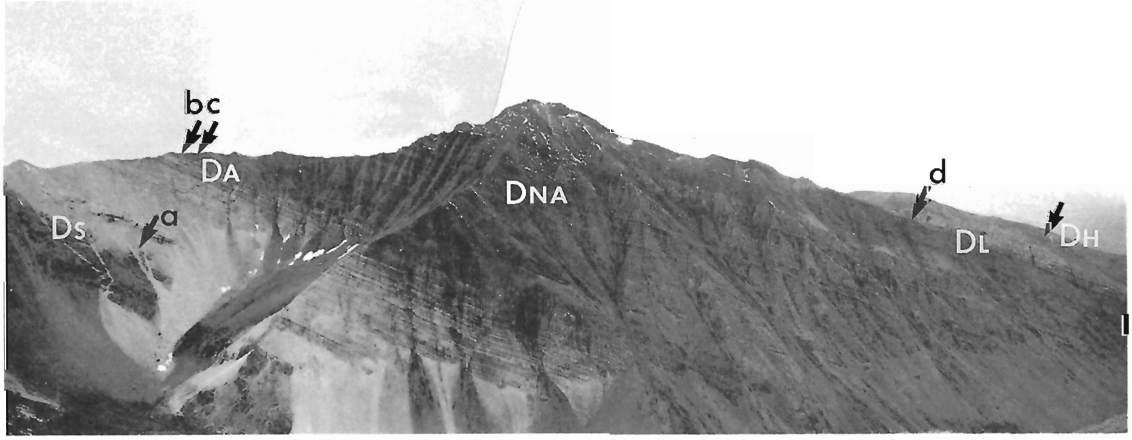


Figure 29. The Natla and adjacent formations on the northeastern limb of Black Wolf Syncline. View is to the south toward section 36. "a" marks the top of the middle dark weathering dolostone member of the Sombre Formation (**D**s). "b" marks the top of the Sombre Formation atop the highest white weathering dolostone bed. "c" marks the top of the Arnica Formation (**D**A). "d" indicates the top of the Natla Formation (**D**NA) and base of the resistant Landry Formation (**D**L). Unlabelled arrow points to ridge in background underlain by Headless Formation (**D**H). GSC 204922-P.

On the southwestern limb of Black Wolf Syncline (section 55) the Natla Formation consists of 327 m of dark grey weathering, platy, very fine crystalline limestone in thin beds. The rock is commonly bioclastic and crinoid ossicles with twin axial canals are characteristic. The Natla Formation sharply and conformably overlies mixed dolostone and limestone of the Sombre Formation and is overlain by medium-bedded, dark grey, fine crystalline limestone assigned to the Landry Formation.

Environment, age, and correlation. The abundant fossils in the Natla Formation attest to deposition in open marine waters. Depositional slump structures (section 56) may indicate a slope environment. On the basis of contained and bracketing conodont faunas the formation ranges in age from the late Emsian to early Eifelian (*serotinus* to *C. costatus* conodont zones) (Appendix 4).

The Natla Formation is mapped by Gabrielse et al. (1973) in southwestern Glacier Lake (95L) map area. There, as in Nahanni map area, it represents the offshelf correlative of shallow water restricted marine dolostone of the Arnica and Sombre formations. To the southwest in Nahanni map area it correlates in part to the Grizzly Bear Formation, and to the Sapper Formation (Fig. 27).

Southwestern belt - offshelf facies of Selwyn Basin

Strata southwest of South Nahanni River consist predominantly of sandstone, shale, chert, and limestone deposited southwest of Mackenzie Platform within relatively deeper water of Selwyn Basin. The oldest strata form the Hyland Group which includes two formations. A lower thick coarse clastic turbidite succession capped by a thin limestone member makes up the Yusezyu Formation. This is overlain by maroon to dark grey shale of the Narchilla Formation. The overlying Lower to Middle(?) Cambrian Gull Lake Formation consists of rusty to buff weathering slate, and minor quartz sandstone. An archaeocyathid-bearing limestone conglomerate occurs locally at its base. Cambro- Ordovician limestone of the Rabbitkettle Formation rests unconformably above both the Gull Lake and Narchilla formations. The Rabbitkettle Formation, in turn, rests beneath the Road River Group. Ordovician and Silurian black graptolitic shale and chert of the Duo Lake Formation forms the lower part of this group. Its upper part consists of Upper Silurian dolomitic mudstone of the Steel Formation. Lying above the Steel Formation is the Portrait Lake Formation of the Earn Group, the basal strata of which consist of Lower to Middle Devonian black shale and chert. The upper part of the formation contains clastics of the turbidite basin assemblage, so that this formation is described under that heading (see Assemblage II).

Precambrian to Lower Cambrian

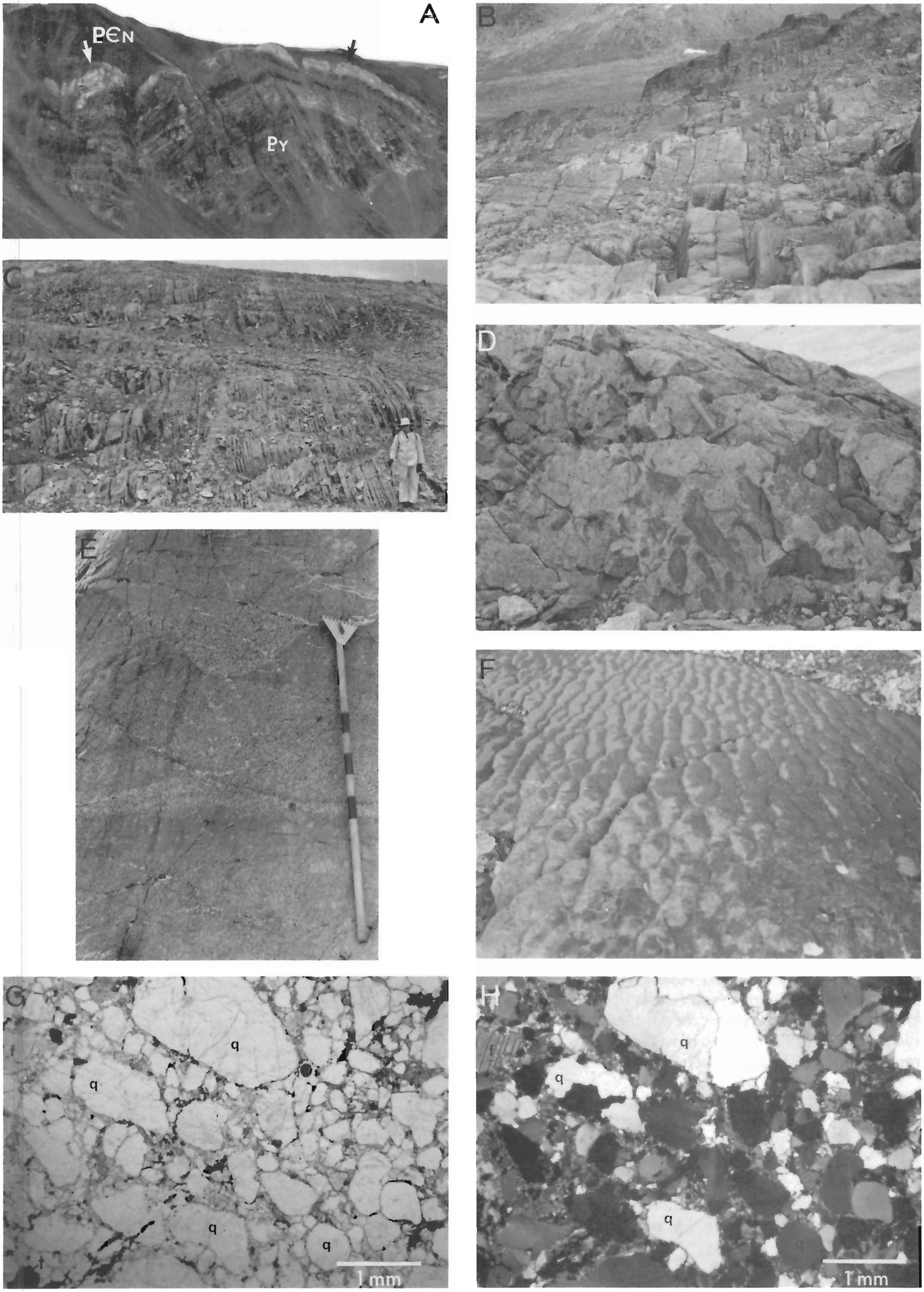
Hyland Group, (new)

The name Hyland Group is proposed for gritty, quartzose clastic rocks (Yusezyu Formation) and overlying maroon to dark grey shales (Narchilla Formation). The name "Hyland" is derived from the Hyland River which has its headwaters in southern Nahanni map area. The term Hyland Group is intended to replace the informal name "Grit Unit", which has been applied in many places in the Yukon to undivided late Precambrian rocks characterized by gritty quartzose clastics, commonly with maroon shale in their upper part (Gabrielse, 1967; Green, 1972; Gabrielse et al., 1973). The base of the group is not exposed, and as defined here, the top is overlain sharply and conformably by shale of the Lower Cambrian Gull Lake Formation.

Yusezyu Formation (ⱣY) (new). The Yusezyu Formation, constituting the oldest strata known within the Selwyn Basin region, is a thick succession of grey-brown weathering, gritty quartz sandstone and evenly interbedded shale. It is well exposed in the southern part of the map area. The proportion of coarse to fine clastics varies from place to place, but at least 50 percent of any given section may be fine to coarse grained sandstone. Quartz is the predominant constituent, and many of the coarse grains are opalescent blue. Limestone is a minor lithology, forming a thin discontinuous member at the top of the formation. The Yusezyu Formation is overlain sharply and conformably by maroon or dark grey shale of the Narchilla Formation.

Type section - section 2 - 62°7.9'N;129°11.3'W. Unfortunately, there is no locality that displays both the upper contact of the formation and a significant thickness of Yusezyu strata. Therefore, a type section that portrays the thickest, best exposed section of representative lithologies and a separate reference section for the top contact of the formation are described separately. In stratigraphic position the top of the type section is estimated to lie 1500 m below the top of the formation. The base of the type section is estimated to lie about 500 m above the oldest exposed Yusezyu strata in the map area.

The type section is located 25 km east-southeast of Mount Pike, and about 13 km north of the west-flowing headwaters of the Yusezyu (pronounced yoo'says'yoo) River, after which the formation is named. The basal 273 m consist of white weathering, grey, locally gritty massive quartz sandstone. Sandstone beds are commonly graded, and rarely their upper parts are parallel laminated. Beds range from 0.5 to 1.5 m thick and are stacked without intervening slate to form "sandstone-only" members up to 30 m thick. Intervals of pale green slate up to 5 m thick separate adjacent coarse clastic units. Grey weathering, black, fine crystalline, thin(?) - bedded limestone occurs from 273 to 330 m. In its middle part are 14 m of grey, very coarse grained, locally gritty quartz sandstone. Orange weathering laminated blue-grey slate composes the overlying interval from 330 to 361 m. The coarsest clastics in the section occur at 361 to 600 m. In this interval three coarse members from 37 to over 100 m thick are recognized. Two members of brown-green to rusty blue-grey weathering slate less than 30 m thick separate the three coarse members. The coarse clastics are composed of grey-white weathering, grey, coarse to very coarse grained quartz sandstone and minor quartz-pebble conglomerate; outsize shale clasts are common. The rocks are typically massive, but locally show a 2 to 3 m thick bedding-parallel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parting. At least 7 m of erosional relief is demonstrated below the middle coarse member. The upper part of the section from 660 to 1140 m comprises light green to rusty blue-grey weathering, pale green to blue-green slate. Scattered beds and thick-bedded members up to 30 m thick of fine to coarse grained, locally gritty quartz sandstone occur within the slate. Orange weathering, blue-black argillaceous to silty limestone forms the interval from 1038 to 1089 m. The highest beds in the section, from 1089 to 1140 m, are medium- to thick-bedded quartz sandstone with rare interbeds of pale green slate.

Reference section for top of formation. The upper contact of the Yusezyu Formation is well exposed 6 km north-northwest of Mount Pike (section 6 - 62°15.5′N; 129°40.2′W), about 29 km northwest of the type section. Upward from the base of measurement the Yusezyu Formation consists of 8 m of grey-green laminated shale, 27 m of grey weathering, grey, medium grained sandstone with a 1 to 2 m thick parting, 60 m of pale to dark green weathering shale and siltstone, with minor sandstone, and 12 m of blue-grey to white weathering, dark grey to black, very fine crystalline limestone in beds 1.0 to 1.5 m thick. The limestone is designated the limestone member of the Yusezyu Formation. The basal contact of the limestone member against the siltstone is sharp. The upper contact with the overlying Narchilla Formation is defined at the top of the highest limestone bed. In a 2 m interval beneath the top of this bed, limestone and shale interfinger in beds about 0.3 m thick. In this zone the limestone is white weathering, and light to dark grey on fresh surface. The interbedded shale is pale green on weathered and fresh surfaces. The highest limestone bed is overlain by maroon weathering shale (Narchilla Formation). The maroon shale is punctuated by pale green shale interbeds 1 to 3 cm thick, spaced every 5 to 10 cm.

Figure 30. Sedimentary features of the Yusezyu Formation. **A.** Contact of resistant Yusezyu (ⱣY) (below) and recessive Narchilla (ⱣЄN) (above) formations marked by arrows. The white weathering discontinuous band below the arrows is the limestone member of the Yusezyu Formation. The view looks to the west toward a ridge 6 km east-southeast of Gull Lake. GSC 204922-Q. **B.** Coarse sandstone. This commonly occurs in thick units of thick even beds, without interbedded shale. Bedding surfaces are planar. Packsack for scale near right edge of photo. GSC 204922-R. **C.** Fine sandstone. This commonly occurs in thin, even, laterally continuous beds interbedded with slate. Beds on left of photo are thicker and coarser grained. GSC 204922-S. **D.** Large, randomly oriented shale rip-up clasts within massive, very coarse grained sandstone. GSC 204922-T. **E.** Grain size variation within part of a thick unit of gritty sandstone. Exceptional exposure shows it to be amalgamated, i.e. formed of several beds, each on the order of 1 m thick. Channel scour, and fill by very coarse sandstone which grades upward to medium sandstone is seen left of top of Jacob's staff (1.5 m long). GSC 204922-U. **F.** Exhumed bedding plane showing well-developed ripple marks. Knife for scale near centre of photo. GSC 204922-V. **G.** Photomicrograph (plane light) of Yusezyu sandstone. Rock is composed of monocrystalline and polycrystalline quartz, minor feldspar (f), and traces of detrital muscovite (none in this view) and tourmaline (t) in a matrix of fine grained quartz and opaques. Derivation was ultimately from a plutonic-metamorphic terrane. However, the generally low amounts of feldspar, lack of mafic minerals, and excellent rounding of some quartz suggest second cycle derivation and that the immediate source rock was sedimentary. See also Figure H GSC 1993-002T **H.** Crossed nichols view of G. GSC 1993-002Q

Other areas - summary of sedimentary features. Several other sections within the Yusezyu Formation were measured (sections 1 to 7) and all are essentially similar. The Yusezyu Formation is a thick sequence (3000 m) dominated by coarse grained clastic rocks with lesser interbedded shale and minor limestone (Fig. 30). Beds are even and continuous, and sandstone-shale bedding contacts are sharp and planar. Sole markings, including grooves and load casts, are rare. Many beds show normal size grading. Outsized shale clasts, some to a few tens of centimetres in diameter, are common and usually occur along discreet horizons near the bases of beds. Most coarse sandstone beds are massive or graded. Rarely the tops of beds are planar laminated, and locally ripple cross-laminated. Large scale cross-bedding is absent. Some thin fine grained sandstone beds show climbing ripple lamination, and locally exhumed bedding planes show well-developed ripple marks. Amalgamation of sandstone beds into shale-free units up to 100 m thick is common; quartz- pebble conglomerate is restricted to these intervals. In many places these units are massive, the only discernible structure being a 1 to 2 m thick parting. Scour of several metres into underlying shale is also locally seen at their base. Concentrated near the top of the formation are members to 50 m thick of medium to coarse grained sandstone, in massive, even, medium to thick beds. This sandstone contains little interbeded shale and virtually no other associated sedimentary structures. The uppermost Yusezyu Formation is variably calcareous. In many places there are abrupt and irregular changes from carbonate to silica cement. The limestone member at the top of the Yusezyu Formation consists of fine crystalline light to dark grey limestone that varies from 0 m to as much as 15 m thick (section 7). Where this member is absent uppermost Yusezyu sandstone is highly calcareous, and is in sharp contact with overlying shale of the Narchilla Formation.

Petrography of sandstones. About 40 thin sections of sandstone selected at random from the Yusezyu Formation were examined. A synopsis of the results is presented in Figure 31. Because of coarse grain size and/or extensive replacement by carbonate, half of these thin sections were not suitable for point counting.

The sandstones consist predominantly of quartz, usually less than 8 percent feldspar, and only traces of lithic (shale or siltstone) fragments. Quartz consists of both monocrystalline and polycrystalline types, the latter usually forming less than 20 percent of the quartz present. Subgrains have serrate to locally 120° equilibrium boundaries. Undulose extinction is common and deformation lamellae are locally developed. There is a minor amount of quartz cement overgrowth. In hand specimen coarse grains of quartz are commonly opalescent blue. Plagioclase feldspar consists of fresh, albite-twinned grains that are generally of smaller grain size than quartz. Potassium feldspar occurs as both large and small grains subequal in abundance to plagioclase. Plaid-twinned microcline and untwinned orthoclase are both found. Minor perthite was also seen. Muscovite occurs as rare detrital grains. Anhedral small grains of zircon and tourmaline occur in trace amounts. Carbonate is common in large patches that partly replaces matrix and framework. It also occurs as fracture fillings. In one sample detrital carbonate as recrystallized oolites was discovered, hinting that some of the carbonate thought diagenetic in other samples, could be of detrital origin. The matrix of Yusezyu sandstones commonly forms from 15 to 25 percent of the rock. It consists of fine grained felsic minerals and sericite. The sericite commonly forms films around grain boundaries and beards mantling some grains.

Texturally, the sandstones are moderate to well sorted. Grains are subangular to subrounded and have a high sphericity. Lithification and compaction has produced a low level of grain interpenetration, deformation, and suturing, except for commonly squashed or bent detrital muscovite.

A granitic and perhaps high grade metamorphic terrane seems to have been the ultimate source of Yusezyu clastics, contributing the quartz, feldspar, tourmaline, and zircon. The muscovite and locally pebble-size quartz may be derived from metamorphic rocks and vein quartz respectively. The commonly low proportion of feldspar, excellent rounding of some quartz, complete lack of mafic minerals, and lack of granitic pebbles suggest the sands have been reworked. However, the thickness and interpreted depositional environment (below) suggest rapid sedimentation and little reworking. Yusezyu sandstones are therefore probably not first cycle sediments. Their immediate source may have been a sedimentary terrane.

Narchilla Formation (**ⱣЄ**N)(new). The Narchilla Formation outcrops extensively in the southwestern part of the map area where it comprises several hundred metres of recessive, maroon to dark blue-grey weathering shale. It rests above grey-brown weathering, coarse clastics and limestone of the Yusezyu Formation and underlies buff-brown weathering shale of the Gull Lake Formation. Along Fork Anticline and parts of Steel Syncline there is a thick member of fine grained quartzose sandstone in the middle part of the formation.

Type section - section 7 - 62°15.7′N;129°13.2′W. The type section is located 11 km southeast of Summit Lake on the northeastern limb of Steel Syncline. The formation is named after Narchilla Brook, the headwaters of which cross the formation about 30 km southwest of the type section. The type section is the only locality known to the author in which the entire thickness of the formation is represented. However, exposure is mostly scree, slaty cleavage is pervasive, and structural complication is likely. Measured thicknesses are considered a maximum.

The type section can be divided into three members totalling 828 m in thickness. The basal contact with the underlying limestone member of the Yusezyu Formation is not exposed but is abrupt in scree and presumed conformable. The lowermost member consists of 341 m of dark blue-grey weathering, dark blue-grey slate and pale green weathering, pale green slate. Aside from the basal 161 m which is of the green variety, these lithologies typically alternate in units several tens of metres thick. The pale green slate is laminated to thinly banded in dark to light green. The dark slate commonly contains laminae and beds (to 5 cm) of light blue-grey or pale green slate. Overlying the basal member is a middle member of 71 m of orange-grey weathering, grey, fine grained quartz sandstone and siltstone in thin to thick beds. This is overlain by the upper member that consists of 416 m of mostly blue-grey weathering, dark blue-grey slate. Lamination and thin beds of green slate are rare. Minor quartzose sandstone occurs in the central portion of the member. The upper 75 m comprises pale apple green weathering, apple green slate which upward becomes tan to buff weathering. The top of the formation is defined at the conformable(?) base of 1.5 m of limestone conglomerate float. The conglomerate and overlying tan-buff weathering blue-grey slate compose the Gull Lake Formation.

Sandstone member. At the type section and in the core of Fork Anticline, orange-buff weathering, fine grained quartz sandstone and pale green slate can be mapped as a separate member within the Narchilla. Where best developed on Fork Anticline this member is about 500(?) m thick and interfingers with overlying and underlying purple to maroon slate. It consists of about 90 percent pale green to pale brown slate and 10 percent white to pale green, very fine grained quartzarenite. The sandstone is not distributed uniformly throughout the member but occurs in sandstone-rich intervals. Sandstone beds average about 0.3 m thick but range from a few centimetres to a metre in thickness. Interbeds of slate are of similar thickness, but locally, sandstone beds are so abundant that the slate is reduced to thin partings between them. Most sandstone beds are massive, have sharp bottom and top contacts, and are planar. Normal size grading, parallel lamination in the bottom portions of beds, or ripple cross-lamination in the upper portions of beds are visible at some localities. Flute and groove casts are well developed at one outcrop (Fig. 32), and are rarely seen in float elsewhere.

As revealed in thin section, the sandstones consist of quartz, a few percent feldspar, rare detrital muscovite and chlorite, and traces of tourmaline, zircon, and opaque material. The detrital chlorite is composed of thin even patches of anomalous blue (crossed nichols) chlorite alternating with higher birefringent white mica. The feldspar consists of fresh to slightly altered albite-twinned plagioclase, rare plaid-twinned microcline and perthite. Quartz grain boundaries are sutured, reflecting a high degree of compaction and interpenetration of grains, as well as recrystallization of original matrix or cement. Grains are now equant, and their original sorting and roundness are obscured. Sericite is common as films and beards around grain boundaries.

Other areas. To the southeast along Summit Syncline and southwest of March Fault, the formation retains the colours typical of the type section. However, across Steel Creek to the southwest and northwest, the equivalent stratigraphic interval is maroon weathering. Although the colour contrast with the type section is marked, the lithologies are the same. Unfortunately, no section of maroon coloured strata is complete enough to be designated a reference section. However, this lithology may be examined at these localities: the top of section 6; the northwestern end of Fork Anticline; and the ridge 6 km southeast of Gull Lake. In these places the dominant rock type is maroon weathering slate that has thin laminations, beds, and locally thick intervals of pale green slate (Fig. 33). The green colouration typically parallels bedding but it also follows fractures and locally forms reduction spots. Thin beds of sandstone are invariably green coloured. Along Fork Anticline northwest of Steel Creek the colour change from dark blue-grey through purple to lighter coloured maroon occurs through a distance of about 10 km.

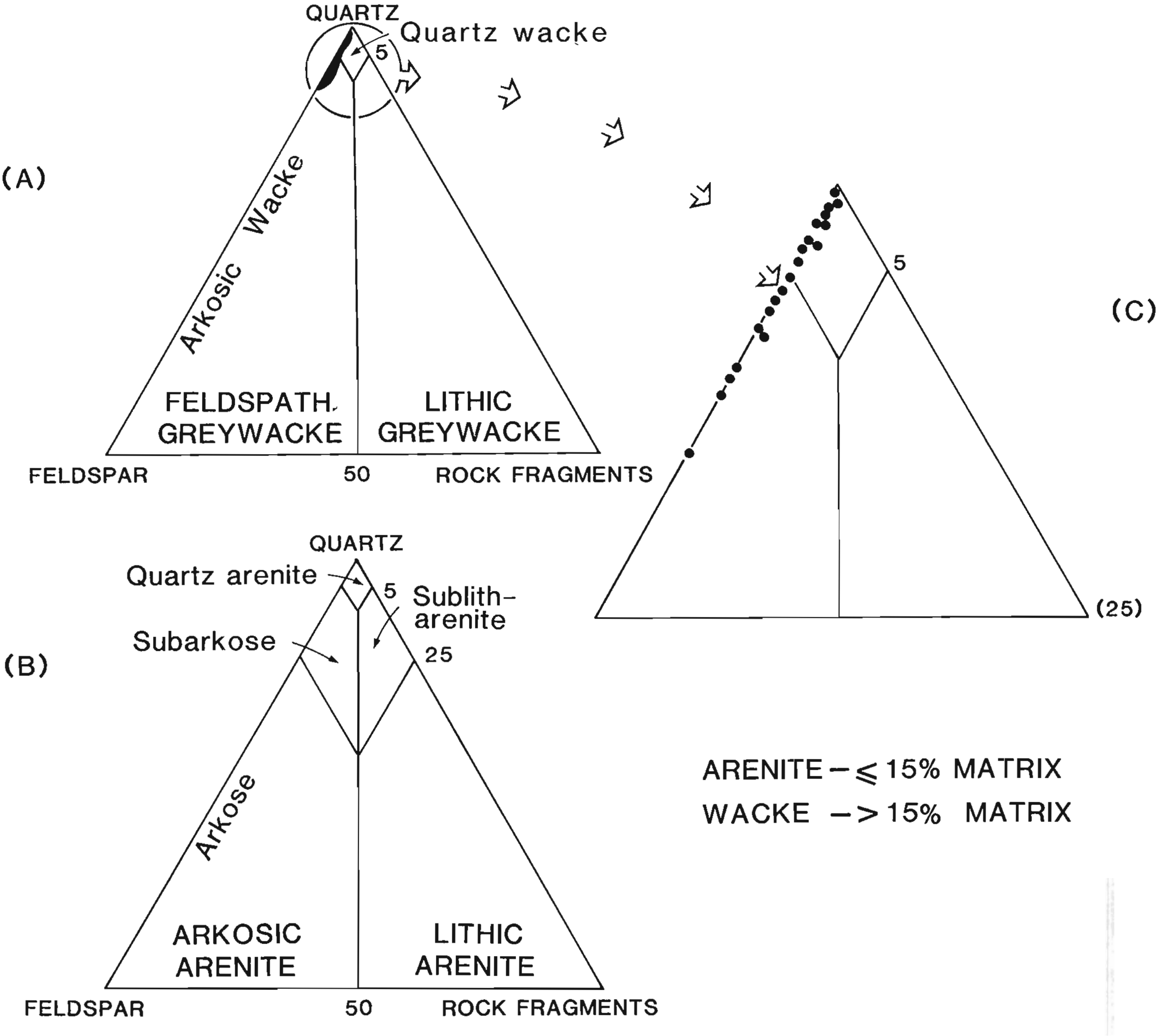

Figure 31. Composition of Yusezyu Formation sandstones (n=20) based on thin section point counts (500 points per section) of randomly selected specimens. The sandstones comprise arkosic wacke and quartz wacke (Pettijohn et al., 1973); the field of composition is shown in (A). An enlargement of this compositional field is shown in (C). No samples plot in the arenite field (B). Feldspar reaches a maximum of 15 percent, and is usually less than 8 percent of framework grains. Lithic fragments are rare and mafic minerals are absent. Tourmaline and zircon are found in trace amounts. The matrix of fine grained felsic minerals (which may include some silica cement) commonly amounts to 15 to 25 percent.

The Narchilla Formation conformably overlies the Yusezyu Formation (at section 6 basal beds are interbedded with underlying Yusezyu limestone). It is in sharp and presumably conformable contact with overlying buff slate or limestone conglomerate of the Gull Lake Formation.

Environment, age, and correlation of Hyland Group strata. Sedimentary fabrics of the Yusezyu Formation suggest deposition of the coarser clastics as sediment gravity flows. Middleton and Hampton (1973) recognized that coarse sediment may be supported during transport by any combination or proportion of four end member mechanisms including turbulence (turbidity flows), upward movement of pore fluids (fluidized flows), dispersive pressure (grain flows), and matrix strength (debris flows). Turbidity flows appear to give rise to the idealized Bouma sequence of sedimentary structures in which a single bed deposited from a passing turbidity current may have any combination of the following divisions (but always in vertical succession) that reflect waning-upward flow conditions: massive, or graded division (A); plane parallel laminated division (B); rippled division (C); upper parallel laminated division (D); and interturbidite division (usually pelite) (E). Using letters corresponding to these divisions, the most common sequences of divisions making up coarse grained beds are AE, ABE, and ABCE. Amalgamated or stacked, coarse, massive, sandy beds, which do not show Bouma divisions, are also common and may have arisen from grain flow, fluidized flow, or debris flow. One depositional model for sediment gravity flows is the submarine fan (Fig. 34), in which a point source clastic discharge onto a slope produces a fan-shaped accumulation in which coarse thick-bedded channelized deposits (proximal) grade outward to fine grained thin-bedded distal deposits (classical turbidites) (Walker, 1979). Judging by the proportion of coarse clastics, amalgamation of sandstones to form thick shale-free intervals, and evidence of scour beneath some coarse clastic members, much of the Yusezyu Formation was deposited in upper or mid-fan channels. However, the size, shape, sediment source, and water depth of the fan(s) are unknown. Paleocurrent data (Fig. 35) are meagre, but Bouma division (C) ripple cross-laminae suggest dominantly southeasterly paleoflow. The orientation of groove marks is consistent with this direction. Asymmetrical ripple marks suggest southwest paleoflow but it is unknown if these are depositional current directions or represent postdepositional reworking by bottom currents. Yusezyu clastics could represent sediments rapidly deposited in water of shallow to moderate depth setting fed by rapid discharge of debris-choked braided streams. The submarine fan depositional model predicts rapid lateral facies changes. The coarse clastics, typical of Nahanni map area, could undergo rapid fining toward other regions. The limestone member of the upper Yusezyu Formation is lenticular; it may have been deposited in relatively shallow(?) water.

The Narchilla Formation was deposited below wave base in relatively deep water. The sedimentary structures in the sandstone member are consistent with deposition from sediment gravity flows, probably mostly turbidites (see above discussion on turbidites). The similarity in composition of Yusezyu and Narchilla sands suggests a similar source terrane. Reasons for the striking maroon colour of the Nachilla Formation as well as the abrupt lateral colour change within it from maroon to dark blue-grey are uncertain.

The upper part of the Yusezyu Formation is of latest Precambrian age based on primitive trace fossils reported on by Fritz et al. (1983) from beneath the limestone member. The age of the lower part of the formation is not known, but the sediments were likely deposited rapidly, and hence may not be much older. The age of the overlying Narchilla Formation is late Precambrian to Early Cambrian. Overlying limestone conglomerate of the Gull Lake Formation contains Early Cambrian archaeocyathids as clasts. Fritz et al. (1983)

Figure 32. Flute casts on base of near vertical bed of sandstone of the sandstone member of the Narchilla Formation. Two casts are indicated by dotted lines, others are well developed near rock hammer on left side of photo. View of outcrop is looking to the southwest. Flutes indicate west-to-east paleoflow. Whether this paleoflow is regionally representative is uncertain. GSC 204922-W.

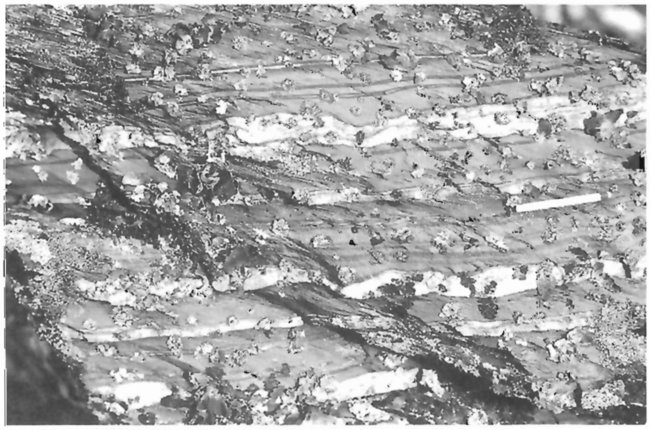

Figure 33. Laminated dark grey to maroon (dark bands) and light green (light bands) slate typical of the Narchilla Formation. Slaty cleavage dips about 35° to the right. GSC 204922-X.

reported trace fossils from the lower 20 m of the Narchilla Formation (7 km southeast of Gull Lake) that they tentatively place in the late Precambrian. Near the headwaters of Hess River in Niddery Lake (105O) map area, lithologically similar maroon shale contains the Early Cambrian trace fossil *Oldhamia Radiata* in its upper part (Hofmann and Cecile, 1981). Gritty lithologies of the Hyland Group have been correlated historically with similar lithologies characteristic of the Precambrian Windermere Supergroup (e.g. Eisbacher, 1981). Evidence in Nahanni map area indicates a definitely younger Eocambrian age for these gritty lithologies in Selwyn Basin.

Strata known informally as the "Grit Unit" are equivalent to the Hyland Group and outcrop widely over the Selwyn Basin region where they form the oldest exposed strata (Fig. 36). In many areas, although not subdivided, they are characterized by gritty quartzose clastics with maroon shale in their upper part. Hyland Group (i.e. "Grit Unit") strata have been described from Flat River (95E) (Gabrielse et al., 1973), and Dawson, Larsen Creek, and Nash Creek (116A, B; 106D) (Green, 1972, p. 20) map areas. In the latter areas, the succession is remarkably like that in Nahanni map area, consisting of gritty quartzose clastics capped by a light grey to white weathering limestone member (Yusezyu equivalent), and overlain by maroon shale (Narchilla equivalent) (Thompson and Roots, 1982, p. 409). Largely undivided Hyland Group clastics are also widespread in Sheldon Lake (105J) (unit 1, Roddick and Green, 1961a), Tay River (105K) (unit 1, Roddick and Green, 1961b), Frances Lake (105H) (unit 1, Blusson, 1966), Bonnet Plume Lake (106B), Nadaleen River (106C), Niddery Lake (105O), Lansing (105N) (unit Hs, Blusson, 1974), Mayo (105M) (units 1 to 9, Bostock, 1947), and McQuesten (115P) (unit 4, Bostock, 1964) map areas.

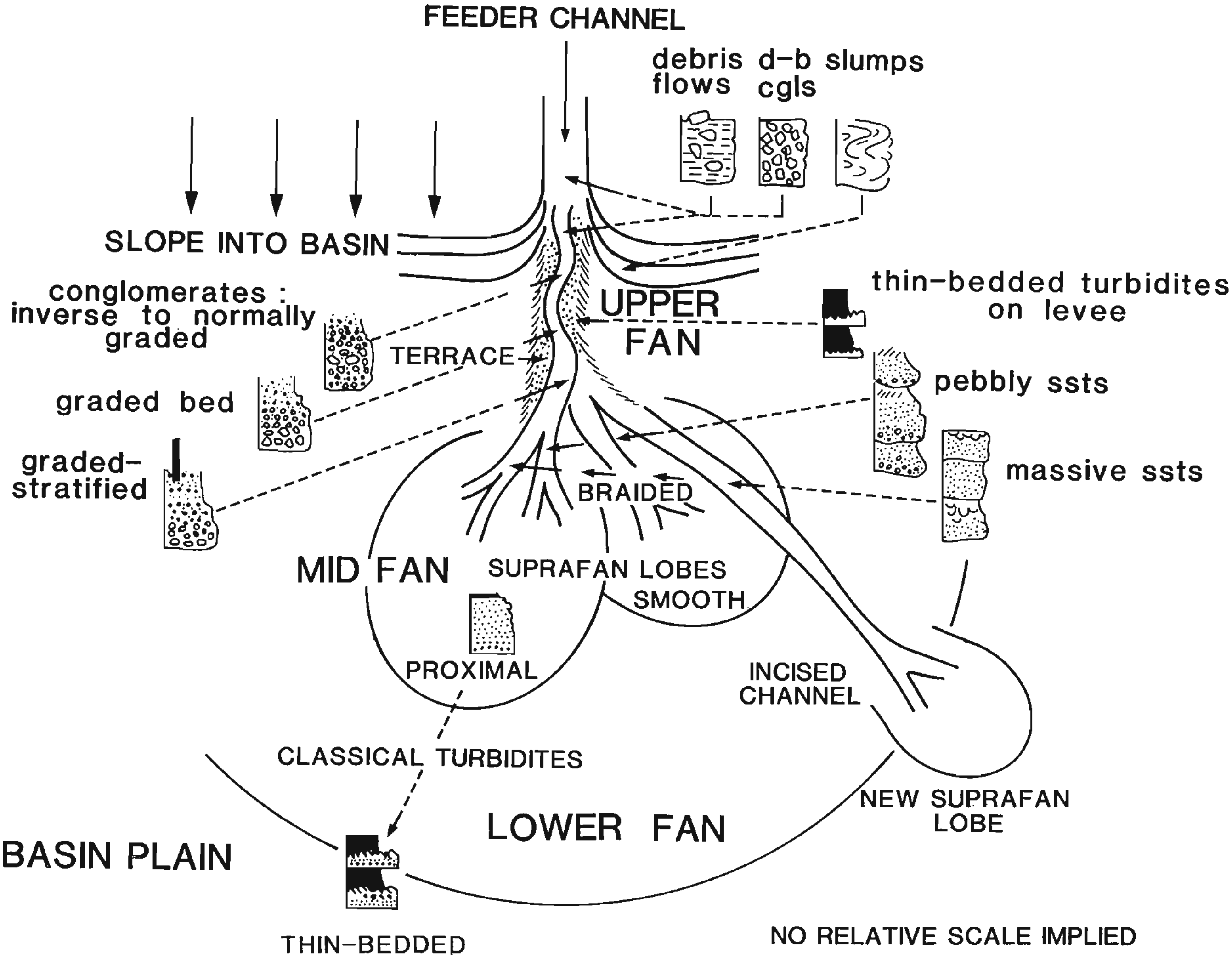

Figure 34. Submarine fan depositional model (from Walker, 1979, Fig. 13; d-b cgls = disorganized bed conglomerates). Sedimentary features of the Yusezyu Formation suggest deposition in mid or upper fan channels, and/or suprafan lobes (see text). The size and shape, and possibility of there being more than one such fan within the Nahanni area remain unknown.

Cecile (1981, units Hls, HЄg1, and HЄg2; 1984, units Hq, Hl, HЄa, and Hma) has described strata in Niddery Lake (105O) map area that are here considered part of the Hyland Group. His limestone unit (Hls, Hl) may correspond to the limestone member at the top of the Yusezyu Formation (Fig. 36). In that area, however, maroon shale persists below the limestone. In Nahanni map area Fritz et al. (1983) noted an occurrence of maroon shale beneath the limestone member (shown diagrammatically on Fig. 36). Perhaps in areas not engulfed by clastic influx, maroon shale (or locally dark grey shale) may have been the normal distal equivalents to Yusezyu clastics.

On the basis of trace fossils and stratigraphic position, Fritz et al. (1983) correlated the Yusezyu Formation with the Backbone Ranges Formation in Mackenzie Mountains (Gabrielse et al., 1973), and the limestone member with the middle carbonate member of the Backbone Ranges Formation (Fig. 36). The Narchilla Formation is correlative with the Vampire Formation in the eastern part of Nahanni map area. The transition occurs southeast of Steel Creek and southwest of March Fault where units typical of Vampire and Narchilla lithologies intertongue. Farther southwest the two formations are found on opposite sides of Little Hyland River valley. Immediately southeast of the map area, east of the Nahanni Range Road, dark blue-grey weathering slate like that of the Narchilla Formation locally occurs low within the Vampire Formation.

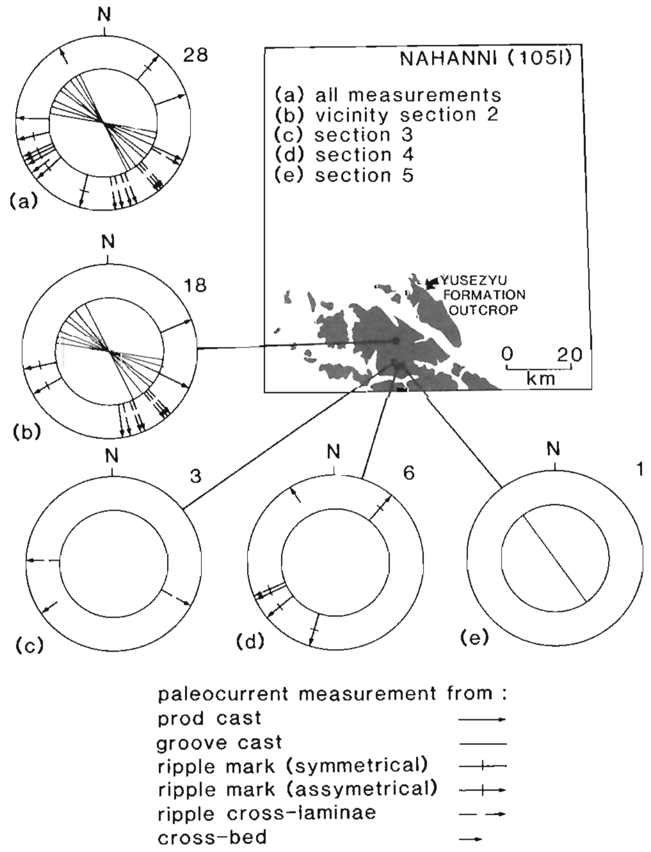

Figure 35. Paleocurrent data from the Yusezyu Formation. Diagram (a) includes all data, and (b) to (e) are from locations indicated on the index map. Grooves and ripple cross-laminae (from Bouma division (C)) (see text) suggest southeasterly paleoflow. Asymmetrical ripple marks, which could represent reworking by bottom currents (see text), indicate dominantly southwest paleoflow.

Provenance and tectonic significance of the Hyland Group. The late Precambrian to Lower Cambrian Hyland Group and in particular the Yusezyu Formation is a thick sequence (at least 3 km of turbiditic clastics from the Yusezyu Formation) that reflects rapid erosion of sedimentary (?) source terranes (see sandstone petrography section) of unknown extent and location. Contemporaneous structure has not been identified in Nahanni map area (the depositional basin). However, it is clear that for such an influx of thick locally coarse sediment there must have been moderate to high relief in the source area, a relief likely produced by synerosional faulting and/or folding.

Two possibilities for the provenance of Hyland Group (particularly Yusezyu Formation) coarse clastics are: 1) they are part of the easterly derived (Gabrielse et al., 1973) depositional system of the correlative, thick, Backbone Ranges Formation (see Fig. 36) of Mackenzie Mountains; or 2) they form a separate depositional system of west, north, or south derivation that laterally interfingers with the Backbone Ranges system.

The first possibility seems favoured by the striking compositional similarity of Backbone Ranges (Gabrielse et al., 1973, p. 33) and Yusezyu Formation sandstone. Granule sandstone and quartz-pebble conglomerate with bluish opalescent quartz grains, although not typical, are found within the Backbone Ranges Formation. However, it seems unlikely that an as yet unidentified submarine channel crossed the northwest-trending shallow marine Backbone Ranges shelf and funnelled coarse clastics into the Yusezyu depositional basin. This scenario also fails to explain why a similar situation did not develop during deposition of the Narchilla Formation, when the equivalent upper Backbone Ranges Formation, compositionally like the lower Backbone Ranges Formation, merely shaled-out to the west. Paleocurrent data also present difficulty for this first possibility.

The second possibility is hinted at by easterly paleocurrent directions obtained from excellent flute casts at one locality within the Narchilla Formation (Fig. 32). However, the relevance of these few measurements to the Hyland Group as a whole is uncertain. Limited paleocurrent data for the Yusezyu Formation are dominantly southeasterly (Fig. 35), and could indicate a northwest source area. The chance that southeast paleoflow reflects currents that have turned through 90° to parallel the basin axis (i.e. originally flowed southwest or northeast) seems remote in these proximal fan deposits. If a west or northwest source is accepted, then the compositional similarity to the easterly derived Backbone Ranges sandstone implies similar source rocks were uplifted in both source areas.

In summary, available data suggest a west or northwest source for the Hyland Group. Compositional similarity with easterly derived Backbone Ranges clastics may merely

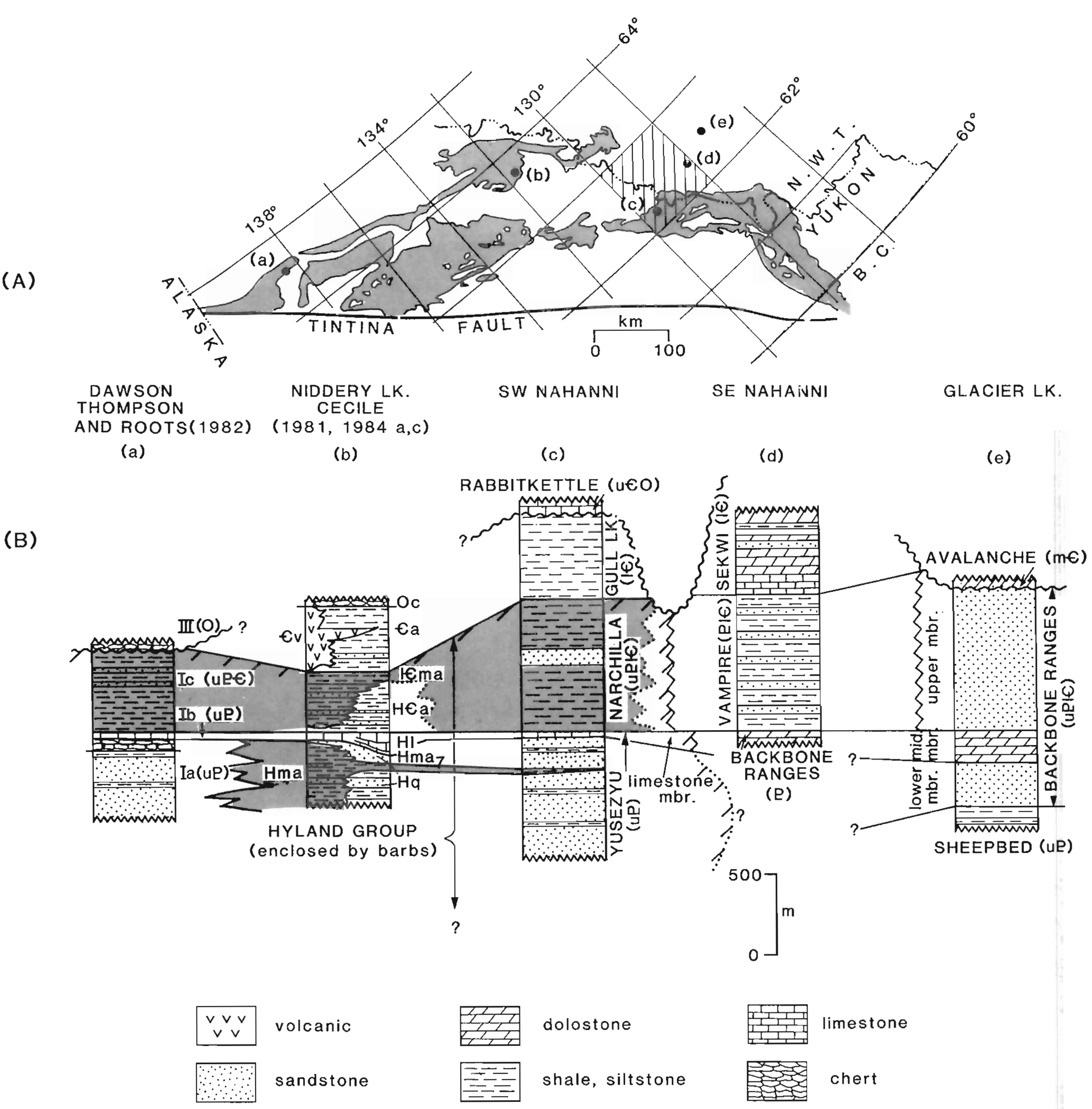

Figure 36. Regional correlation of the Hyland Group. **A.** Regional distribution of strata that may be assigned to the Hyland Group. Gritty quartzose clastics with maroon shale in their upper part (formerly called the "Grit Unit") are widespread in the Selwyn Basin region, forming the oldest exposed strata. Locations (a) to (e) refer to localities in "B". Diagonal rule pattern indicates Nahanni map area. **B.** Regional correlation of the Hyland Group (of Selwyn Basin) and equivalent strata in Mackenzie Mountains (Mackenzie Platform). Maroon, predominantly fine clastic strata are indicated by shading. A limestone member at the top of the Yusezyu Formation forms a marker that may allow regional subdivision of the Hyland Group. Fritz et al. (1983), on the basis of trace fossils and stratigraphic position, correlated this limestone with the middle carbonate member of the Backbone Ranges Formation (e) in Mackenzie Mountains. The Yusezyu Formation correlates in part with the lower member of the Backbone Ranges Formation (quartz sandstone), but the mutual sedimentary and tectonic relations of these formations are nowhere exposed. The succession in Dawson map area (a) is remarkably like that in Nahanni map area (c). In Niddery Lake map area (b), Cecile described maroon shale beneath a limestone marker. The latter is equated here with the Yusezyu limestone member (see Hofmann and Cecile (1981) for an alternate view). Maroon shale was noted beneath the limestone member in Nahanni map area by Fritz et al. (1983) (shown diagrammatically at (c)). The sections shown in (a) and (b) are from maps and descriptions of the authors indicated (symbols refer to map units used by the author). Symbols in brackets in sections (a), (c), (d), and (e) refer to geological age (Ᵽ-Proterozoic; Ꞓ-Cambrian; O-Ordovician; l-lower; m-middle; u-upper).

reflect erosion of similar source rocks. The possibility that the Backbone Ranges depositional system also contributed coarse detritus to the Hyland Group seems unlikely.

Gull Lake Formation (ЄG)(new). The Gull Lake Formation consists of buff-brown weathering, blue-grey slate and siltstone, and minor limestone conglomerate exposed in the southwestern quadrant of the map area. The best exposures are along the southwest limb of Fork Anticline. The formation sharply overlies maroon shales of the Narchilla Formation and underlies white weathering limestone of the Rabbitkettle Formation.

Type section - section 8 - 62°23.4′N;129°19.2′W. The type section is located on the southwestern limb of Fork Anticline, about 4 km north-northeast of Summit Lake (Fig. 37). Gull Lake, after which the formation is named, is located 28 km southwest of the type section. Most of the type section, which totals 1050 m in thickness, is underlain by scree, except for the upper part which is resistant weathering and well exposed.

The type section consists of three members: 1) a thin, discontinuous, basal limestone conglomerate (limestone member); 2) a middle member (shale member) of slate, siltstone, and very fine grained sandstone; and 3) an upper member (mudstone member) of siltstone and mudstone. The

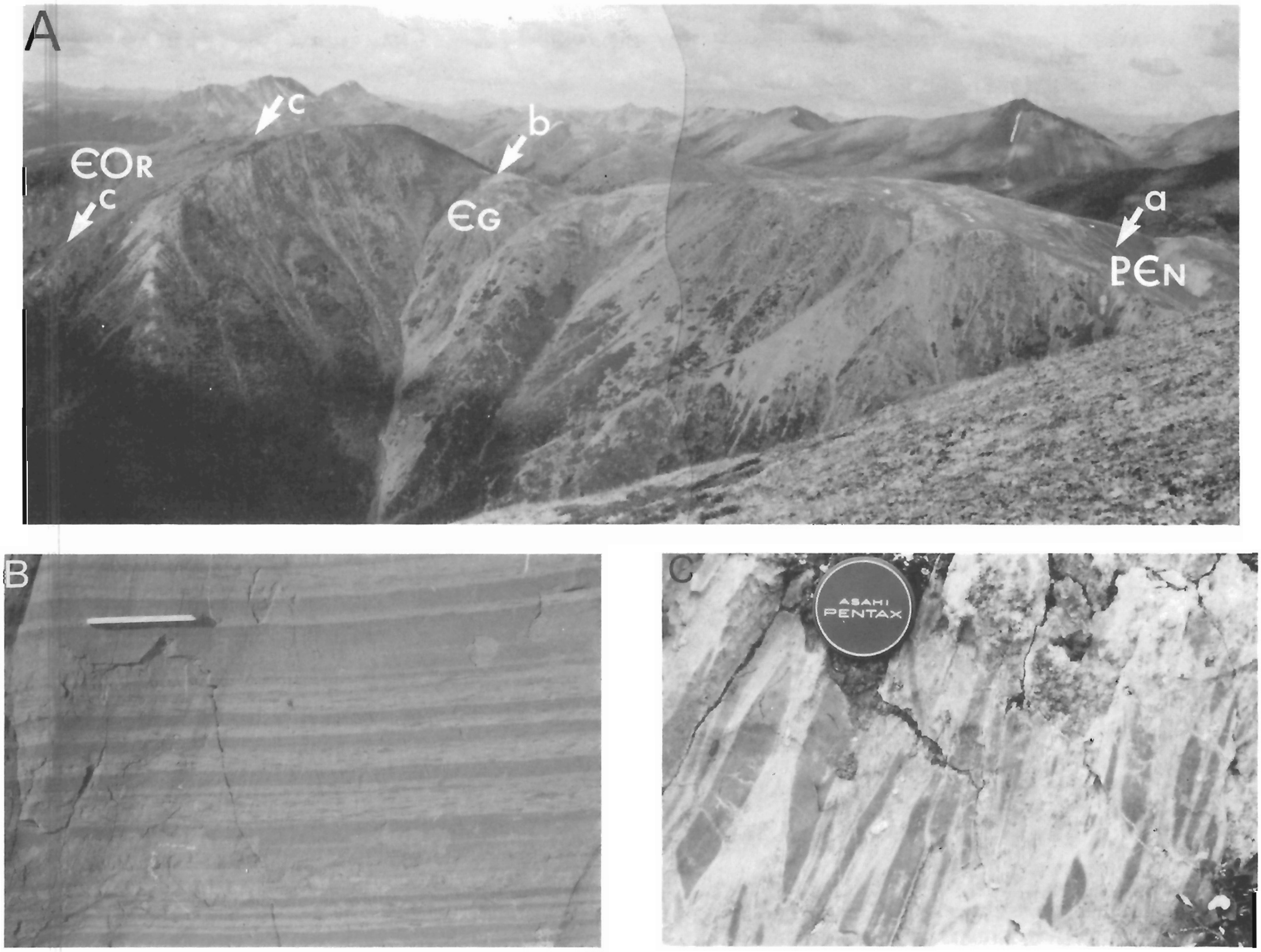

Figure 37. Gull Lake Formation. **A.** West-looking view of the type section (no. 8) of the Gull Lake Formation (ЄG)4 km north-northeast of Summit Lake. "a" marks the base of the section, and the contact with the underlying Narchilla Formation (PЄN). "c" marks the approximate location of the upper contact of the Gull Lake Formation with the Rabbitkettle Formation (ЄOR). "b" marks the lower contact of the resistant grey mudstone member of the Gull Lake Formation. Apparent dip of beds is about 45 degrees to the left side of the photo. GSC 204922-Y. **B.** Centimetre-scale bedding and discontinuous wispy lamination (bioturbation) characteristic of the upper grey mudstone member of the Gull Lake Formation. Photo from type section. GSC 204922-Z. **C.** Limestone conglomerate locally found at the base of the Gull Lake Formation. In this example, clasts are tabular. At other locations there is a diversity in roundness and sphericity, and the conglomerate looks similar to that of the Sekwi Formation (e.g. Fig. 14B). The photo was taken on Steel Syncline, about 12 km southeast of the southern end of Summit Lake. GSC 204922-AA.

basal conglomerate is less than 1 m thick. It is a moderately sorted, clast supported conglomerate consisting of subrounded to subangular clasts to 3 cm across set in an orange weathering, highly calcareous quartz sandstone matrix. Light grey weathering, dark grey, fine crystalline limestone, and rarely, archaeocyathids form the clasts. The conglomerate separates maroon weathering shales of the underlying Narchilla Formation from the brown weathering shale member of the Gull Lake Formation. A few tens of metres along strike, the conglomerate is absent, and the formational boundary is defined at this abrupt colour change. The bulk of the Gull Lake Formation consists of the shale member, which comprises 662 m of orange-brown to rust-brown weathering slate and siltstone to very fine grained sandstone. The strata on fresh surface are dark blue-grey and are poorly to strongly laminated in shades of like colour. In the upper part of the member, laminae are locally bioturbated. The upper or mudstone member at the type section consists of 386 m of mostly resistant, grey weathering, thick-bedded bioturbated siltstone and mudstone. The rocks are grey to black on fresh surfaces, and range from strongly calcareous to noncalcareous and dolomitic. Centimetre-scale bedding and wispy lamination are characteristic (Fig. 37B). The lower limit of resistant outcrop marks the base of the mudstone member. Its upper contact is defined in scree at a sharp change to white weathering limestone of the overlying Rabbitkettle Formation.

Other areas. The Gull Lake Formation elsewhere is similar to the type section. The basal limestone conglomerate is discontinuous and probably, at most, a few tens of metres thick. About 15 km south-southwest of the southern end of Gull Lake, it consists of 10 to 20 m of grey weathering, massive, black fine crystalline limestone, laminated calcareous fine grained sandstone, and limestone conglomerate. Conglomerate clasts consist of grey weathering, fine crystalline limestone and rare oolitic and oncolitic limestone, and are set in an orange weathering, calcareous shale matrix. The clasts are up to 15 cm in diameter, poorly sorted, well rounded to angular, and matrix supported. A few tens of metres above the conglomerate is a 20 to 30 m thick rib of white weathering, fine grained quartzarenite. Overlying and underlying Gull Lake strata are dark to rust-brown weathering, blue-grey slates.

Along the northeastern limb of Steel Syncline, the limestone conglomerate consists of poor, discontinuous exposures of mostly tabular, dark grey weathering, fine crystalline limestone clasts up to 25 cm long in an orange weathering, very fine crystalline, dark grey limestone groundmass (Fig. 37C).

The basal Gull Lake Formation immediately west of Narchilla Brook comprises a few metres of brownish-tan weathering, calcareous quartzarenite interbedded with and overlain by minor greenish-brown shale which in turn is overlain by limestone cobble conglomerate probably less than 10 m thick. Conglomerate clasts are rounded to subangular, averaging 7 cm in length but occasionally reaching 0.5 m. They are predominantly grey, fine crystalline limestone and are contained in a fine crystalline shaly limestone matrix.

The upper grey mudstone member of the Gull Lake Formation is not mappable away from Fork Anticline although highly burrowed Gull Lake beds in the southwestern part of the map area may be correlative. The Gull Lake Formation is probably thickest at the type section and thinner elsewhere because of varying amounts of pre-Rabbitkettle erosion.

Gull Lake strata are truncated and locally absent beneath the Rabbitkettle Formation, indicating gentle pre-Rabbitkettle folding and/or faulting, and a sub-Rabbitkettle angular unconformity. The large thickness of Gull Lake and Narchilla strata and the relative closeness in age of the two formations suggests that their sharp mutual contact is conformable.

Environment, age, and correlation. Most of the Gull Lake Formation was likely deposited below wave base in an offshelf, quiet water setting. Limestone conglomerate of the basal member may represent debris flows derived from the time-equivalent Sekwi Formation of the platform. The Sekwi Formation in its lower part contains lithologically similar conglomerate. However, in some places the basal member contains fine crystalline limestone, and locally quartz sandstone that is not of obvious debris flow or turbidite origin. These could represent relatively shallow water sedimentation. The age of the Gull Lake Formation is as old as Early Cambrian as indicated by Early Cambrian archaeocyathid clasts in the basal member. It is no younger than Late Cambrian, the lower age limit of the unconformably overlying Rabbitkettle Formation.

The Gull Lake Formation correlates with similar strata in northern Niddery Lake (105O) map area (unit lꞒa, Cecile, 1981; unit Ꞓa and tꞒa, Cecile, 1984a). There, Gull Lake equivalents are interstratified with abundant mafic volcanics and volcaniclastics. Abbott (1977) has mapped phyllite with lenses of archaeocyathid-bearing limestone of Early Cambrian age in Watson Lake map area. The Gull Lake Formation is probably largely equivalent to the Lower Cambrian Sekwi Formation of Mackenzie Platform, the Gull Lake slates representing offshelf equivalents of the upper clastic-rich member of the Sekwi Formation. However, partial equivalence with the Middle Cambrian Rockslide and Avalanche formations of Mackenzie Platform cannot be ruled out. The extent of Lower Cambrian shale facies over much of the Selwyn Basin remains to be determined.

Cambro-Ordovician

Rabbitkettle Formation (southwest of South Nahanni River) (ꞒOR1). Grey to white weathering limestone of the Rabbitkettle Formation (Gabrielse et al., 1973) is most extensively and best exposed in the central part of the map area. Good exposures are also found in the southwestern part of the region. The Rabbitkettle Formation forms an excellent marker unit beneath dark weathering shale and chert of the Duo Lake Formation. It rests above various dark weathering shales including those of the Vampire, Gull Lake, and Narchilla formations.

Northeast of Placer and Don creeks (Fig. 2A) several different facies are developed in the Rabbitkettle Formation, which may total 900 m in thickness (e.g. section 10). The upper 120(?) m in this area consists of grey weathering, grey, fine crystalline nodular limestone. The nodules are dark grey weathering, up to 2 cm across, and abundant within a light grey weathering, argillaceous to silty limestone matrix (Fig. 38A). The rest of the formation is dominated by grey-orange weathering, blue-grey to black, fine crystalline argillaceous to silty limestone, usually in beds less than 10 cm thick. Intervals a few tens of metres thick of medium- to thick-bedded, massive, blue-grey to black, fine crystalline limestone compose up to 10 percent of the succession. Brick red weathering, sugary, sandy dolostone, quartz sandstone, and intraformational limestone conglomerate amount to less than 5 percent. About 10 km north-northeast of the 7171 foot peak (section 10) there is, within the lower Rabbitkettle Formation, a 316 m thick member dominated by green to orange weathering, green volcanic tuff. The tuff is mostly massive, and comprises altered dark green aphanitic volcanic fragments less than 2 cm in diameter. Green colour lamination and grain size variation outline beds 3 to 5 cm thick (Fig. 38C). Also, within the succession are several intervals less than 10 m thick, and one at 47 m thick of grey-green weathering, laminated, grey tuffaceous(?) shale. Along and east of Lened Syncline the lower Rabbitkettle Formation changes facies to dolostone and quartz sandstone of the Haywire Formation. The Rabbitkettle Formation overlying the Haywire Formation is composed of locally nodular, thin-bedded, argillaceous to silty limestone.

Southwest of Placer and Don creeks the Rabbitkettle Formation is of uniform lithology. There it consists of white weathering, evenly laminated to thin-bedded, grey to white, fine crystalline, variably argillaceous limestone (Fig. 38B) about 250 m thick (section 8).

The Rabbitkettle Formation is overlain abruptly and conformably by shale of the Duo Lake Formation. At most localities the contact is sharply delineated in scree. Where examined in outcrop, 8.6 km northeast of the 7171 foot (2187m) peak, scattered nodules and thin beds of limestone persist upward as much as 30 m into basal Duo Lake shale. The Rabbitkettle Formation rests variously on the Vampire, Gull Lake, and locally Narchilla formations. Gentle pre-Rabbitkettle folding and/or faulting, and a sub-Rabbitkettle low-angle unconformity are required to explain this

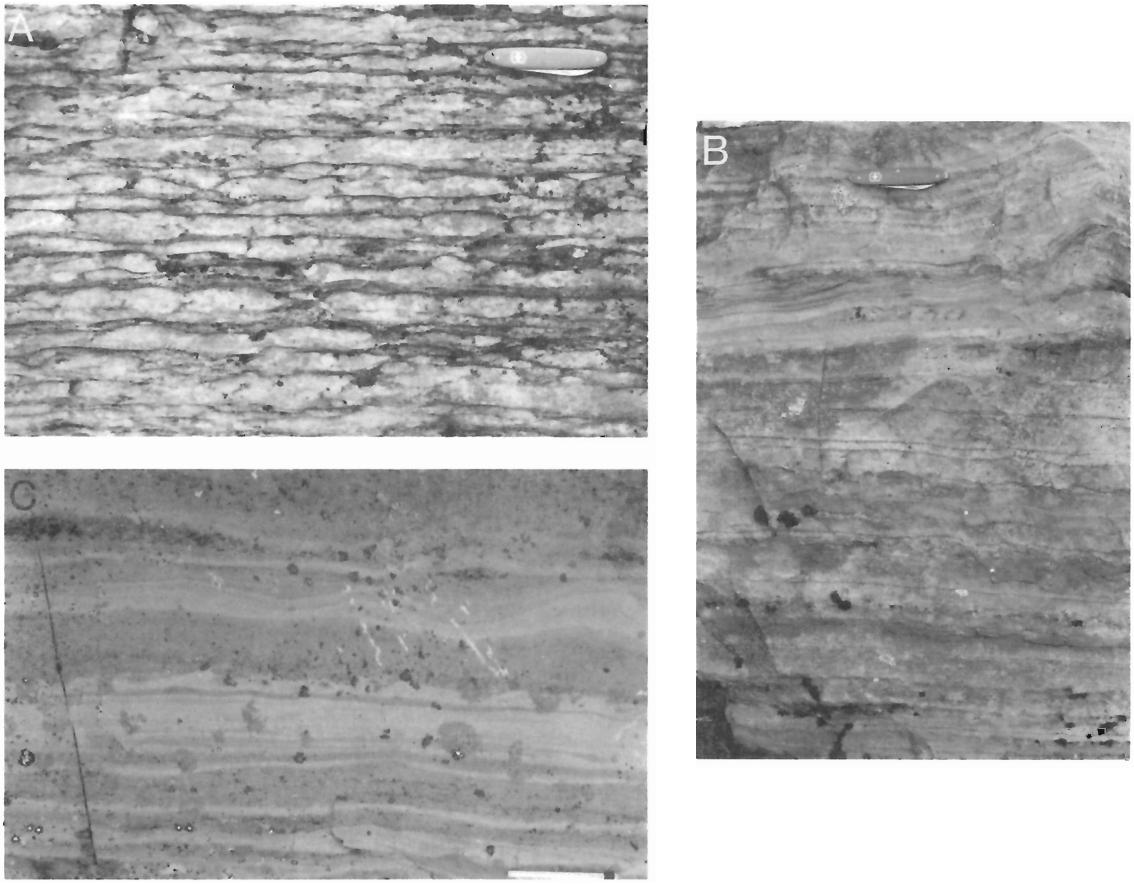

Figure 38. Rabbitkettle Formation (southwest of South Nahanni River). **A.** Thin-bedded nodular limestone typical of the central part of the map area. GSC 204922-BB. **B.** Evenly laminated argillaceous limestone typical of the southwestern part of the map area. This limestone is farther from the shelf edge, and presumably of deeper water origin than the nodular limestone of photo A. GSC 204922-CC. **C.** Thinly laminated, grey-green, subaqueous fine tuff from thick volcanic strata within the Rabbitkettle Formation, 7 km north of the head of Placer Creek (section 10). GSC 204922-DD.

relationship. Northeast of South Nahanni River, deposition of the Middle Cambrian Rockslide Formation and overlying Rabbitkettle Formation seems to have been continuous (see section on Rabbitkettle Formation northeast of South Nahanni River).

Environment, age, and correlation. Fine lamination, lack of traction features, and position west of correlative, shallow water carbonate strata, indicate that Rabbitkettle deposition was in a quiet water, sub-wavebase, offshelf setting.

Conodont collections range in age from probable Late Cambrian to late Middle Ordovician, most of the youngest ages being from exposures near the South Nahanni River (Appendix 4). A Middle Ordovician age was also determined for exposures near the head of March Creek. The Rabbitkettle Formation in these areas is clearly younger than elsewhere, and equivalent to the northwest to black siliceous shale and chert of the Duo Lake Formation. In northeast Nahanni map area strata assigned to the Rabbitkettle Formation include tan weathering, laminated to thin bedded, nodular limestone of Late Cambrian age (see section on Rabbitkettle Formation northeast of South Nahanni River).

Basinal limestone of Cambro-Ordovician age is widespread in the northern Cordillera. The Rabbitkettle Formation is widely recognized over the Selwyn Basin area including Flat River (95E) and Glacier Lake (95L) map areas (Gabrielse et al., 1973), and in Niddery Lake (105O), Sekwi Mountain (105P), Mount Eduni (106A), and Bonnet Plume Lake (106B) map areas (Cecile, 1982). Equivalent strata in the Anvil Range (Tay River map area) (105K) of western Selwyn Basin include calcareous phyllite, and basic volcanic tuffs and flows (Gordey, 1983). Abbott (1977) described calcareous, thinly laminated or nodular phyllite of Cambro-Ordovician age, similar to that in Anvil Range, in Watson Lake map area. In the Richardson Mountains, the basal part of the Road River Group is lithologically similar to the Rabbitkettle Formation (Cecile et al., 1982). Cambro-Ordovician basinal strata in Pelly (Gordey, 1981b) and Cassiar (Gabrielse, 1963a) mountains comprise calcareous phyllite to limestone and local mafic volcanics of the Kechika Formation. Shallow shelf correlatives of Mackenzie Platform are the Broken Skull and Franklin Mountain formations.

Ordovician and Silurian

Road River Group (**OS**R).

Gabrielse et al. (1973) first noted the similarity of argillaceous graptolitic rocks present in many parts of Selwyn Basin to the Lower Cambrian to Lower Devonian Road River Formation in the Richardson Mountains (Jackson and Lenz, 1962). Gabrielse et al. (1973) proposed the name "Road River" be used in Selwyn Basin also. In Flat River and Glacier Lake map areas they applied it to black shale, chert, and limestone overlying the Rabbitkettle Formation and underlying the Funeral Formation. Faunas indicated a range in age from Caradocian (late Middle to early Late Ordovician) to Early Devonian.

The "Road River" as used in Nahanni map area corresponds largely to the usage of Gabrielse et al. (1973). However, it is raised to group status because two formations, the Steel and Duo Lake, are recognized within it. The lower boundary of the group, as in Gabrielse et al., (1973), is at the top of the Rabbitkettle Formation. Placement of the upper boundary above the Steel Formation makes an easily mappable contact for the top of the group. The overlying Portrait Lake Formation comprises an indivisible sequence of black shale and chert of Early to Late Devonian age.

Gabrielse et al. (1973) also locally included in the Road River Formation strata mapped herein as the Sapper Formation. The Sapper Formation comprises tan weathering siltstone, calcareous siltstone, and limestone, occupying an intermediate position between shallow shelf carbonates to the east and offshelf Road River rocks to the west. The common connotation of "Road River" with black graptolitic shale and chert lithologies suggested the Sapper Formation not be included in the Road River Group.

Duo Lake Formation (**OS**D). The Duo Lake Formation (Cecile, 1982) comprises recessive weathering, black siliceous graptolitic shale and chert and minor limestone in the southwestern part of the map area. The weathering colour ranges from tan to black to bluish white and contrasts sharply with underlying white weathering limestone of the Rabbitkettle Formation and overlying orange weathering mudstone of the Steel Formation.

About 15 km northeast of the 7171 foot (2186 m) peak (section 12), the Duo Lake is about 300 m thick and composed mostly of blue-black weathering, platy black shale. Its upper 60 m contains about 10 percent blue-black weathering, laminated black chert. The lower 90 m of the formation consists of orange-buff weathering, black silty shale and minor limestone.

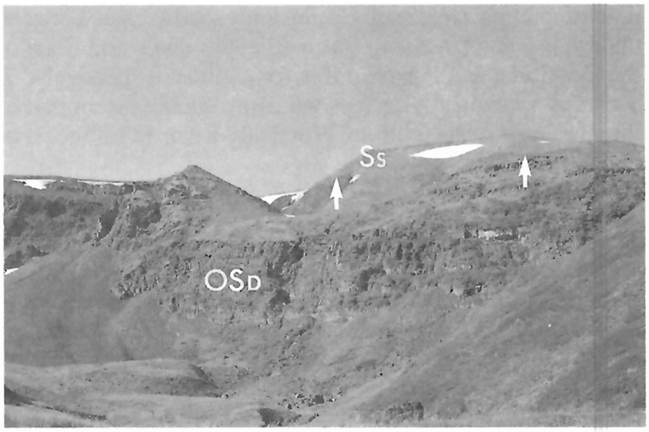

Figure 39. Thick-bedded, dark grey to black weathering chert of the Duo Lake Formation (**OS**D), overlain by orange weathering, wispy-laminated mudstone of the Steel Formation (Ss) (contact marked by arrows). View is to the southwest, about 8 km southwest of Summit Lake. GSC 204922-EE.

Five kilometres southwest of Summit Lake (section 14) the formation is 296 m thick and is dominated by black chert. Beds range in thickness from 1 to 70 cm, with a norm of about 20 cm (Fig. 39).

About 12 km north of the junction of Pelly River and Don Creek (section 9) the Duo Lake is 225 m thick. The bottom 156 m comprises black or tan weathering, light grey siltstone. This is overlain by about 69 m of black or gun-blue weathering black shale. Black, blocky weathering chert is abundant in the upper 30 m.

South of the Woodside River the formation is of uncertain thickness (250? m). Thick, dark tan-brown weathering shale is capped by about 30 m of thin-bedded black chert with white pinstripe laminations.

West of Clea pluton, the great apparent thickness of the Road River Group is a structural artifact. The alternating black (Duo Lake) and orange (Steel) striping seen over large areas of uniformly dipping strata is caused by structural imbrication. The Duo Lake Formation consists of blue-black weathering black shale and chert, whereas the Steel Formation comprises orange weathering, pyritic, locally wispy-laminated siliceous shale.

Despite uncertainty caused by poor exposure and complex deformation, 300 m seems a reasonable average thickness for the Duo Lake Formation. Facies within the formation change in a general way from mostly shale with minor chert in the northeast, to predominantly chert southwest of Summit Lake, to predominantly shale southwest of Woodside River.

The Duo Lake Formation overlies the Rabbitkettle Formation conformably. In most places the contact, although defined in scree, is abrupt (see Rabbitkettle Formation). The contact with the overlying Steel Formation is sharp and apparently conformable.

Steel Formation (**S**S)(new). The Steel Formation is a thin unit of orange weathering mudstone sandwiched between underlying and overlying black siliceous shale and chert of the Duo Lake and Portrait Lake formations, respectively. It outcrops sporadically across the entire southwestern part of the map area from south of Woodside River to northeast of Placer and Don creeks.

Type section - section 14 - 62°19.5'N;129°27.0'W. The type section is situated along a ridge crest about 5 km southwest of Summit Lake. Steel Creek, after which the formation is named, lies 13 km to the east. The formation at the type section is about 143 m thick and of uniform lithology. Siliceous, light to dark grey mudstone, in beds 10 to 80 cm thick, weathers yellowish brown, dull olive-grey, or dark yellowish brown. One 10 m thick interval comprises blue-grey weathering siliceous argillite. Dark grey to black, wispy discontinuous lamination within a lighter coloured matrix is abundant throughout the formation. Upper and lower contacts with the black siliceous shale and chert of the Portrait Lake and Duo Lake formations are sharply delineated within scree, and presumed conformable.

At other localities (see sections 9, 13) the Steel Formation is very like that at the type section. It is regionally characterized by its orange weathering colour (caused by disseminated pyrite), mud to silt grain size, and ubiquitous wispy lamination (Fig. 40). The mudstone is variably dolomitic, and locally thin members of orange weathering, massive grey-green argillaceous dolostone are present. Both upper and lower contacts can be picked easily from a distance on the basis of a change in weathering colour. Locally however, the formation does contain members up to 10(?) m thick of dark grey burrowed mudstone. Where this lithology occurs at the top of the formation it can be confused with the black siliceous shale of the overlying Portrait Lake Formation. In that event, the upper contact is defined at the top of the highest occurrence of wispy lamination. The Steel Formation is 97 m thick 2.5 km northeast of Placer Creek (section 13) and 96 m thick about 43 km to the northwest (section 9).

The basal contact with Duo Lake strata was observed in outcrop at one locality (section 12) to be gradational over about 2 m. It and the upper contact, which was not seen in outcrop, are both presumed conformable.

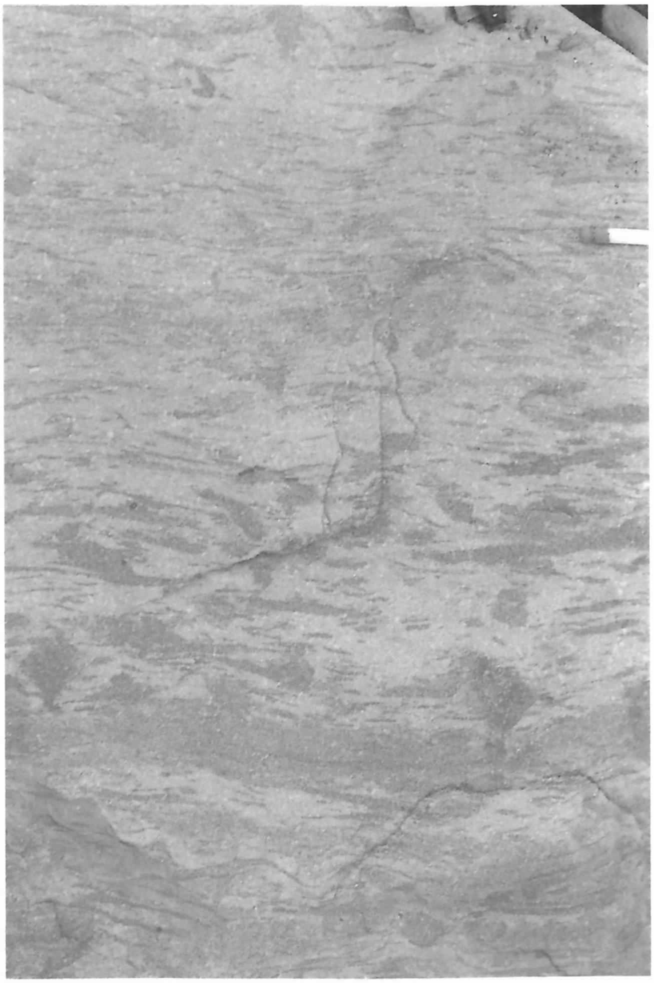

Figure 40. Mudstone of the Steel Formation. The wispy-laminated texture, caused by disruption of bedding by burrowing organisms, is regionally characteristic of the formation. GSC 204922-FF.

Environment, age, and correlation of the Road River Group. Black siliceous shale and chert of the Duo Lake Formation were deposited in a quiet, euxinic offshelf setting starved from clastic input. Water depth is not known other than it was greater than wave base. The cherts are presumably biogenic, despite few preserved radiolaria. These are now represented by recrystallized spheres that amount to only a few percent in thin section. Lack of current structures, and position west of time-equivalent shallow water carbonate strata of Mackenzie Platform, indicate deposition of the overlying Steel Formation in a relatively quiet water, sub-wavebase offshelf setting. The wispy lamination was a product of dominantly horizontal burrowing. The presence of burrowing organisms reflected a change to oxygenated bottom water from the reducing euxinic conditions prevailing during Duo Lake deposition. Such a change could occur by a reduction of water depth or overturn of the water column.

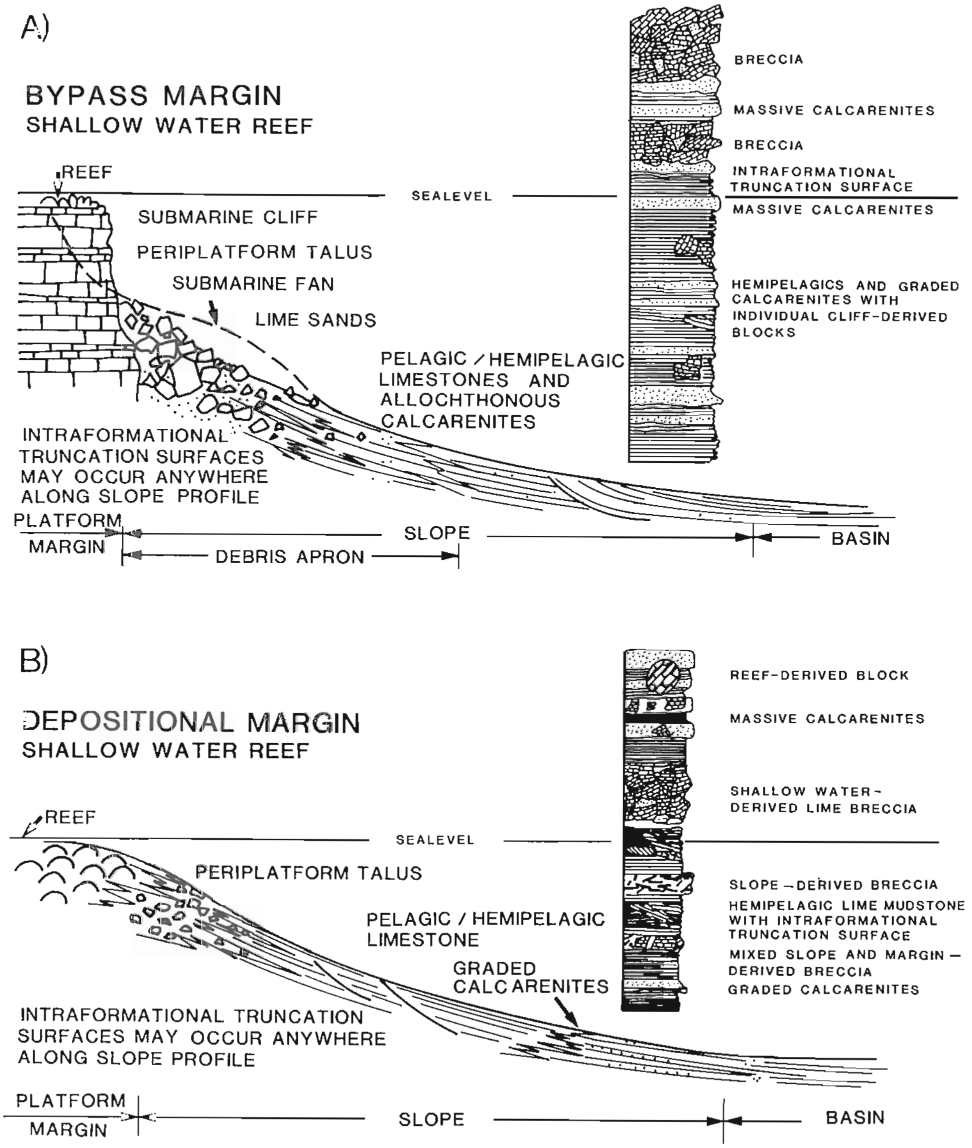

Figure 41. Characteristics of bypass and depositional carbonate bank margins. Bypass margins (**A**) have a cliff or submarine escarpment edge. Sediment bypasses the escarpment and much of the slope, transported through widely spaced channels or canyons in front of which may develop small submarine fans. The zone of periplatform talus near the scarp is well developed and can consist of very large blocks. Depositional margins (**B**) are featured by a gentle slope that decreases basinward to merge with the flat basin floor. Their periplatform talus is composed of smaller clasts and is less extensive than that of the bypass margin. If the shelf edge is characterized by shallow water lime sand shoals, rather than reefs as pictured, periplatform talus may be minor for both types of margin. Columnar sections show typical expected stratigraphic profiles. From McIlreath and James (1984, Fig. 12, 14).

Graptolite faunas from the Duo Lake Formation range from early Arenig (Early Ordovician) to mid-Wenlockian (early Late Silurian) in age. The Rabbitkettle-Duo Lake contact is clearly diachronous as mid-Ordovician conodonts have been collected from the former near the head of March Creek (# 110, Appendix 4). The age of the Steel Formation is not well constrained. One graptolite collection within the Steel Formation (#145, Appendix 4) is from the *leintwardensis-primus* Zone of late Ludlovian (mid-Late Silurian) age. Graptolites from immediately beneath the Steel Formation at another locality (#142, Appendix 4) are from the *rigidus* Zone of mid-Wenlockian (mid-Silurian) age. At a locality projected to lie 20 m above the Steel Formation (#400, Appendix 4) graptolites from the *thomasi* Zone of middle Early Devonian age were collected. The Steel Formation therefore is of definite Ludlovian age but may range from late Wenlockian to earliest Devonian.

Ordovician-Silurian strata of shale and chert facies typical of the Road River Group are found to the west of Mackenzie and Macdonald platforms (see Fig. 6) over most of the northern Cordillera. In the Yukon, strata similar in age and lithology to the Duo Lake Formation have been mapped or described in nearby Sheldon Lake (105J), Tay River (105K) (unit 3, Roddick and Green, 1961a,b), Flat River (95E), and Glacier Lake (95L) (Road River Formation; Gabrielse et al., 1973) map areas. Cecile (1982) described the Duo Lake Formation at its type section in Bonnet Plume Lake (106B), and in adjacent Sekwi Mountain (105P), Mount Eduni (106A), and Niddery Lake (105O) map areas.

Mid- to Upper Silurian strata that can be assigned to the Steel Formation are found in Sheldon Lake (105J), Tay River (105K) (within unit 3, Roddick and Green, 1961a,b; Gordey, 1983), and Niddery Lake (105O) (unit Sa, Cecile, 1981, 1984a; unit Sp, Abbott, 1983) map areas. In northern British Columbia, and in Pelly and Cassiar mountains, Ordovician black, graptolitic shale is widely overlain by tan weathering, burrowed, platy siltstone that is of mid-Silurian age (MacIntyre, 1983; H. Gabrielse, pers. comm., 1984; D.J. Tempelman-Kluit, pers. comm., 1984). This two-fold succession broadly corresponds to the Duo Lake and Steel formations.

The Duo Lake Formation is equivalent to shallow water carbonate of parts of the Haywire, Sunblood, Whittaker (Gabrielse et al., 1973), and Mount Kindle formations of Mackenzie Platform. The Steel Formation correlates with the upper part of the Sapper Formation in the northeastern part of Nahanni map area, and farther to the east to the shallow water dolostone of the uppermost Whittaker and lowermost Delorme formations of Mackenzie Platform.

Characteristics of shelf to offshelf facies changes

The transition zone between shelf and offshelf facies consisted of a carbonate shelf-edge and slope environment. McIlreath and James (1984) classified such transitions into two main types (Fig. 41). Those dominated by a gradual slope profile, or depositional margins, have gentle slopes that decrease basinward to merge with the flat basin floor. Those where the margin is atop a cliff or submarine escarpment so that sediments are transported directly from shallow to deep water through local, widely spaced channels or canyons are termed bypass margins. Both types of transition feature a zone of periplatform talus flanking the shelf edge. In the instance of bypass margins this may be spectacularly developed. Intraformational truncation surfaces and slump folds may be common. McIlreath and James (1984) also recognized that the lithology of the slope sediments would depend on whether the shallow water margin was formed by reef-building organisms or by lime sand shoals (Fig. 41).

In Nahanni map area many of the shelf-to-offshelf facies changes (Fig. 42) are not exposed. Details of part of the Lower Cambrian shelf edge (Sekwi Formation) are obscured beneath Flat Lake Syncline (Blusson, 1968) and the Ordovician to Devonian margin (Broken Skull, Whittaker, Delorme, Camsell, Sombre formations) is concealed beneath Black Wolf Syncline. In these instances periplatform talus was not observed in offshelf strata exposed nearest to the margin. This and the separation of several kilometres between exposed offshelf and shelf strata make evaluation of the type of shelf edge difficult.

The lower part of the Lower Cambrian Sekwi Formation along South Nahanni Anticline contains several beds of limestone conglomerate. Most clasts are composed of fine crystalline limestone like that of the enclosing beds. Slump

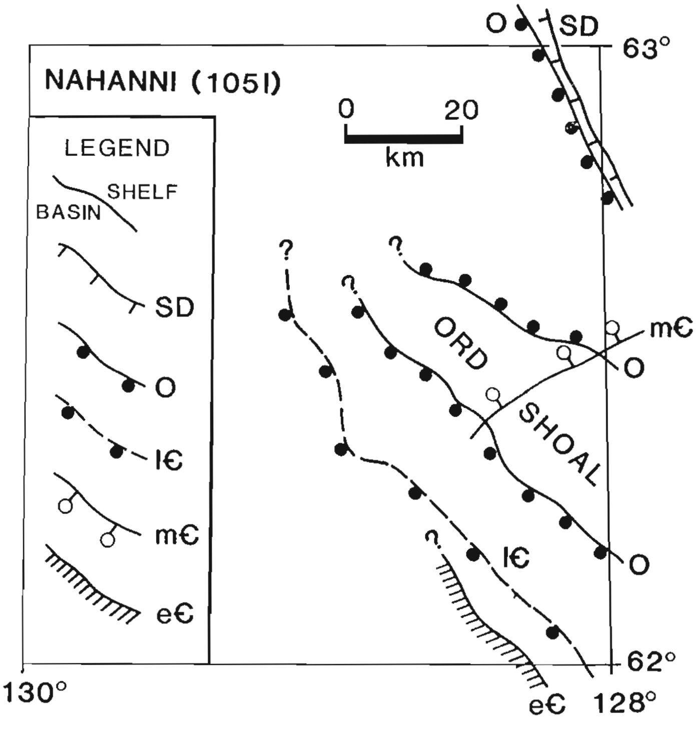

Figure 42. Position of Mackenzie Platform edge (carbonate-shale boundary) during the Early Cambrian (**eЄ**), Middle Cambrian (**mЄ**), Late Cambrian (**lЄ**), Ordovician (**O**), and Siluro-Devonian (**SD**). A shoal area coincident with South Nahanni Anticline is defined by the distribution of Ordovician to Early Silurian dolostone.

folds of the enclosing, thin-bedded nodular limestone are common. This part of the Sekwi Formation was likely deposited in a slope environment, the slump folds and conglomerates resulting from slope failure. Rare oolitic limestone and quartz sandstone clasts were probably contributed from the shelf edge. The position of the shelf edge during lowermost Sekwi time, and whether it was a bypass or depositional margin, are uncertain.

The Middle Cambrian Rockslide and Avalanche formations are correlatives and form the offshelf and shelf facies respectively of a depositional margin on the southwestern limb of South Nahanni Anticline. To the northwest, the entire Middle Cambrian interval consists of slope limestone of the Rockslide Formation, but this is gradually replaced to the southeast by thick-bedded, even-bedded dolostone of the Avalanche Formation. At the southeastern end of the anticline, the Middle Cambrian is represented only by dolostone. No periplatform talus of Avalanche dolostone was seen within the Rockslide Formation.

The Ordovician-Silurian margin (Haywire Formation) along South Nahanni River is obscured by structure and poor exposure. Well-bedded dolostone of the Haywire Formation on the southwestern limb of South Nahanni Anticline changes across South Nahanni River valley to poorly bedded or massive dolostone. Although there is no indication of its original fabric this latter dolostone could represent a shelf-edge reef facies. The dolostone in turn is partly correlative to argillaceous limestone of the Rabbitkettle Formation mapped in the same area. Only one small exposure of a carbonate debris flow was observed within the Rabbitkettle Formation. The lack of peritidal platform talus despite the proximity of shelf and offshelf lithologies, even allowing for minor foreshortening along some faults in the area, suggests a gradual sloping depositional margin.

On the northeastern flank of South Nahanni Anticline, the middle part of the Haywire Formation gradually changes to the northeast, from thick-bedded dolostone to presumably deeper water, thin-bedded limestone of the Broken Skull Formation. Although the facies change is shown as abrupt on the map there is an intermediate facies on the northeastern side of the anticline consisting of thick-bedded limestone of unknown thickness and distribution. The gradual facies change and lack of periplatform talus suggests a depositional margin. Reef facies are absent.

The Middle Devonian shelf edge is defined by the change across Black Wolf Syncline from highly fossiliferous limestone of the Headless Formation to poorly fossiliferous shaly limestone of the Funeral Formation. The two formations are laterally gradational, and no marginal reef facies are developed. The transition probably represents a gradual slope to deeper water, a depositional margin.

Assemblage II: Lower Devonian to mid-Mississipian turbidite basin sequence

In Middle to Late Devonian time the character of sedimentation changed abruptly when shale transgressed across Mackenzie Platform far to the east. At the same time to the west, chert conglomerate, sandstone, and shale accumulated in a number of submarine fan complexes. The regional boundary between the western coarse clastics and eastern fine clastics is laterally gradational and occurs in Nahanni map area at about the South Nahanni River. The Earn Group is characterized by these Upper Devonian and Lower Mississippian clastic strata. It also includes Lower to Middle Devonian chert and shale that rests above the Steel Formation. The Earn Group is overlain by normal marine clastic shelf sediments of the Tsichu formation[1].

Earn Group

The Earn Group was first proposed by Campbell (1967) for chert, conglomerate, and limestone in Glenlyon map area (105L), about 250 km northwest of the Nahanni area. In Nahanni map area two regionally mappable formations compose the Earn Group (Gordey et al., 1982). The lower one, called the Portrait Lake Formation, locally includes offshelf Lower Devonian strata and ranges into the Upper Devonian. Gun-blue weathering siliceous shale and chert are dominant lithologies, but chert quartzarenite and wacke, pebbly mudstone, and chert-pebble conglomerate occur locally. The upper Earn Group, or Prevost Formation, of latest Devonian to mid-Mississippian age overlies the Portrait Lake Formation unconformably and is composed of brown weathering shale and thick members of sandstone and chert conglomerate. Stratigraphic relations at the base of the Earn Group are complicated and range from diachronous to unconformable (see Portrait Lake Formation). It is overlain unconformably(?) by quartz sandstone and shale of the mid-Mississippian "Tsichu" formation.

Portrait Lake Formation (**DP**)(new). The Portrait Lake Formation, comprising shale, chert, and minor sandstone and conglomerate is the oldest unit that extends across the entire map area. The best exposures occur along Margaret Syncline, north of O'Grady Batholith, in the general vicinity of Placer and Don creeks, and 18 km southwest of Pelly River pluton. The gun-blue to black weathering colour of the formation contrasts sharply with underlying light coloured carbonates of the Funeral, Sapper, and Haywire formations in the northeast and with the orange weathering Steel Formation which underlies it to the west.

Type section - section 45 - 63°8.0′N;130°1.5′W. The type section is located in southeastern Niddery Lake map area, about 22 km northwest of the lake after which the formation is named. The section (Fig. 43A), totalling 897 m, is divisible into three members; lower and upper fine clastic members are

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[1] "formation" retains lower case "f" to indicate informal status of map unit.

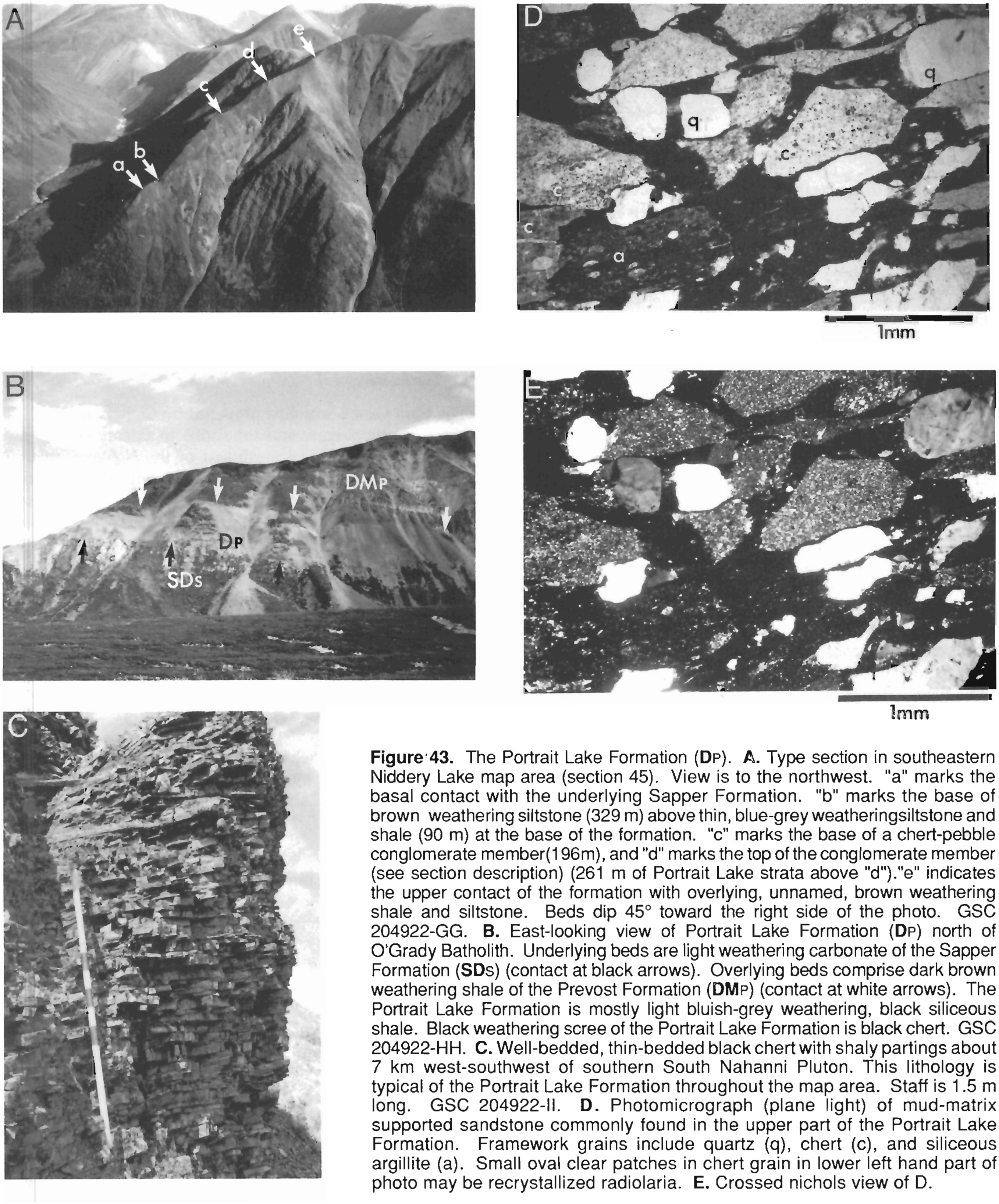

Figure 43. The Portrait Lake Formation (**D**P). **A.** Type section in southeastern Niddery Lake map area (section 45). View is to the northwest. "a" marks the basal contact with the underlying Sapper Formation. "b" marks the base of brown weathering siltstone (329 m) above thin, blue-grey weatheringsiltstone and shale (90 m) at the base of the formation. "c" marks the base of a chert-pebble conglomerate member(196m), and "d" marks the top of the conglomerate member (see section description) (261 m of Portrait Lake strata above "d")."e" indicates the upper contact of the formation with overlying, unnamed, brown weathering shale and siltstone. Beds dip 45° toward the right side of the photo. GSC 204922-GG. **B.** East-looking view of Portrait Lake Formation (**D**P) north of O'Grady Batholith. Underlying beds are light weathering carbonate of the Sapper Formation (**SD**s) (contact at black arrows). Overlying beds comprise dark brown weathering shale of the Prevost Formation (**DM**P) (contact at white arrows). The Portrait Lake Formation is mostly light bluish-grey weathering, black siliceous shale. Black weathering scree of the Portrait Lake Formation is black chert. GSC 204922-HH. **C.** Well-bedded, thin-bedded black chert with shaly partings about 7 km west-southwest of southern South Nahanni Pluton. This lithology is typical of the Portrait Lake Formation throughout the map area. Staff is 1.5 m long. GSC 204922-II. **D.** Photomicrograph (plane light) of mud-matrix supported sandstone commonly found in the upper part of the Portrait Lake Formation. Framework grains include quartz (q), chert (c), and siliceous argillite (a). Small oval clear patches in chert grain in lower left hand part of photo may be recrystallized radiolaria. **E.** Crossed nichols view of D.

separated by a middle member of chert conglomerate. The lower member, 419 m thick, consists mostly of dark brown weathering, silty shale and shale in beds 0.1-0.3 m thick. Locally the rock shows dark grey and black lamination. The basal 90 m of the member comprises dark to light bluish-grey weathering, black platy siltstone. Its basal contact with underlying black silty limestone of the Sapper Formation is poorly outlined in scree. From 168 to 194 m above its base the lower member includes black coarse grained chert-quartz sandstone in beds 0.3 to 0.4 m thick. Similar sandstone occurs from 237 to 240 m and above the 240 m level as rare thin beds.

The middle member, 196 m thick, consists of black weathering, massive pebble conglomerate. Clasts are composed of chert and siliceous argillite which are mostly grey to black; some are light grey to white. They are commonly well rounded, averaging about 3 cm in diameter, but range up to 10 cm across. Heavy growth of black lichen obscures primary fabric, but the conglomerate appears to be clast supported and moderately sorted. The matrix is black to grey, fine to coarse grained chert-quartz sandstone. The middle member is in sharp contact with silty shale of the lower member.

The upper member comprises 261 m of light gun-blue weathering, black platy siltstone. Grey weathering, black, coarse crystalline limestone forms a 0.4 m thick bed about 893 m above the base of the section. A 10 m thick quartz porphyry sill(?) intrudes the middle and upper members at their contact. The top contact of the formation with overlying unnamed rust-brown weathering, laminated quartz siltstone is sharply outlined in scree. Detailed geological mapping in the vicinity by Abbott (1982) indicates that this upper contact is unconformable. This contact at the type section may also be unconformable (Abbott, 1982).

Other areas. Southeastward from the type section in Nahanni map area, brown shale and siltstone of the lower member is not represented. Coarse clastics which may correlate with the middle member occur locally. In the northeastern half of Nahanni map area the Portrait Lake Formation usually ranges from 160 to 280 m thick (sections 41, 43, 47, 49, 50, and 53). Extremes in formation thickness were recorded west of Broken Skull River at 39 m (section 35) and at 563 m (section 54) in westernmost Glacier Lake map area. Recessive blue-grey to light grey weathering, black siliceous shale and siltstone (Fig. 43B,C) are the dominant lithologies. Resistant, thin-bedded, well-bedded black chert with shaly partings forms rare members generally less than 5 m, but locally up to 40 m thick.

In the southwestern half of the map area, thicknesses of the formation range from 119 to 321 m (sections 9, 13, 14, and 16). The main lithologies are bluish-grey weathering, black siliceous shale and bluish-grey weathering, black thin-bedded chert. The chert is not evenly interbedded with the shale, but tends to form discreet members to several tens of metres thick. Southwest of a line joining the headwaters of Don and Placer creeks, chert is dominant or in equal proportion to shale. In that area, mud-matrix chert sandstone with rare floating quartz grains and small shale clasts is a minor, but common constituent in the upper part of the formation (Fig. 43D,E). This sandstone is well exposed at the 6367 foot (1941 m) peak (15 km northwest of Summit Lake), and in the area 6 km to the northeast. At likely the same stratigraphic level 15 km southwest of Pelly River pluton (section 9), black weathering matrix supported pebbly mudstone is about 90 m thick. Most clasts comprise well-rounded dark grey to black chert and shale. These are up to 3 cm in diameter and randomly oriented. Rare clear quartz grains float within the mud matrix. Small scattered carbonized plant fragments are found within the muddy clastic rocks at most localities.

The basal contact of the Portrait Lake Formation is diachronous, and is defined at the lowest occurrence of gun-blue to grey weathering siliceous siltstone, shale, and chert. From northeast to southwest across the map area the base of the formation rests on different formations and is of different ages as follows. Near Broken Skull River, the basal Portrait Lake Formation is Eifelian or younger as it conformably(?) overlies the Eifelian Nahanni Formation. Toward the southwest it sharply and unconformably overlies carbonate of the Funeral, Grizzly Bear, Sapper, and locally Haywire formations (see Fig. 12 and 25). Farther to the southwest near Summit Lake, the base rests conformably above orange weathering mudstone of the Steel Formation. There the basal Portrait Lake has yielded Early Devonian graptolites (Appendix 4). At this last locality the formation clearly includes chert and shale correlative with Lower Devonian carbonate strata (Sapper Formation) which it unconformably overlies to the northeast (see Fig. 12). The extent of the marked sub-Portrait Lake (sub-Frasnian?) unconformity of northeastern Nahanni map area (Fig. 12) both to the southwest and northeast is uncertain. To the southwest the hiatus cannot be proven within monotonous poorly dated black shale and chert. To the northeast, it may exist but is also not proven within shale and chert that appears (at section 35) to overlie the Nahanni Formation conformably.

Regional barite. The Portrait Lake Formation is host to regionally extensive bedded barite. Although age control is not strict or widespread enough to be certain of a unique age of mineralization (see below), many occurrences are found near the top of the formation, several metres above muddy chert-quartz sandstone and conglomerate (Abbott, 1977[1]; Morganti, 1979). This barite horizon is described by Morganti (1979, p. 73-75) as locally exceeding 25 m in thickness. In most sections it is represented by barite concretions less than 1 cm in diameter which occur within carbonaceous mudstone. The concretions are typically found over a 50 cm to 5 m thick stratigraphic interval. The thickest barite occurrence within the map area, known as the Oro (50 m thick), occurs 30 km south-southwest of Mount Wilson. This occurrence underlies pebbly mudstone and chert-wacke lithologies (see section on Environment, age, and correlation below).

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[1] Handout presented at Selwyn Basin Workshop, Vancouver.

Prevost Formation (**DMP**)(new). The Prevost Formation comprises brown weathering shale, resistant grey to grey-brown weathering chert pebble conglomerate, and dark grey to black chert-quartz sandstone. It rests sharply above gun-blue weathering siliceous shale and chert of the Portrait Lake Formation. Exposures in the northwestern part of the map area are extensive; the best outcrops occur southwest of the headwaters of Placer and Don creeks and south of Pelly River pluton. Black lichen obscures sedimentary structures, particularly the internal fabric of the conglomerates. The Prevost Formation is overlain by resistant, clean quartz sandstone and black shale of the Tsichu formation.

Type section - section 15 - 62°26.8'N;129°18.1'W. The type section is located about 5 km west-southwest of the divide between Placer and Don creeks, about 50 km southeast of the headwaters of the Prevost River after which the formation is named. It is the thickest (555 m), the least structurally complicated, and most representative section of the formation containing both coarse grained and fine grained facies. Unfortunately it includes neither upper nor lower formational contacts. At no locality where formational boundaries are exposed, is there sufficient structurally undisturbed thickness with enough lithological variation for a type section. Reference sections for the top and bottom formation contacts are described separately. The base of measurement at the type section is difficult to locate precisely. It is best located by measuring down from prominent units higher in the section.

For descriptive purposes the type section is divided into three members: 1) a lower member of mostly sandstone; 2) a middle member of shale and siltstone; and 3) an upper member of sandstone and conglomerate. The lower member, 160 m thick, consists of grey weathering, dark grey, medium to coarse grained chert-quartz sandstone and rare chert granule to pebble conglomerate. Beds average 0.8 m in thickness, and rarely show normal size grading. Suspended shale clasts to 2 cm in diameter are rare. Units of shale and siltstone occur from 27 to 29 m and from 131 to 135 m above the base of measurement.

The middle member, 90 m thick, comprises brown weathering, dark grey, thin-bedded shale and siltstone. The strata are commonly laminated in shades of black and light grey. Parallel laminated, fine to medium grained chert-quartz sandstone forms rare interbeds 0.2 m thick.

The upper member comprises massive, coarse grained, chert-quartz sandstone and chert-pebble conglomerate totalling 305 m. From a distance this member appears thick bedded because of a thick parting, but at close view bedding is not apparent. The coarsest clastics occur from 392 to 402 m above the base of the section. This interval consists of clast-supported, poorly sorted cobble conglomerate that contains well-rounded clasts up to 0.3 m across. Grey chert (25%) and grey to white, fine grained and coarse grained quartz sandstone (75%) are the clast lithologies (see Fig. 45, locality 2). The top 14 m of the upper member comprises grey to blue-grey weathering, thinly interbedded shale and fine to medium grained sandstone. On their bases the sandstone beds exhibit abundant groove and prod casts. These beds also commonly display ripple cross-lamination or parting lineation. Above the top of measurement, and in sharp contact with the upper member, there are at least 27 m of grey weathering chert-pebble conglomerate with clasts up to 0.1 m across.

Reference sections for the base and top of the formation. Throughout the map area the contact between the Portrait Lake and overlying Prevost formations is marked by a sharp change in colour and lithology. Gun-blue or grey weathering shale and chert, or locally chert-quartz wacke of the Portrait Lake Formation is overlain sharply by brown weathering shale and minor sandstone of the Prevost Formation. Section 41 is chosen as a reference section for the basal contact of the Prevost Formation. Unfortunately, at all localities known to include basal Prevost beds, this contact is defined in scree. At the reference section, brown weathering, blue-grey shale scree of the Prevost Formation rests sharply against dark blue-grey weathering chert scree of the uppermost Portrait Lake. The sharp contact and elsewhere the local absence or thinning of the Portrait Lake Formation (e.g. immediately northeast of South Nahanni River; section 16; 7 km north of Summit Lake) suggest the contact is regionally unconformable. Pre-Prevost or even syn-Prevost erosion is indicated by the occurrence of blocks of Grizzly Bear limestone within Prevost shale east of Bologna Creek (for location see Appendix 4, fossil locality #408).

The upper contact of the Prevost Formation with the Tsichu formation is poorly exposed and was examined at only two localities. One of these, section 20, is provisionally chosen as a reference section for this contact. There, a few metres of brown weathering, black shale scree assigned to the Prevost Formation is exposed beneath overlying grey-white quartz sandstone scree of the Tsichu formation. At the second locality, section 17, the Earn-Tsichu contact is provisionally defined in very fine scree at an upward change from brown weathering grey shale to dark grey siliceous shale. At this section (see section 17, Appendix 4) quartz sandstone appears higher within the Tsichu formation than at the reference section. The Earn-Tsichu contact is presumed to be unconformable (see section on Tsichu formation).

Other areas. Lithologies elsewhere are the same as those at the type section but the proportion of fine to coarse clastics is variable. Most well-exposed sections comprise up to several hundred metres of mostly shale and siltstone or conversely, consist of thick intervals of coarse clastics enclosed in shale (Fig. 44A). Thick intervals of evenly interbedded sandstone and shale are rare. Conglomerate was not noted northeast of South Nahanni River. There the Prevost Formation comprises shale and siltstone with rare interbeds of fine to medium grained sandstone. The basal 100 m of the formation is everywhere dominated by shale and siltstone.

Conglomeratic mudstone and mud-matrix conglomerate are distinctive lithologies not present at the type section. About 9.4 km northeast of the junction of Pelly River and Don Creek, these form a member at least 70 m thick that rests above coarse, relatively clean chert-pebble conglomerate. The member comprises matrix to locally clast supported conglomerate containing rounded clasts averaging 2 to 3 cm in diameter, but ranging up to 3 m across (Fig. 44D). Clasts less than 5 cm in diameter are mostly grey to black chert and minor, fine grained, white quartz sandstone. Those of greater size make up 10 percent of the clasts and consist mostly of gritty quartz sandstone. These may reach up to 0.5 m in diameter. Rare blocks of shale, some that are well rounded, form the largest clasts, reaching up to 3 m across. The shale clasts are uniformly grey to black and have a distinctive wide-spaced white lamination.

Because the base and top of the Prevost Formation are not exposed at a single locality, and there are no internal markers, its total thickness cannot be measured. An estimate of 900 m aggregate thickness seems reasonable, considering the 550 m thickness at the type section and the extent and distribution of exposure elsewhere.

Summary of sedimentary features. The coarse clastics of the Prevost Formation, well represented at the type section, occur in units up to several hundred metres thick overlain and underlain by shale, siltstone and minor sandstone (Fig. 44A). Their distribution suggests they form a complex of several(?) southeast-trending tongues at various levels both vertically and laterally within the fine clastics. Sedimentary features (Fig. 44) include massive bedding, graded bedding, rare beds showing Bouma sequences (see section on Yusezyu Formation), suspended outsize shale clasts, horizons of chaotic (slumped) bedding, and large groove casts. Parting lineation, groove and prod casts, and rare flute casts occur locally in thinly interbedded fine grained sandstone and shale. Local coarse mud-matrix supported conglomerate may have originated as debris flows. Sedimentary features in predominantly shale successions include thin graded siltstone beds and rare thin to thick beds of graded sandstone. Some of the latter show complete Bouma sequences and outsize shale clasts.

Petrography and provenance. Pebble counts of Prevost conglomerates at seven localities are summarized in Figure 45. A minimum of 25 percent to 100 percent of the conglomerate clasts are chert. Grey and black chert occur in subequal amounts followed by less common green-grey, light grey, and white varieties. Dark grey to black siliceous shale and shale clasts compose up to 40 percent but usually below 10 percent of the clasts. Sandstone clasts, ranging from fine grained to gritty, coarse grained quartz sandstone typically range from 5 percent to 20 percent, but at one locality compose up to 75 percent of clasts counted. A small proportion of the larger quartz grains are opalescent blue. The abundance of sandstone clasts is a function of clast size, the coarser conglomerates containing the greater proportion.

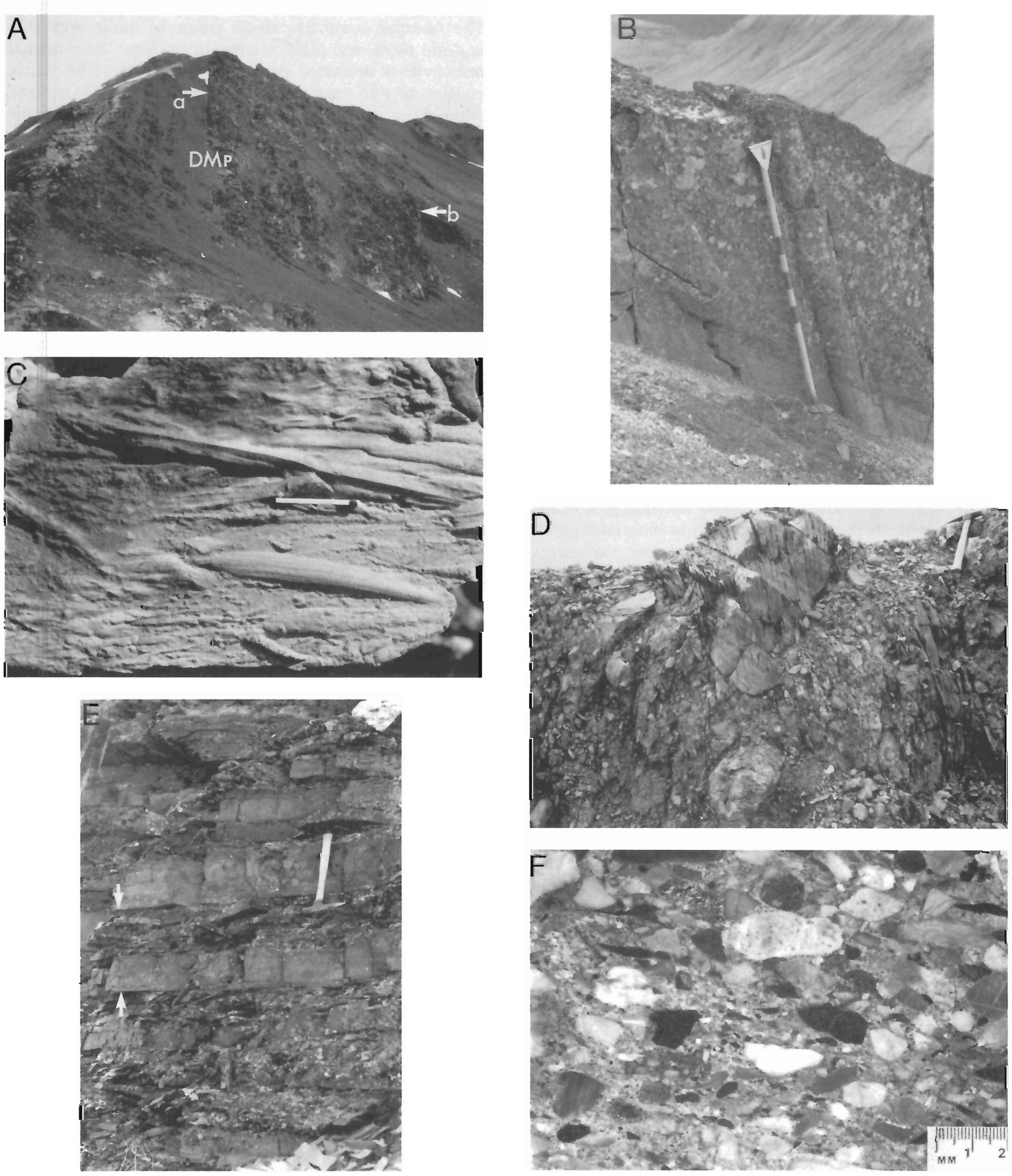
Results from petrographic examination of Prevost sandstones are presented in Figure 46 (see also Fig. 44). The sandstones consist of subequal proportions of chert and quartz, a maximum of 1 percent feldspar, rare siltstone and shale fragments, and trace tourmaline, zircon, and detrital muscovite. The quartz occurs as both monocrystalline and polycrystalline grains. The latter type has internal polygonal to serrate grain boundaries and forms one half to one tenth of the total quartz present. Undulose extinction is common. In hand specimen a small proportion of quartz has an opalescent blue colour. Chert grains range from pure microcrystalline quartz to similar grains crowded with needles of sericite. Rare small spherules of recrystallized quartz, perhaps originally radiolaria, are also present in some chert grains. The feldspar comprises small grains of albite with thin uniform twins, and plaid-twinned microcline. Rare detrital muscovite is deformed between other grains. The matrix consists of fine grained felsic minerals (mostly(?) quartz), white mica, and unidentified patches and seams of opaque material. In many specimens the degree of compaction, grain interpenetration, and silica cement overgrowth is so great that there is little original matrix preserved. Sorting is generally moderate, but ranges from poorly sorted to very well sorted. The roundness of framework grains varies from angular to subrounded for the chert and from angular to very well rounded for quartz. Wackes are slightly less abundant than arenites for those thin sections examined.

Eleven sandstone clasts from Prevost conglomerate were examined in thin section. They consist essentially of quartz, up to 3 percent feldspar, and traces of detrital muscovite, tourmaline, and zircon. The matrix comprises unidentified, fine grained, low birefringent minerals (mostly quartz?) that compose from 0 percent to 25 percent of the rock. Framework quartz grains are mostly monocrystalline. However, polycrystalline quartz with irregular serrate internal grain boundaries may compose up to 12 percent of the quartz present. The feldspar is unaltered and comprises both albite in small even-twinned grains and plaid-twinned microcline. The muscovite is deformed between other grains. The sandstone is moderate to well sorted, and grain roundness ranges from subrounded to well rounded. In fine grained samples compaction has caused interpenetration and suturing of grains, so that original grain shapes are not recognized. In coarse grained examples, original well-rounded grain boundaries are outlined by lines of dark inclusions mantled by clear silica overgrowth.

A sedimentary terrane underlain by shale, chert, and quartz sandstone was the source of detritus for Prevost Formation clastics. All of the nonchert detritus within Prevost sandstone including quartz, feldspar, muscovite, zircon, and tourmaline, are of at least second cycle derivation. Their characteristics and relative abundance show they derive from sandstone identical to that found as sandstone clasts within Prevost conglomerate (for further discussion see section on Tectonics).

Environment, age, and correlation of Earn Group strata. The Portrait Lake Formation was deposited in a quiet sub-wavebase setting which, at most times, featured low clastic influx and deposition of siliceous shale and chert. Chert-pebble conglomerate, chert quartzarenite, chert-quartz wacke, and pebbly mudstone were deposited by sediment gravity flows. These clastics and bedded barite in the upper part of the formation are the first indication of Devonian tectonic instability in the Selwyn Basin area.

The characteristics of the Prevost clastics are indicative of a submarine fan setting (eg. Fig. 34). The local even interbedding of sandstone and shale, the presence of Bouma sequences and outsize shale clasts in some sandstone beds, and local sole marks suggest deposition of much of the detritus from sediment gravity flows. A high proportion of coarse clastics occur as thick (200 m) members typically with erosive bases. These members were likely deposited within submarine fan channels. Shale and some sandstone were deposited as lateral equivalents of the coarse channel deposits. In more distal areas shale formed the normal background sediment. The three-dimensional tongue-like



distribution of coarse facies is consistent with rapid shifting of channels. The northwestern trend of the channels concurs with the east- to southeast-directed paleoflow determined by sole marks and other features (Fig. 47).

Fossils from the Portrait Lake Formation include graptolites and conodonts which range in age from Early Devonian to late Late Devonian (mid-Famennian). The age of the clastics that occur within the upper part of the formation

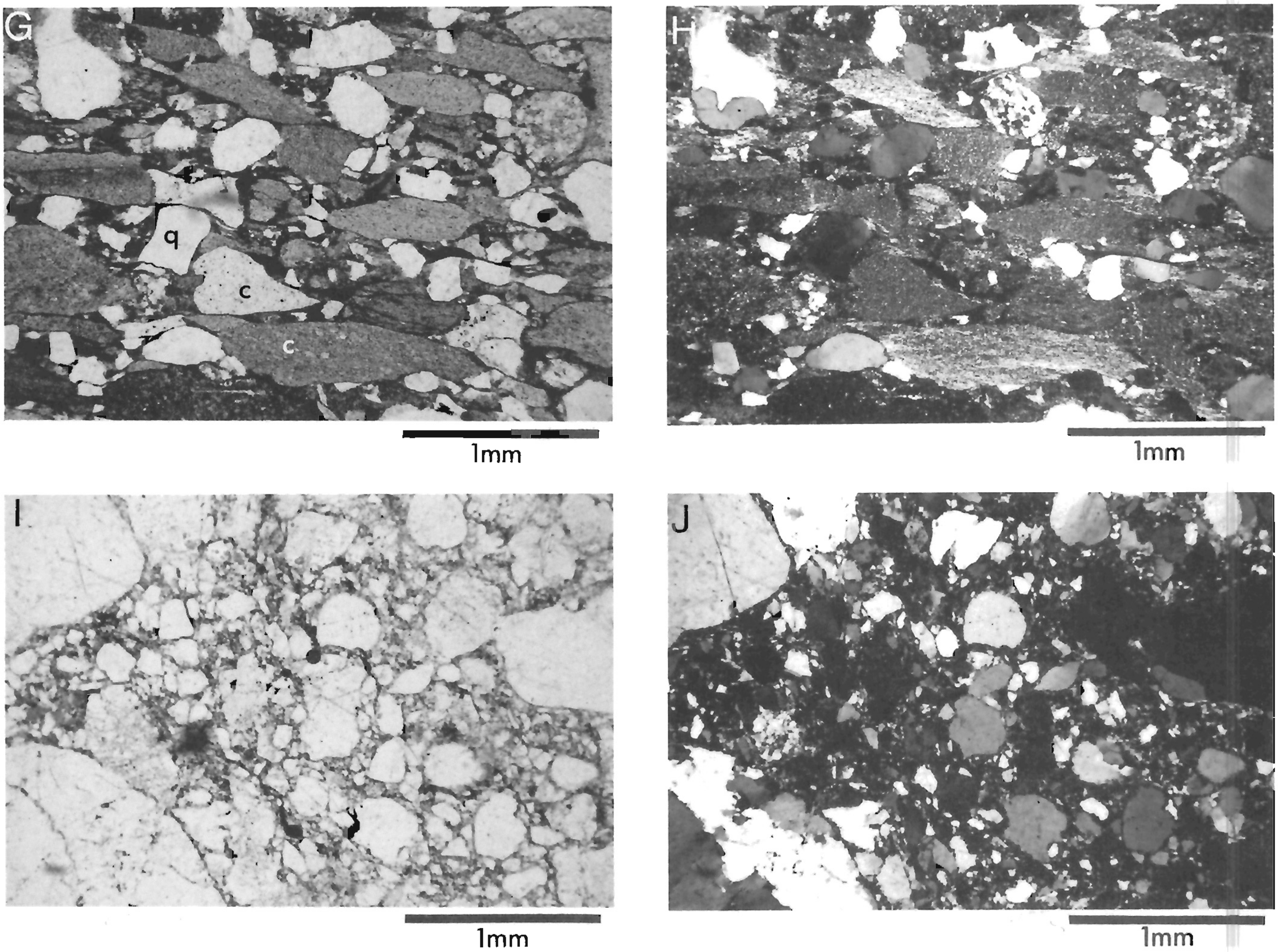


Figure 44. Sedimentary features of the Prevost Formation (**DMp**). **A.** Thick member (150 m) of quartz-chert sandstone and chert-pebble conglomerate with little interbedded shale, overlain and underlain by fine clastics. A sharp erosional base is indicated by "a". "b" shows the approximate top of the coarse thick-bedded interval. The thick sandstone body is interpreted as a submarine fan channel deposit. The photo is a southeast-looking view of a ridge 4 km northwest of the 7171 foot (2186 m) peak. GSC 204922-JJ. **B.** Large groove cast at location "a" in Figure 44A. Staff is 1.5 m long. GSC 204922-KK. **C.** Groove casts on talus block, from interbedded chert-quartz sandstone and shale. The photo was taken 8 km northwest of Summit Lake. Match stick is about 5 cm long. GSC 204922-LL. **D.** Mud-matrix supported, debris flow conglomerate. Large clast in upper centre of photo is slate with a cleavage parallel to the regional slaty cleavage. Other clast types include pebbles to cobbles of chert, and cobbles of coarse grained, gritty quartzose sandstone. The outcrop is located along a ridge, 9.5 km northeast of the junction of Pelly River and Don Creek. GSC 204922-MM. **E.** Interbedded, thick-bedded, chert-quartz sandstone and shale. The base and top of one graded bed are shown by arrows. The outcrop is located 7 km west-southwest of southern South Nahanni Pluton. GSC 204922-NN. **F.** Close-up of typical Prevost chert-pebble conglomerate (sawn surface). Clasts are mostly grey, but range from white to black. Matrix is chert-quartz sandstone. GSC 204922-OO. **G.** Photomicrograph (plane light) of chert-quartz sandstone. Chert is indicated by "c". Quartz is indicated by "q". The chert is probably derived from the Road River Group. The quartz grains are likely derived from the Hyland Group (see photo I). GSC 1993-002O **H.** Crossed nichols view of G. GSC-002J **I.** Photomicrograph (plane light) of gritty quartzose sandstone cobble from the Prevost conglomerate. Clasts of such composition are common in coarse Earn Group clastics, and probably derive from the Hyland Group (see Fig. 30G). GSC 1993-002F. **J.** Crossed nichols view of I. GSC 1993-002A

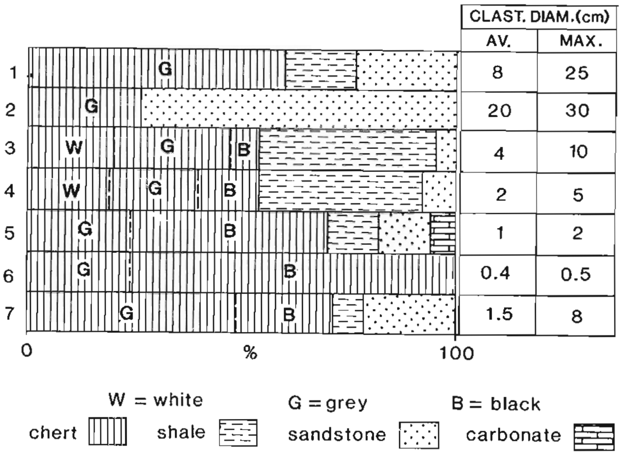


Figure 45. Pebble counts of Prevost Formation conglomerates. Sandstone clasts vary from fine to coarse grained quartzarenite to wacke, and are lithologically like Hyland Group sandstone. Chert and siliceous shale clasts possibly derive from Duo Lake or lower Portrait Lake or equivalent strata. The origin of rare carbonate clasts is uncertain; they may derive from the Hyland Group or Rabbitkettle Formation. All counts are based on 50 or more clasts selected at random over a 1 to 2 m stratigraphic interval. The location of pebble count stations is shown on Figure 47.

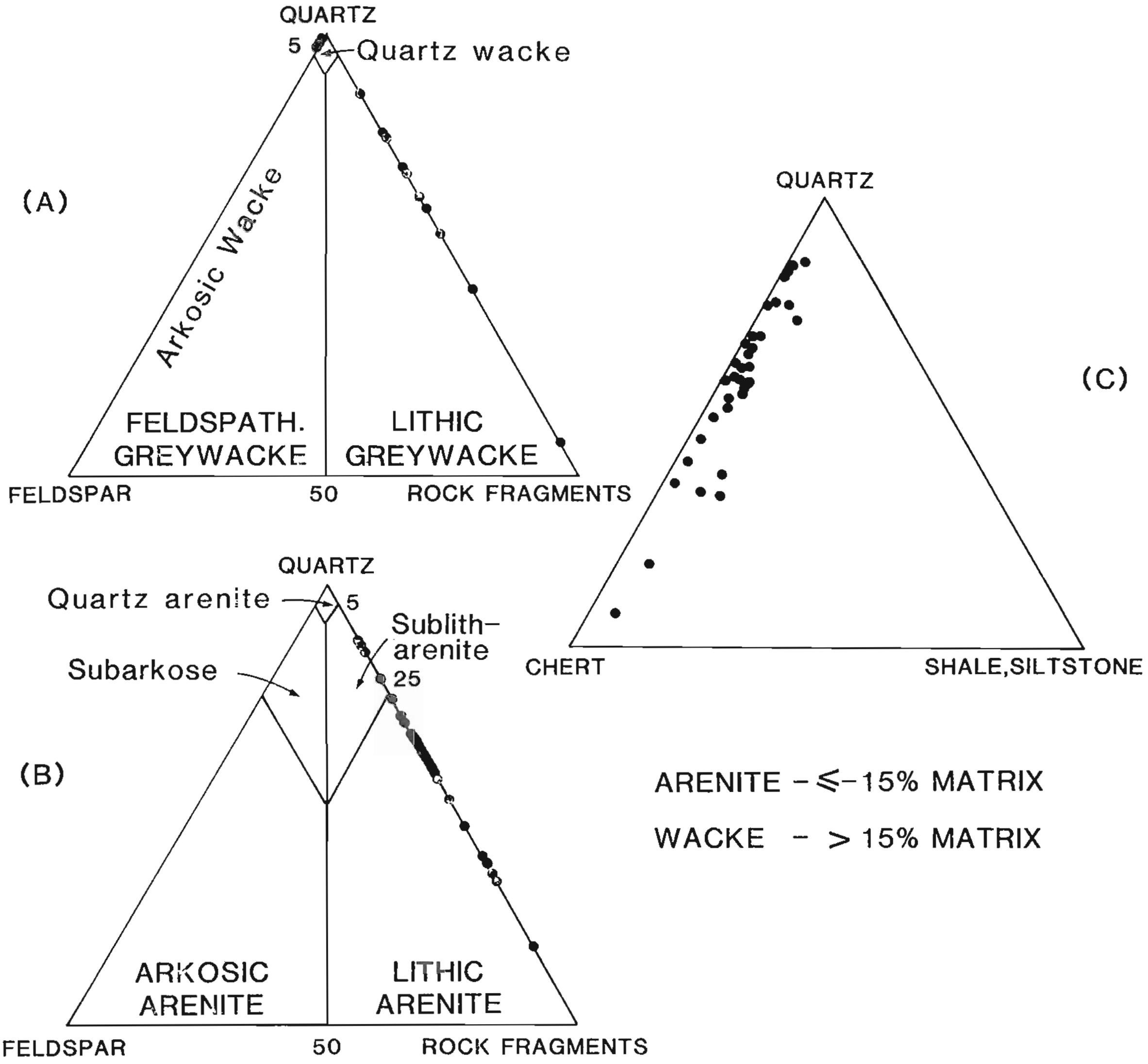


Figure 46. Composition of Prevost Formation sandstones (n=33) based on thin section point counts (500 points per section) of randomly selected specimens. The sandstones comprise lithic arenite, sublitharenite, and lithic greywacke (Pettijohn et al., 1973) ((A)=wacke; (B)=arenite). Feldspar, tourmaline, and zircon are found in trace amounts. The matrix of fine grained felsic minerals and opaques ranges from 8 to 25 percent. The data points shown in the quartz wacke field represent quartz sandstone clasts (n=3) in Prevost conglomerate. In composition and texture they are like sandstone of the Yusezyu Formation (see Fig. 30H, 31). In (C) is shown the proportions of chert, shale and siltstone lithic clasts, and quartz.

is not tightly constrained, but is considered Frasnian. At a locality in southeastern Niddery Lake map area, a Frasnian ammonoid was uncovered from scree above Portrait Lake chert-pebble conglomerate (Gordey et al, 1982, locality 26). On the basis of conodont data from nine barite occurrences, many outside the map area, Dawson and Orchard (1982) indicate at least two intervals of barite deposition within the Portrait Lake Formation. The older is of late Middle Devonian (Givetian) age and occurs near Macmillan Pass. The presence of this horizon within Nahanni map area is uncertain, but the age of the ORO occurrence mentioned above may be similar. The younger, this one within the map

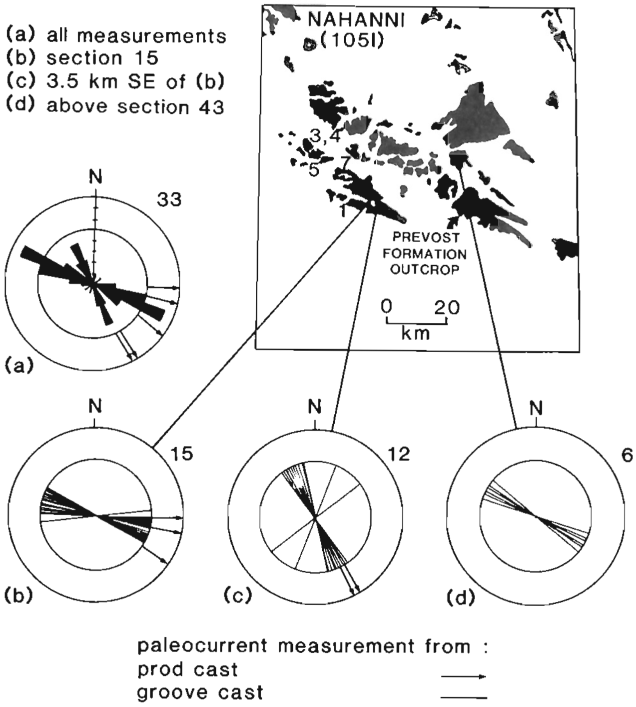


Figure 47. Paleocurrent data for the Prevost Formation. Diagram (a) includes all data (rose diagram of nondirectional structures). (b) to (d) are from locations shown on the index map, which shows Prevost Formation outcrop. Parting lineation was seen locally at (b) to be of the same orientation as grooves. Data, although meagre, indicate dominantly east-southeast to southeast paleoflow. Numbers 1 to 7 show pebble count localities shown on Figure 45.

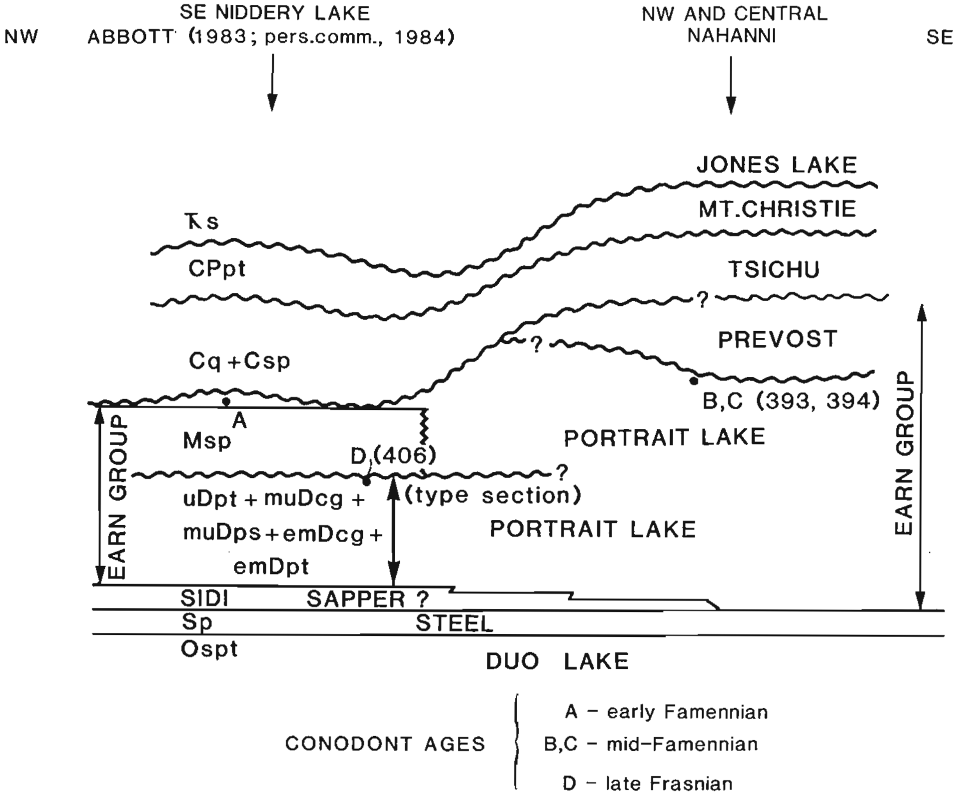


Figure 48. Speculative diagrammatic correlation of Earn Group strata of northwest and central Nahanni map area and southeastern Niddery Lake map areas. Map unit symbols are those of Abbott (1983). A, B, C, and D are fossil localities described in the text; the relative ages of these fossils indicate that ripple cross-laminated siltstone, sandstone, and shale (Msp) in the Niddery Lake area, previously correlated with the Prevost Formation (Gordey et al., 1982), are older and equivalent to Portrait Lake beds.

area and described previously, is an early Late Devonian (Frasnian) horizon that is of regional extent. It likely corresponds to one of the stratiform Pb-Zn-Ba horizons at Macmillan Pass. The age of the sub-Portrait Lake unconformity is uncertain, but it is above beds as young as late Eifelian and may correspond to a regional sub-Frasnian (sub-Canol Formation) unconformity in northern Yukon and northern Mackenzie Mountains (see Fig. 12) (Aitken et al., 1982).

Two fossil collections were made from the Prevost Formation at widely separated localities in the Nahanni area. Both come from clasts and so provide only an older age limit for the formation. One (Grizzly Bear Formation? clast) contains Middle Devonian, Eifelian (*australis* Zone) conodonts; the other (Appendix 4), contains conodonts of Late Devonian (late Frasnian to early Famennian) age. The underlying Portrait Lake Formation contains conodonts as young as mid-Famennian (*marginifera* to *velifera* zones). The upper age limit for the Prevost Formation is uncertain but the overlying Tsichu formation contains conodont faunas as old as Kinderhookian (Early Mississippian) (J.G. Abbott, pers. comm., 1984). The age of the Prevost Formation is therefore weakly constrained as latest Devonian to earliest Mississippian.

In southeastern Niddery Lake (105O) map area, Earn Group and younger strata have been mapped by Abbott (1983). Speculative correlation with strata in Nahanni map area is shown in Figure 48. The correlation is based on three critical fossil localities. In the Niddery Lake area, early Famennian (early Late Devonian) conodonts (M.J. Orchard, pers. comm., 1984) have been collected by J.G. Abbott (pers. comm., 1984) immediately above a thick unit of ripple cross-laminated siltstone, sandstone, and shale (Abbott's unit Msp, or upper Earn Group, 1983). In Nahanni map area, two collections from high in the Portrait Lake Formation are mid-Famennian, slightly but demonstrably younger. Contrary to previous correlation by Gordey et al. (1982) of Prevost strata with this ripple cross-laminated unit, it now seems that the Prevost Formation is younger, and may not even be represented in the southeastern Niddery Lake area (Fig. 48). At its type section, the Portrait Lake Formation is as young as late Frasnian (section 15, locality 406) whereas the formation as mapped in Nahanni map area includes younger beds (Fig. 48).

The Lower and Middle Devonian parts of the Portrait Lake Formation correlate with all or part of shallow water Mackenzie Platform carbonates of the Delorme, Camsell, Sombre, Arnica, Natla, Landry, Headless, and Nahanni formations (Fig. 12). Clastic formations correlative with Devono-Mississippian parts of the Earn Group blanket the northern Cordillera (Fig. 8). These include the Giventian Hare Indian, Frasnian Canol (Aitken et al., 1982), and Frasnian to early mid-Famennian Imperial formations (Chi and Hills, 1974) of northern Mackenzie Mountains and northern Yukon. The Besa River Formation (Pelzer, 1966) and the Fort Simpson Formation (Belyea and McLaren, 1962) are correlatives in northern British Columbia and western Northwest Territories respectively. MacIntyre (1983) and Jefferson et al. (1983) describe correlative chert-pebble conglomerate, shale and sandstone, and stratiform barite-sulphide deposits of the Gataga District of northeastern British Columbia. In Pelly Mountains, clastic strata and felsic volcanic rocks of Earn Group age have been described by Gordey (1981b) and Mortensen (1982).

Provenance and tectonic significance of the Devono-Mississippian Earn Group. Coarse clastics of the Earn Group reflect uplift of a sedimentary terrane composed of quartz sandstone, shale, and chert, all lithologies that are found in older Selwyn Basin strata. The chert of the Road River Group and quartz sandstones of the Hyland Group are likely candidates to have underlain the source area(s). There is a remarkable likeness between Yusezyu Formation sandstones and sandstone cobbles found in the Prevost Formation, a similarity that extends to thin-section scale. The abundances and compositions of framework and accessory grains, the types of feldspar and their style of twinning, and even matrix are very much alike.

The nearest possible source area for the clastics is in northeastern Tay River map area (Fig. 49). This is the nearest location in which Road River and Hyland Group strata were eroded in the Late Devonian. There, Earn Group clastics locally rest directly above deeply eroded block-faulted Hyland Group sandstone. The Earn strata include nonmarine(?) debris-flow and mud-matrix conglomerates carrying chert, gritty sandstone, and rare black limestone blocks to several metres in diameter. The sandstone and limestone blocks are identical to lithologies found in the immediately underlying Hyland Group. On adjacent fault blocks, erosion was insignificant and Road River cherts are not much removed beneath Earn Group strata. The faults recognized within this area may reflect synsedimentary tectonics at the edge of a much larger uplift, an uplift that may have extended well to the north into Lansing map area (Fig. 49).

A Devono-Mississippian submarine(?) conglomerate channel complex mapped in southwestern Niddery Lake map area (Fig. 49) (Blusson, 1974; M.P. Cecile, pers. comm., 1987) extends into northern Sheldon Lake map area. This may have been depositionally tied to the Prevost coarse clastics to the southeast in the Nahanni region. This dispersal pattern is consistent with the southeastern paleoflow demonstrated for the Prevost Formation. The similar composition of Portrait Lake and Prevost Formation clastics suggests the same source area for the former.

If these contiguous coarse clastic deposits are part of one depositional system, they outline a major submarine channel complex along which coarse clastic detritus was transported at least 200 km (see Fig. 49). Long-distance transport of coarse clastics within submarine channels has been reported for modern and ancient settings. Submarine channels on the modern Laurentian Fan on the east coast of Canada are some 250 km long, and dominated by deposition of coarse sand and gravel (Piper et al., 1985). The Northwest Atlantic Mid-Ocean Channel serves as a conduit for turbidity currents which deposit sand along its 4000 km length (Chough and Hesse, 1976). Cretaceous deep-water conglomerates in southern Chile were deposited in a fan channel greater than

120 km long (Winn and Dott, 1979). The confinement of turbidity flows by channel walls allows such flows to travel and carry coarse material for great distances. The passing of powerful turbidity currents may also induce traction and saltation transport of coarse bedload (see above examples).

Exposures are not extensive enough to be able to deduce the shape of the Prevost submarine fan(s). However, modern fans with very long channels (see examples in Bouma et al., 1985) are typically elongate in a direction parallel to the main channel system. Their elongate shape is partly controlled through confinement by bottom topography (see also Winn and Dott, 1979). Similarly, the Prevost submarine fan may have been elongate in a northwest-southeast direction. This orientation may have been partly controlled by bottom topography developed through faulting (see Tectonics section).

Assemblage III: Mid-Mississippian to Triassic clastic shelf

The mid-Mississippian to Triassic sequence represents a return to normal marine clastic sedimentation after the influx of westerly derived turbiditic clastics represented by the Devono-Mississippian Earn Group. This interval includes the mid- to late Mississippian Tsichu formation (quartz sandstone and shale), the early Permian Mount Christie Formation

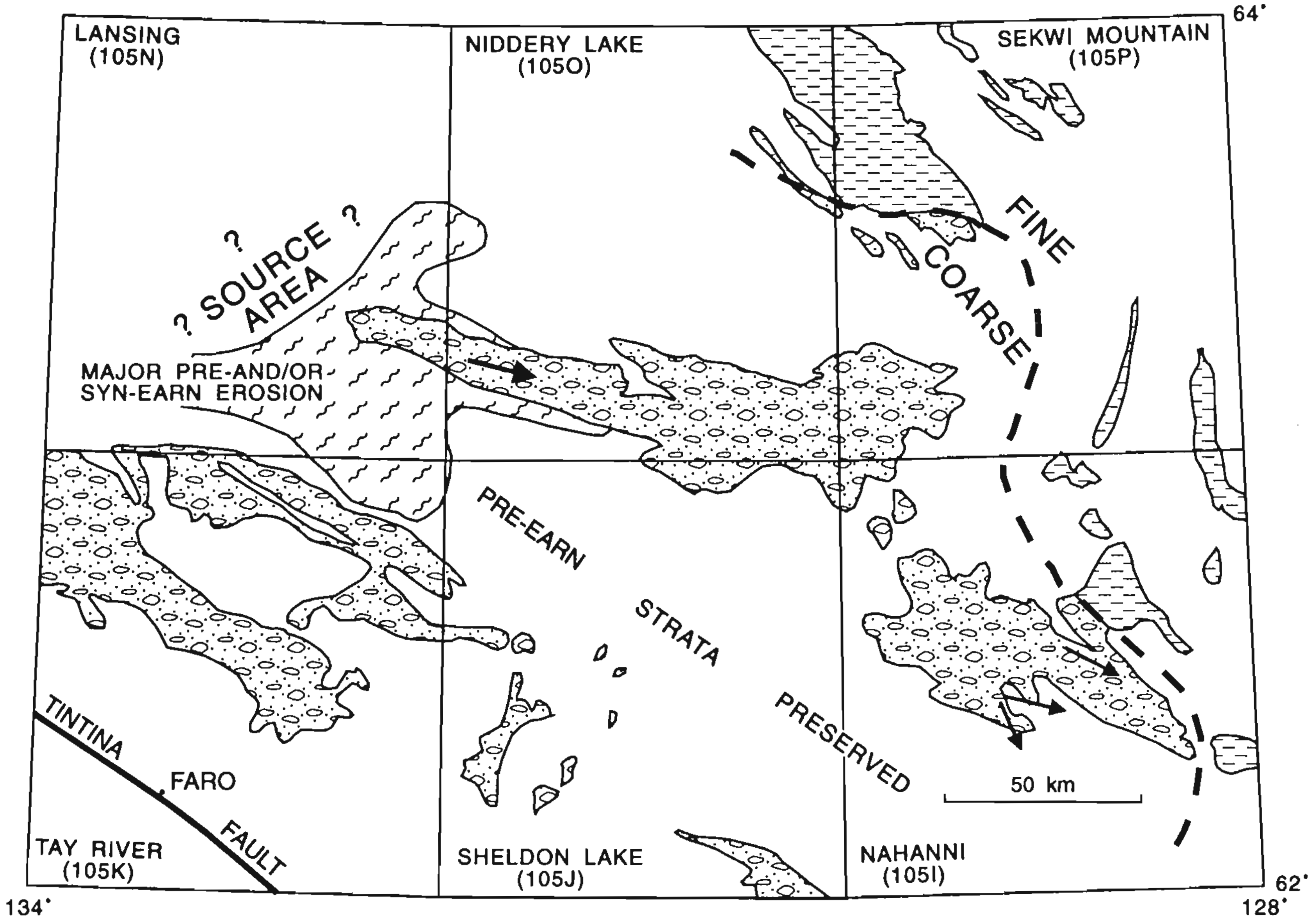


Figure 49. A possible source area for Earn Group clastics (wavy pattern) is located in Lansing map area. Its extent to the north and northwest of the area indicated is unknown. Other patterned areas show the generalized distribution of Earn Group strata (modified from Gabrielse et al, 1980). The conglomerate pattern indicates the presence of sandstone or coarser clastics. The dashed pattern indicates shale and siltstone. The bold dashed line is the approximate eastward limit of sandstone. In northeasternmost Tay River map area, possibly the fringe of the source area, Earn Group strata rest unconformably above block-faulted Hyland Group sandstone and Road River Group chert. Debris flows within the Earn Group contain metre-size blocks of these lithologies. Paleoflow (indicated by arrows) and the preservation of pre-Earn strata in other areas also serve to limit the source area to where shown. Generalized paleoflow in southeastern Niddery Lake map area was inferred from Abbott (1982) and Carne (1979, p. 11), and in the southwestern part of the Niddery area, from the distribution of coarse facies (as a channel? complex) as shown by Blusson (1974). The Cretaceous-Tertiary Tintina Fault and townsite of Faro are indicated for location.

(chert and shale), and the Middle to Late Triassic Jones Lake Formation (siltstone, sandstone, and shale). Uppermost Permian and lowermost Triassic strata are not represented.

Tsichu formation (**MT**) (informal). The Tsichu (pronounced tish-yu) formation is most extensively exposed in southeastern and east-central Niddery Lake map area (Abbott, 1982, units **Csp**, **Cq**, **Cl**; Cecile, 1986b, units **CPq**, **CPsh2**, **CPls**), northwest of the Nahanni area. There, the name is applied informally to strata above the Earn Group and beneath the Mount Christie Formation (J.G. Abbott, pers. comm., 1984; M.P. Cecile, pers. comm., 1988). As a type section remains to be designated, the name is also herein used informally (indicated by lower case "f" in "formation"). In the Niddery Lake map area the unit comprises quartzarenite, shale, and limestone which have yielded conodont faunas ranging from Tournaisian to Early Pennsylvanian in age. The quartz sandstone occurs as thin to thick discontinuous bodies in the lower part of the formation and limestone as thick members in its upper part. The lower contact is mapped at the base of quartzarenite or blue siliceous shale above brown weathering siltstone and shale of the Earn Group. An unconformity at the basal contact is suspected on the basis of stratigraphic omission of underlying units as revealed by regional mapping (Abbott, 1982; Cecile, 1986a). Tsichu shale in places weathers brown and in these areas is difficult to distinguish from the similar shale of the Earn Group. The upper contact is sharp, unconformable, and easily mapped at the first appearance upward of orange-brown weathering, green shale and chert of the Mount Christie Formation.

Nahanni map area. The Tsichu formation in Nahanni map area consists of grey to white weathering, resistant quartz sandstone interbedded with recessive black shale and siliceous shale. The best exposures are near Mount Wilson. Quartz sandstone, having the same stratigraphic position east of O'Grady Batholith, is also assigned to the Tsichu formation.

The best exposed section in the map area (section 17) occurs 6 km west of Mount Wilson, where the formation totals 306 m. The lowermost 140 m consists of black weathering, black shale, variably siliceous, brown weathering, grey to brown siltstone, and minor medium grained quartz sandstone. The sandstone is commonly muddy, contains small shale clasts, and exhibits load casts against underlying shale or siltstone. This predominantly fine clastic interval is overlain by 153 m of grey weathering, resistant, grey, fine- to medium grained, clean quartz sandstone. The sandstone is punctuated in its upper part by several even medium beds of black weathering, black recessive shale. Sandstone-shale contacts are sharp and planar. Internally, the sandstone is massive except for a 1.5 m thick parting. Sharply overlying the sandstone are 13 m of blue-black weathering, black platy siliceous siltstone and minor black chert. The basal contact of the formation is poorly located in scree at the lower limit of gun-blue to black weathering siliceous shale above brown weathering, grey shale. The upper contact is defined at the first appearance of rust weathering, black thin-bedded siliceous shale and silty shale (Mount Christie Formation) above the blue-black weathering, platy siltstone of the uppermost Tsichu formation.

About 8 km south-southwest of Mount Wilson, on the western limb of Wilson Syncline (section 20; Fig. 50) the Tsichu formation is at least 173 m thick. There it consists of two quartz sandstone members of subequal thickness, separated by about 36 m of blue-black weathering, black shale. The sandstone is grey-white weathering, grey to black, and very fine to medium grained. Other than a bedding parallel, 2 m thick parting, it is massive. The base of the lower sandstone (the base of measurement) rests sharply above brown weathering, recessive black shale which is provisionally assigned to the upper Earn Group. The top of the Tsichu formation is defined at an abrupt change upward from quartz sandstone to dark brown-tan to blue-grey weathering silty shale provisionally assigned to the Mount Christie Formation. At the southeastern end of Wilson Syncline the quartz sandstone traced from the above section is overlain by rust-orange weathering siliceous shale (Mount Christie Formation). It is underlain by an unknown thickness of heavily weathered, gun-blue weathering siliceous shale scree with minor amounts of fine to medium grained white quartz sandstone that resembles the basal Tsichu formation 6 km west of Mount Wilson.

The Tsichu formation east of O'Grady Batholith comprises quartz sandstone estimated to be at least 100 m thick. It forms a massive blocky felsenmeer and massive medium to thick beds in outcrop. It rarely displays ripple cross-lamination, and is locally dolomitic. It is both overlain and underlain by hornfels including slate, cherty shale, and chert. The original colour and sedimentary features of the enclosing strata have been obscured by contact metamorphism. The assignment of these overlying and underlying beds to the Mount Christie and Prevost formations respectively, is therefore tentative.

Tsichu sandstone consists mostly of monocrystalline quartz, locally up to 20 percent chert, rare detrital muscovite, and up to 15 percent matrix. The last consists of fine crystalline, low birefringent and opaque minerals. Silica cement is widespread, and in places, lines of inclusion trains identify original well-rounded to subrounded quartz grain boundaries. In other examples, grain boundaries are subangular. Sorting ranges from good to moderate.

Contact relations at the base of the Tsichu formation are not exposed in Nahanni map area. On the basis of correlation with the formation in Niddery Lake map area (Abbott, 1982; Cecile, 1986a), an unconformity is assumed. The Tsichu formation is overlain sharply and unconformably by siliceous shale and chert of the Mount Christie Formation.

Environment, age, and correlation. Tsichu quartz sandstone may have been deposited as bar finger sands on a shallow marine shelf. The lateral discontinuity of Tsichu sand bodies noted by Abbott (1982, p. 13) in Niddery Lake map area, and their being overlain in that region by shallow marine carbonate of the upper part of the formation (sections 18, 19; Abbott, 1982, p. 13) are compatible with this setting. Tsichu sandstone does not seem texturally mature enough to have undergone prolonged washing in a beach environment. The large proportion of matrix, suspended shale clasts, sharp contacts with shale, and load casts suggest that some sandstone beds may have been deposited from storm-generated(?) sediment gravity flows. The source area for the Tsichu formation remains uncertain. Equivalent and similar strata in southeastern Yukon (Mattson Formation) are derived from the east. Alternatively, the minor but important chert, as well as quartz in the sandstone could have come from western Earn Group source areas.

Quartz sandstone of the Tsichu formation is in part of late Visean age as indicated by conodont ages from within and above it in Niddery Lake map area (sections 18 and 19). The oldest conodont age definitely from the Tsichu formation is Tournaisian (J.G. Abbott, pers. comm., 1984). In Nahanni map area the formation is not younger than Late Mississippian; a conodont collection from chert from the overlying Mount Christie Formation is of this age (#412, Appendix 4). Tsichu-Mount Christie relations are discussed in detail in the section on correlation of the Mount Christie Formation.

Outside of Niddery Lake and Nahanni map areas strata equivalent to the Tsichu formation are rarely preserved. In southeastern Yukon and southwestern District of Mackenzie the Mattson Formation (Visean), consisting of sandstone, shale, minor carbonate, and coal (Harker, 1963) is correlative (Bamber and Mamet, 1978). In Dawson (116B) map area, the Keno Hill quartzite, previously inferred to be of Cretaceous age (Tempelman-Kluit, 1970) is now known to be Mississippian (Visean) on the basis of several conodont collections (R.I. Thompson and M.J. Orchard, pers. comm., 1987).

Mount Christie Formation (**MP**MC)(new). The buff to orange weathering Mount Christie Formation consists of shale, siliceous shale, chert, and minor sandstone. The best exposures are along Wilson Syncline and south of O'Grady Batholith. At the first location two members are recognized, a lower tan-brown, orange to pale green weathering, variably siliceous shale, and an upper member of medium-bedded chert and shale. The Mount Christie Formation sharply overlies the Tsichu formation and is overlain by brown weathering Triassic strata of the Jones Lake Formation.

Type section - section 20b - 62°48.2'N; 129°42.0'W. The type section is located on the southwestern limb of Wilson Syncline, about 24 km south-southwest of the peak, which is located in Sekwi Mountain map area, after which it is named (Fig. 50). The lower part of the section progresses up a largely scree-covered slope and the upper 100 m is along a ridge crest where outcrop is abundant. This section (totalling 687 m) is the only locality known where both upper and lower contacts are represented.

At the type section the formation can be subdivided into two members: 1) a lower shale member 524 m thick; and 2) an upper chert member 163 m thick. The shale member consists of dark brown, tan, and pale green weathering,

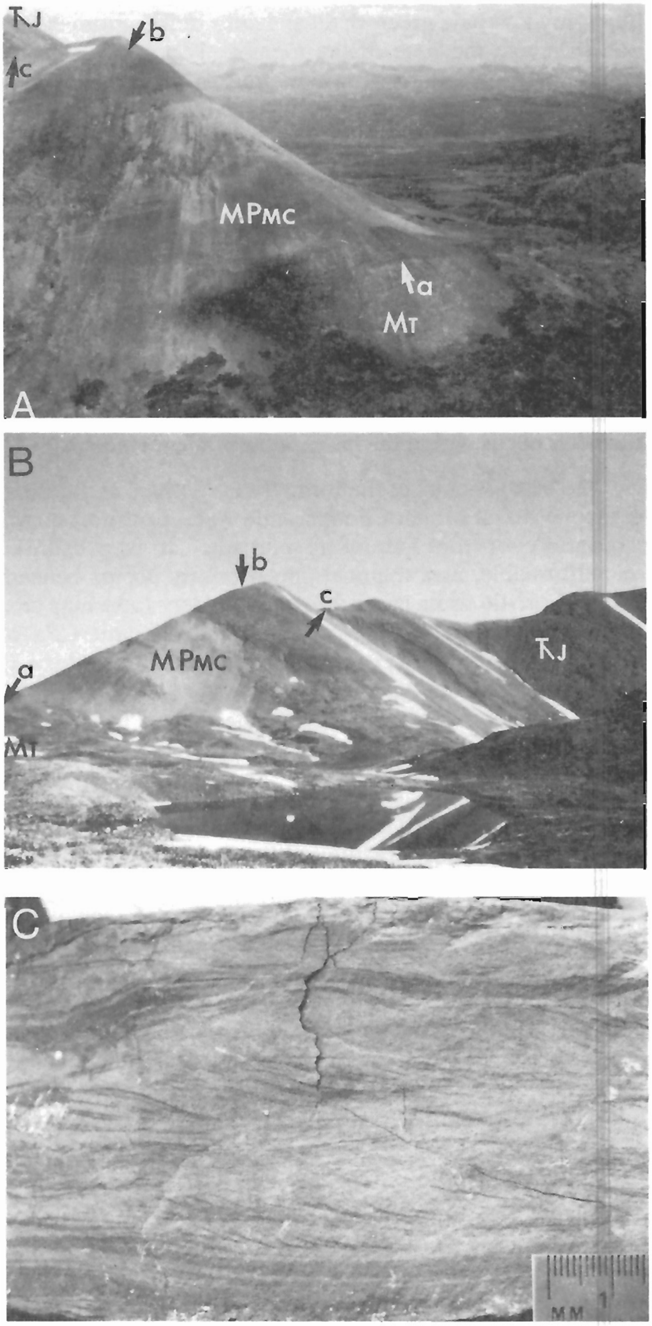


Figure 50. Tsichu (MT), Mount Christie (**MP**MC) (type section; 687 m) and Jones Lake (TRJ) (type section; 750 +m) formations on the southwestern limb of Wilson Syncline (section 20) (A and B). The contact of quartz sandstone of the Tsichu formation and the overlying Mount Christie Formation is at "a". "b" marks the approximate location of a Permian fossil locality and the base of the upper chert member of the Mount Christie Formation. "c" marks the contact of the Mount Christie Formation and the overlying Jones Lake Formation. The top of the Jones Lake Formation is not exposed. **A.** View toward the bottom part of section 20 from the west. GSC 204922-PP. **B.** View of the same ridge as A from the southeast. GSC 204922-QQ. **C.** Ripple cross-lamination typical of siltstone and fine grained sandstone throughout the Jones Lake Formation (this photo of talus block at section 20). GSC 204922-RR.

blue-grey and pale green shale and silty shale. From 309 to 366 m above the base of the member is a submember of white-orange weathering, white, fine to medium grained, locally ripple marked quartz sandstone. The shale member is capped by a bedless than one metre thick of dark red weathering, grey medium crystalline limestone. In its upper part, above 375 m, occur 5 to 10 percent scattered nodules of fine crystalline barite up to 0.3 m in diameter.

The overlying chert member (163 m) consists upward of: 1) 54 m of orange-grey weathering, pale green, blue-grey, and grey chert in medium beds; 2) 80 m of dark green-brown to blue-grey weathering, pale green to dark blue-grey shale; and 3) 29 m of medium-bedded interbedded chert and shale. Scattered nodules of medium crystalline barite up to 0.2 m in diameter occur within the basal 54 m of the member.

The basal contact of the formation is defined at the sharp contact of basal Mount Christie shale with uppermost quartz sandstone of the Tsichu formation. It is presumed unconformable, as a regional unconformity occurs beneath Mount Christie strata in southeastern Niddery Lake map area (beneath unit **Ppt** of Abbott, 1982; beneath unit **CPa** of Cecile, 1986a). The upper formational boundary is unconformable (see type section of Jones Lake Formation) and is picked at the top of the highest chert bed beneath overlying Jones Lake Formation shale.

Other areas. About 10 km northwest of the type section is a well-exposed locality (section 17) at which nearly the entire Mount Christie Formation is preserved. There, both the lower shale and upper chert members are also recognized. The lower shale member, about 296 m thick, consists of: 1) rust weathering, well-bedded siliceous shale and silty shale; 2) resistant thin-bedded, rusty weathering, grey chert and siliceous argillite; and 3) dark green-brown weathering, green argillite. From 134 to 165 m above the base of the member is a submember of white weathering, white fine grained clean quartz sandstone. This likely correlates with a similar submember at the type section. Barite nodules occur scattered throughout all but this sandstone and the basal 50 m of the shale member. The chert member, 106+ m thick consists of orange weathering, grey chert with scattered round barite nodules to 0.3 m in diameter. Near the top of measurement is about 6 m of grey-green weathering, green argillite. The basal contact of the formation with underlying blue-black siliceous Tsichu siltstone is sharp and presumed unconformable. The upper contact is not exposed. The lower shale member at this locality is only about one half as thick as that at the type section, but unlike the type section is highly siliceous and contains thin-bedded chert. Presumably it represents a more condensed sequence.

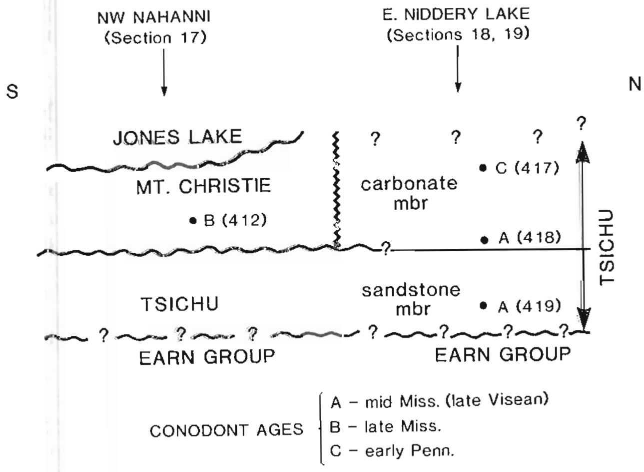


Figure 51. Speculative diagrammatic correlation of Tsichu and Mount Christie formations in northwestern Nahanni and eastern Niddery Lake map areas. See discussion in text. Numbers refer to fossil localities.

Northeast of Mount Wilson and along the southern margin of O'Grady Batholith, the Mount Christie Formation is as described for the previous two sections, although shale and chert members have not been distinguished. It consists of rust-orange to dark grey-brown weathering shale, silty shale, and minor chert, variably hornfelsed. At the first locality, gun-blue weathering siliceous shale assigned to the Tsichu formation is sharply overlain by rusty brown weathering, slightly hornfelsed(?) slate which, on fresh surfaces, is grey-green, black, or pale green.

The Mount Christie Formation is apparently bounded by regional unconformities (see below, and Jones Lake Formation).

Environment, age, and correlation. The lithology and overall lack of wave- or traction-produced sedimentary structures suggests deposition of the Mount Christie Formation in a below wave-base setting. Times of chert deposition would correspond to lulls in clastic input. The quartz sandstone in the shale member might reflect a brief coarse clastic incursion into this relatively quiet environment, and/or might indicate some temporary shoaling in water depth.

No macrofossils have been found in the Mount Christie Formation. Based on four conodont collections, three from high in the unit, the chert member is of late Wolfcampian to Leonardian (Early Permian) age. The shale member in its lower part has only one conodont fauna and this is of probable Late Mississippian age (Appendix 4). To the west, in Tay River map area, a conodont collection recovered from thin-bedded chert assigned to the Mount Christie Formation (Gordey and Irwin, 1987) is of mid-Pennsylvanian age (M.J. Orchard, pers. comm., 1987). This sparse fossil control indicates the Mount Christie Formation ranges in age from Late Mississippian to Permian. It is therefore partly equivalent to carbonate composing the upper part of the Tsichu formation in Niddery Lake map area. These carbonate beds have yielded Mississippian and Early Pennsylvanian conodonts (see sections 18 and 19). This equivalence presents an apparent dilemma, for the Mount Christie Formation also unconformably overlies the Tsichu. An explanation is indicated in the south-north diagrammatic section in Figure 51. The lower Tsichu formation, typified by quartzite, extended across the region. In later Tsichu time however, carbonate developed in the north and east which was flanked to the south and west by the starved shale-chert succession of the Mount Christie Formation. The extension of the sub-Mount Christie unconformity within the upper carbonate-bearing Tsichu (see Fig. 51) is uncertain. A northwest(?) trend for the suggested Tsichu-Mount Christie facies boundary is poorly constrained as there are only two areas of upper Paleozoic Tsichu carbonate (in the vicinities of sections 18 and 19) preserved. Whether this carbonate represented a regional carbonate platform or only a small shoal is uncertain.

Strata assigned to the Mount Christie Formation occur extensively in western Tay River (105K) (Gordey and Irwin, 1987) and northeastern Gleynlyon (105L) map areas where they comprise thin- to medium-bedded chert and shale. Conodont collections from chert in these areas range from mid-Pennsylvanian to Permian in age (M.J. Orchard, pers. comm., 1987). In Dawson (116B) map area, equivalent strata comprise the mid-Permian Tahkandit Formation (limestone) and unit 14 of Tempelman-Kluit (1970). The latter, consisting of green and red slate and minor chert, was inferred to be of Early Cretaceous age by Tempelman-Kluit (1970), but on the basis of unpublished conodont collections it is now considered Permian (R.I. Thompson and M.J. Orchard, pers. comm., 1987). In northeastern British Columbia, southeastern Yukon, and southwestern District of Mackenzie, latest Mississippian to Permian strata include: 1) the Stoddart and Upper Mattson formations (siltstone, shale, sandstone; uppermost Mississippian); 2) the Kindle Formation (siltstone, shale, sandstone; Lower Permian); and 3) the Fantasque Formation (chert; Upper Permian) (Bamber et al., 1968). Because of sub-Permian and sub-late Permian erosion, Pennsylvanian strata in that region may be only locally represented.

Jones Lake Formation (TJ) (new). The Jones Lake Formation comprises siltstone, sandstone, and shale that weather tan-brown. From a distance it is distinguished from the underlying Mount Christie Formation by the latter's more orange weathering colour. The thickest sections compose the core of Wilson Syncline, but additional good exposures are found southwest of O'Grady Lake and southwest of O'Grady Batholith. The Jones Lake Formation is the youngest formation exposed in the map area.

Type section - section 20b - 62°48.3'N; 129°42.4'W. The type section is located 8.8 km south of Mount Wilson and about 31 km southwest of Jones Lake after which the formation is named (Fig. 50). The section totals 750 m (top not exposed) and represents the thickest section of Triassic strata preserved in the Nahanni and surrounding map areas.

Upward, the type section comprises: 1) 33 m of basal recessive dark grey weathering, dark grey to black siltstone and shale; 2) 117 m of moderately resistant, brown weathering, thin- to medium-bedded siltstone and very fine grained sandstone; 3) 213 m of recessive dark brown to dark tan weathering, dark brown siltstone (15%) and shale (85%); and 4) 387 m of resistant, grey to tan weathering, grey to black, very fine grained calcareous sandstone, minor shale, and siltstone in thin to medium beds (0.2 m or less). Above this level, measurement was terminated because of minor folds developed toward the core of Wilson Syncline. Ripple cross-lamination is well displayed in silt and sand sized material throughout the formation (Fig. 50C). The base of the formation is mapped at the top of the highest chert bed of the underlying Mount Christie Formation. Regional stratigraphic omission suggests an unconformity at or close to this contact. Ideally, the formation boundary should be placed at the unconformity. However, because of the similarity of uppermost Mount Christie shale (interbedded with the uppermost chert) and Jones Lake shale this unconformity cannot be pinpointed in the type section. It is possible that the erosion surface is not at the topmost chert bed, but that it separates these similar shales and is located somewhere within the basal 33 m of strata herein included within the Jones Lake Formation.

Other areas. Elsewhere the Jones Lake Formation is similar to that of the type section. Tan-brown weathering, commonly calcareous, thin-bedded monotonous siltstone, sandstone, and shale are the dominant lithologies. Ripple cross-lamination and calcareous cement are diagnostic of Jones Lake strata. A major unconformity beneath Triassic strata is suggested by the absence of the underlying upper chert member of the Mount Christie Formation 12 km east of Mount Wilson, and an isolated occurrence of Triassic strata along South Nahanni River apparently resting above the Earn Group.

Environment, age, and correlation. The abundant ripple cross-lamination suggests deposition of the Jones Lake Formation on a shallow marine shelf constantly swept by bottom currents. No paleoflow analysis was attempted and an eastern source, like similar Triassic strata in British Columbia (Gibson, 1975), is an assumption rather than proven. Two conodont collections date the Jones Lake Formation as Triassic (Appendix 4). One conodont collection from 321 m above the base of the type section is of Early Triassic (Smithian) age. The other, from unknown stratigraphic position, is of probable Triassic age.

Triassic strata are the youngest preserved over much of central Yukon, and seldom form extensive exposures. Most could be referred to the Jones Lake Formation. Lithologies typically include ripple cross-laminated siltstone, sandstone, shale, and minor limestone. Isolated occurrences of Triassic strata are reported in Tay River (105J) and Sheldon Lake (105K) (Roddick and Green, 1961a,b; Gordey and Irwin, 1987), Finlayson Lake (Tempelman-Kluit, 1977a), and Niddery Lake (105O) (Abbott, 1982, 1983; Cecile, 1986a) map areas. In Dawson map area, strata mapped as Triassic include siltstone and fossiliferous limestone (Tempelman-Kluit, 1970). A thick section of strata previously thought Cretaceous in this region by Tempelman-Kluit (1970, unit 15) is now known to be Triassic on the basis of several conodont collections (R.I. Thompson and M.J. Orchard, pers. comm., 1987). These strata include at least 600 m of cross-laminated siltstone with interbedded brownish-grey shale. A regional sub-Triassic unconformity is suspected to account for the thinning or removal of

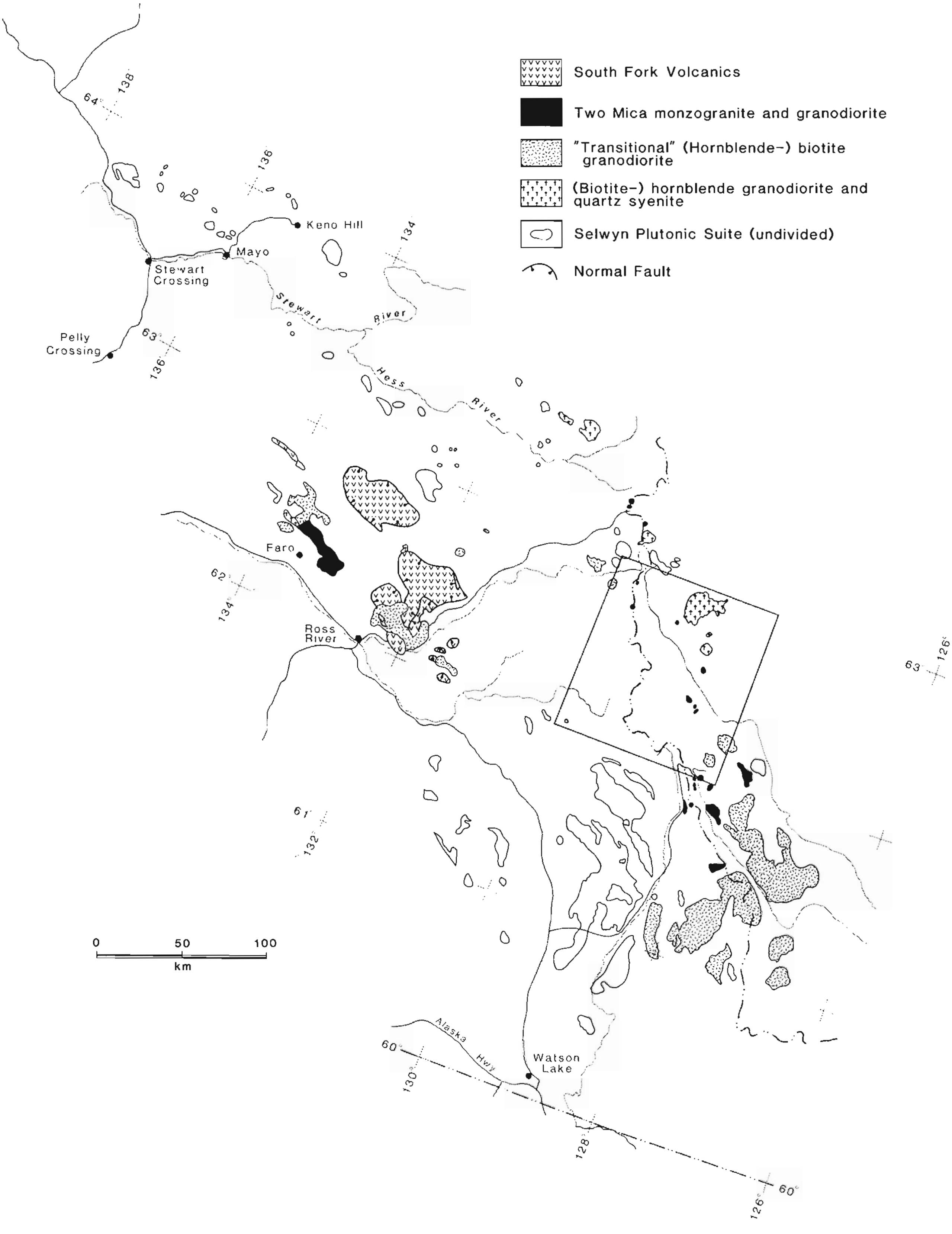


Figure 52. Distribution of Selwyn Plutonic Suite in and around Nahanni map area (shaded; modified from Wheeler and McFeely, 1987).

Carboniferous and Permian strata in all of these areas. The Jones Lake Formation correlates with the Toad Formation and possibly younger and older Triassic formations extensively developed in northern British Columbia (Gibson, 1975).

GRANITIC ROCKS

R.G. Anderson

SELWYN PLUTONIC SUITE (Ks) (new)

Mid-Cretaceous granite and granodiorite underlie about 7 percent of Nahanni map area, forming a northwest-trending belt in the northeastern part of the region (GSC map 1762A). Plutons are commonly circular in plan, and less than 1 km to 20 km in diameter. They intrude and hornfels strata as young as Triassic(?), have aureoles to 3 km in width, and crosscut folds and faults. Contacts with country rocks are generally steep.

The plutons (Fig. 52 and 63b; Table 1) form part of a distinctive group of inclusion poor, compositionally restricted granite and granodiorite intrusions northeast of Tintina Fault, herein termed the Selwyn Plutonic Suite (age of 80-106 Ma; average 92.4 Ma).

Individual plutons are named informally after nearby geographical features. Exceptions are plutons cospatial with important tungsten, tin, and/or base metal skarn deposits or occurrences. These plutons are informally named for the commonly used property or mining camp name (e.g. MacTung, Gun, Clea, Cac, Rudi, and CanTung plutons). Lened pluton and mining camp are the namesakes of Lened Creek.

This summary of field, petrographic, isotopic age date, geochemical, and stable and radiogenic isotopic data includes plutons within the map area as well as those in adjacent regions (e.g. Emerald Lake, Keele Peak, and MacTung plutons in Niddery Lake map area (NTS 105O), Itsi batholith and Gun pluton partly in Sheldon Lake map area (NTS 105J), CanTung pluton in Frances Lake map area (NTS 105H), Hole-in-the-Wall and Coal River batholiths in Flat River (NTS 95E) and Mount Appler pluton in Glacier Lake map area (NTS 95L); Fig. 52, Table 1). Lithological nomenclature (see Fig. 60) is consistent with Streckeisen (1973).

Definition and field relations

Selwyn Plutonic Suite is heterogeneous, comprising white to mottled white-and-grey weathering, mafic-poor to moderately mafic, (hornblende- or muscovite-) biotite granite or granodiorite stocks and batholiths (see Fig. 53, 55, and 56). The intrusions are blocky-jointed, locally inclusion-bearing, and composite (i.e. contain mappable phases) or homogeneous. The plutons are generally massive but locally are foliated or lineated. Equigranular, seriate, and (alkali-feldspar) megacrystic textures are common.

Pigage and Anderson (1985) described the informally named Anvil plutonic suite, 200 km west of Nahanni map area. The Anvil plutonic suite is similar to and is included within the Selwyn Plutonic Suite. The informal name is retained to describe the plutons in the Anvil Range because there the geological relations between plutonic and coeval volcanic rocks (South Fork volcanics) are best exposed (Gordey and Irwin, 1987).

Plutons of the Selwyn Plutonic Suite can be described in terms of a simple threefold division based on the presence of: 1) widespread common hornblende (with or without biotite); 2) biotite, with rare scattered hornblende (transitional plutons); or 3) biotite and muscovite (two-mica plutons).

Within the Nahanni region, hornblende-bearing plutons (unit **K**s1: O'Grady Batholith, and northern and central Nahanni plutons) occur northeast of the more widespread two-mica plutons (unit **K**s2: MacTung, Clea, Pelly River, Mount Wilson, Lened, Cac, Rudi, and Nar plutons). Transitional plutons (unit **K**s2: Gun, southern Nahanni, and Shelf Lake plutons) contain local or scattered hornblende or muscovite as an accessory mineral and form a medial belt between the hornblende- and two-mica-bearing end members of the suite. Silicic homogeneous geochemical compositions mirror a particular pluton's mafic mineralogy and can be classified into less evolved, metaluminous (hornblende-bearing) and more evolved, peraluminous (two-mica) end members and a transitional variety. Stable and radiogenic isotopic values suggest significant but variable contamination and/or assimilation of radiogenic crust on all scales. The peraluminous two-mica plutons are cospatial with tungsten-base metal skarns (e.g., MacTung, Lened-Cac-Rudi, and CanTung plutons).

The lithological variation within the Selwyn Plutonic Suite is formally defined by reference to four type localities (see below). Two of these localities display hornblende-bearing rock types. The transitional and two-mica granitic rocks are also each represented by a type locality.

Plutons with hornblende

There are two varieties of hornblende-bearing pluton: 1) alkali feldspar-rich quartz syenite and granodiorite; and 2) homogeneous granodiorite which lacks titanite (sphene) and opaque minerals (Table 1).

Hornblende-bearing alkali feldspar-rich composite intrusions

Type locality. The type locality for the alkali feldspar-rich composite intrusions (i.e. contains mappable phases) is the southwestern part of O'Grady Batholith (62°49'12"N, 129°01'30"W, Fig. 54). Excellent and extensive exposures reveal gradational changes from equigranular medium grained hornblende-biotite granodiorite near the batholith's margin (Fig. 55C) to foliated transitional (biotite-) hornblende quartz syenite (Fig. 55B) to massive, medium to coarse grained, crowded megacrystic hornblende quartz syenite (Fig. 55A) toward the batholith's core (Fig. 54).

Table1. Geological and petrographical features of Selwyn Plutonic Suite

Pluton (area)	Associated with W skarns	Composite or Homogeneous	Phases	Composition	Abundance and size of Megacrysts	Fabric	Mafic Minerals	Accessory Minerals	Satellitic and Intraplutonic Dykes	Inclusion Type and Abundance
TWO-MICA PLUTONS										
MacTung (2.9 km^2)	yes	composite	equigranular, megacrystic, fine grained, satellitic intrusions	granite, granodiorite	megacrystic phase (7-20%; 1-2 cm long)	massive	biotite, muscovite	muscovite, garnet, tourmaline, apatite, zircon, allanite	peraluminous granite (which contains garnet and muscovite) and aplitic granite	biotite diorite (rare)
Clea (0.3 km^2)	yes	composite	equigranular, coarsely megacrystic	granite (both phases)	equigranular phase (< 2%; 3-5 cm long); coarsely megacrystic phase (5-10%; 5-8 cm long	massive or faintly foliated megacrysts	biotite	muscovite, tourmaline, zircon, allanite	aplite, pegmatite, tonalite	hornfels (common); fine grained mafic inclusions (rare)
Lened (12.3 km^2)	yes	composite	equigranular, coarsely megacrystic	granite (all phases)	equigranular phase (< 1% to < < 1%; 1 cm long); coarsely megacrystic phase (3-7%; 3-5 cm long, up to 7-10 cm long)	massive or weakly lineated or foliated megacrysts	biotite ± muscovite	muscovite, apatite, zircon	aplite, felsic porphyry	fine grained biotite diorite (rare or absent)
Cac (1.9 km^2)	yes	composite	equigranular, coarsely megacrystic, satellitic intrusions	granite	coarsely megacrystic phase (3-10%; 3-5 cm long)	massive	biotite	muscovite apatite, zircon, ± garnet, ± tourmaline, ± andalusite especially in satellitic plutons	peraluminous granite (contains muscovite + garnet + andalusite); aplite	fine grained biotite diorite (rare to absent)
Rudi (4.7 km^2)	yes	composite	equigranular, coarsely megacrystic, satellitic intrusions	granite	equigranular phase (< 1% to < < 1%; 2-3 cm long); coarsely megacrystic phase (3-5%; 2-5 cm long)	massive; rare mafic schlieren near contacts	biotite	muscovite, garnet, tourmaline, (especially in peraluminous intrusions)	peraluminous granite (contains muscovite + garnet + tourmaline); aplite	fine grained biotite diorite (rare)
Nar (0.41 km^2)	yes	homogeneous	porphyritic	granodiorite	plagioclase (10%) and biotite (5%) phenocrysts	massive	biotite		none	none
Mount Wilson (2.1 km^2)	no	composite	equigranular, megacrystic, satellitic intrusions	granite and granodiorite	megacrystic (5-10%; 1-2 cm long)	massive	biotite	apatite, zircon, monazite	coarsely megacrystic granite	biotite-rich, polymictic mafic diorite (1-5%)
Pelly River (5.4 km^2)	no	composite	equigranular, megacrystic, coarsely megacrystic	granite and granodiorite	megacrystic and coarsely megacrystic phases (5-15%; 2 cm x 1 cm, up to 4 cm x 2 cm)	massive or foliated (megacrystic phase); massive (coarsely megacrystic and equigranular phases)	biotite	apatite, zircon, allanite, monazite, muscovite (secondary)	aplite porphyry, lamprophyre	fine grained biotite diorite (1-2%)
TRANSITIONAL PLUTONS										
Gun (25.2 km^2)	no	homogeneous	equigranular to seriate	granodiorite	rare; ≤6 cm long	massive	biotite > hornblende	allanite, zircon, apatite	aplite	fine grained, mafic, biotite monzodiorite (rare) and hornfels (rare)
Southern Nahanni (5.4 km^2)	no	homogeneous	coarsely megacrystic	granite	7-15%; 3-5 cm long	massive or faintly foliated megacrysts	biotite, rare hornblende	allanite, zircon, apatite	aplite, porphyry	fine grained, mafic, biotite diorite (rare)
Shell Lake (47.6 km^2)	no	homogeneous	megacrystic	granite	5-7%; 1 cm x 1 cm	massive	biotite,	allanite, zircon, apatite, hornblende, clinopyroxene	aplite	mafic, biotite porphyroblastic or fine grained biotite-hornblende diorite (uncommon)
HORNBLENDE-BEARING PLUTONS										
O'Grady batholith (270 km^2)	no	composite	marginal (equigranular and coarsely megacrystic), transitional, crowded megacrystic	granite	crowded megacrystic phase (40-60%; 0.5-1 cm); transitional phase (3-5%; 0.5-1 cm); marginal phase (absent or 5-15%; 0.5-2 cm long)	massive (marginal and crowded megacrystic phases) or foliated (transitional phase)	hornblende ± biotite ± clinopyroxene	magnetite, titanite, apatite, zircon, allanite, tourmaline	aplite, pegmatite, rare porphyry	fine grained hornblende diorite (marginal phase, 1-3%; transitional and crowded megacrystic phases, < 1 to < < 1%)
Northern Nahanni (2.0 km^2)	no	homogeneous	equigranular	granodiorite	none	massive; locally intensely fractured	biotite > hornblende	allanite, zircon, apatite	aplite, mafic porphyry	mafic, polymictic hornblende-biotite diorite (< 1 to 2%)
Central Nahanni (37.5 km^2)	no	homogeneous	equigranular	granodiorite	none	massive	biotite > hornblende	apatite, zircon, allanite, tourmaline	porphyry, aplitic granite	mafic, polymictic hornblende- and biotite-rich diorite (1-5%)

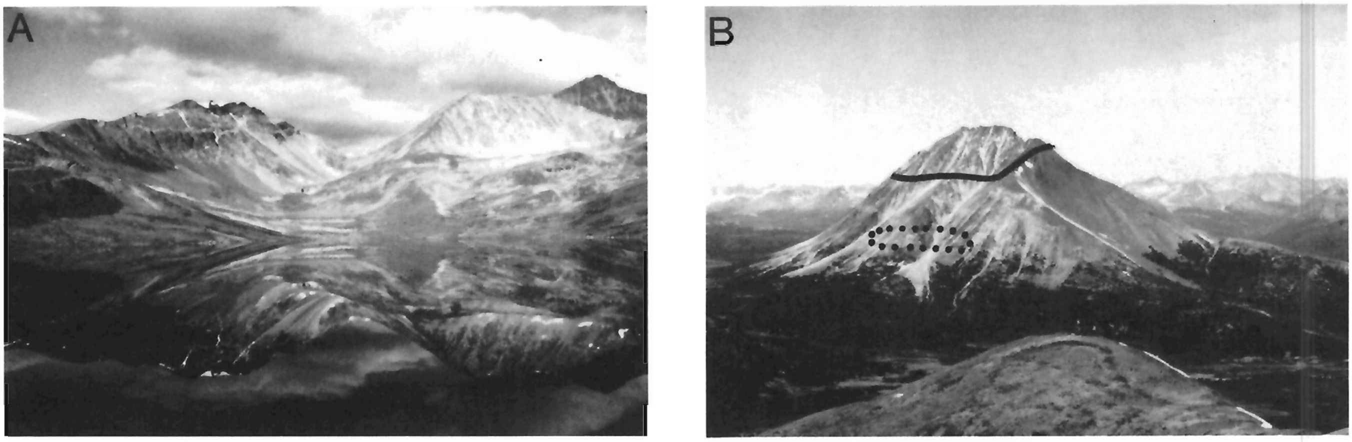


Figure 53. Mactung and Mount Wilson plutons. **A.** View west across Cirque Lake to Mount Allan and the roof of the Mactung Pluton. GSC 204922-SS. **B.** View northwest to Mount Wilson and intrusive contacts (outlined by dots) of Mount Wilson pluton. GSC 204922-TT.

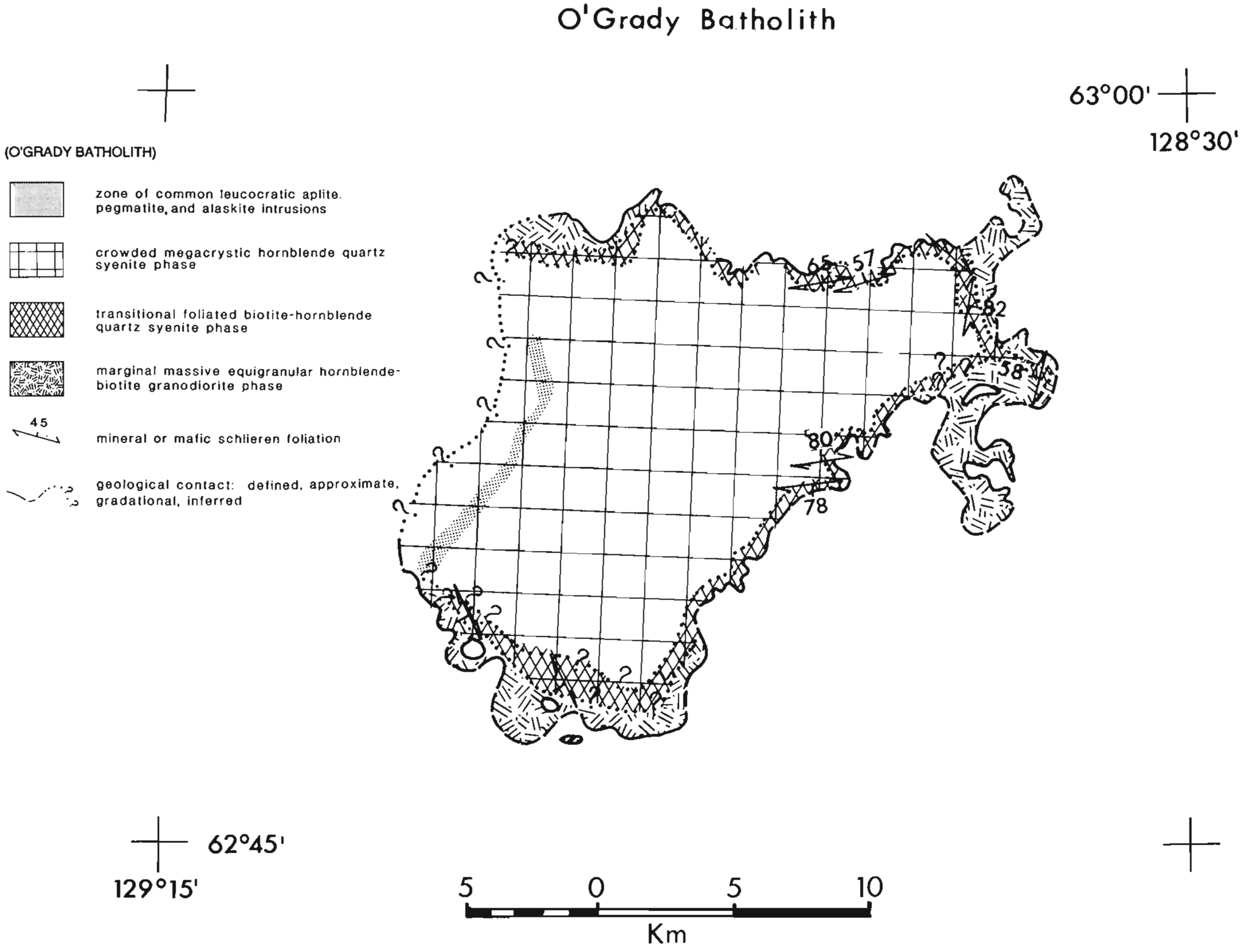


Figure 54. Geology of O'Grady Batholith.

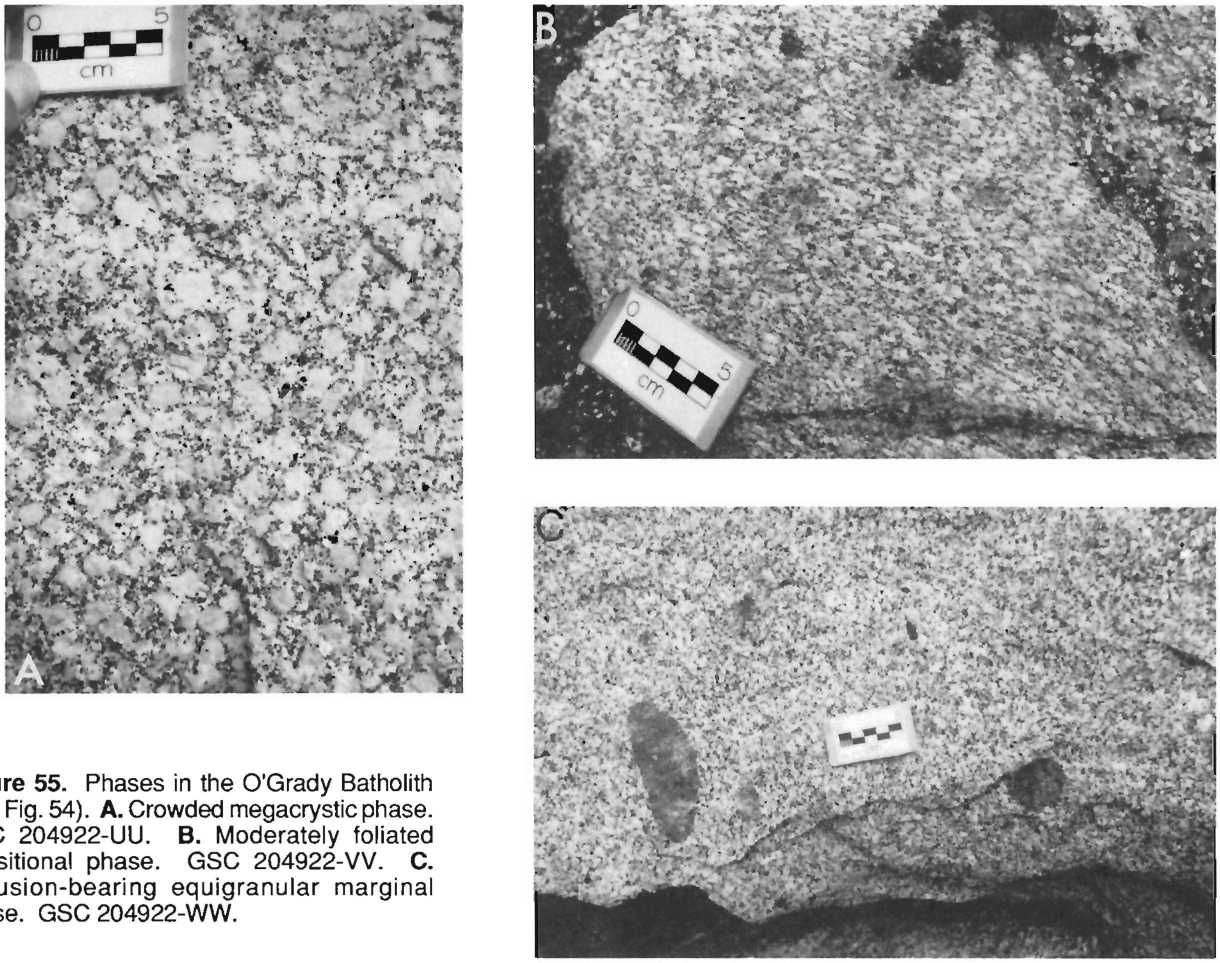


Figure 55. Phases in the O'Grady Batholith (see Fig. 54). **A.** Crowded megacrystic phase. GSC 204922-UU. **B.** Moderately foliated transitional phase. GSC 204922-VV. **C.** Inclusion-bearing equigranular marginal phase. GSC 204922-WW.

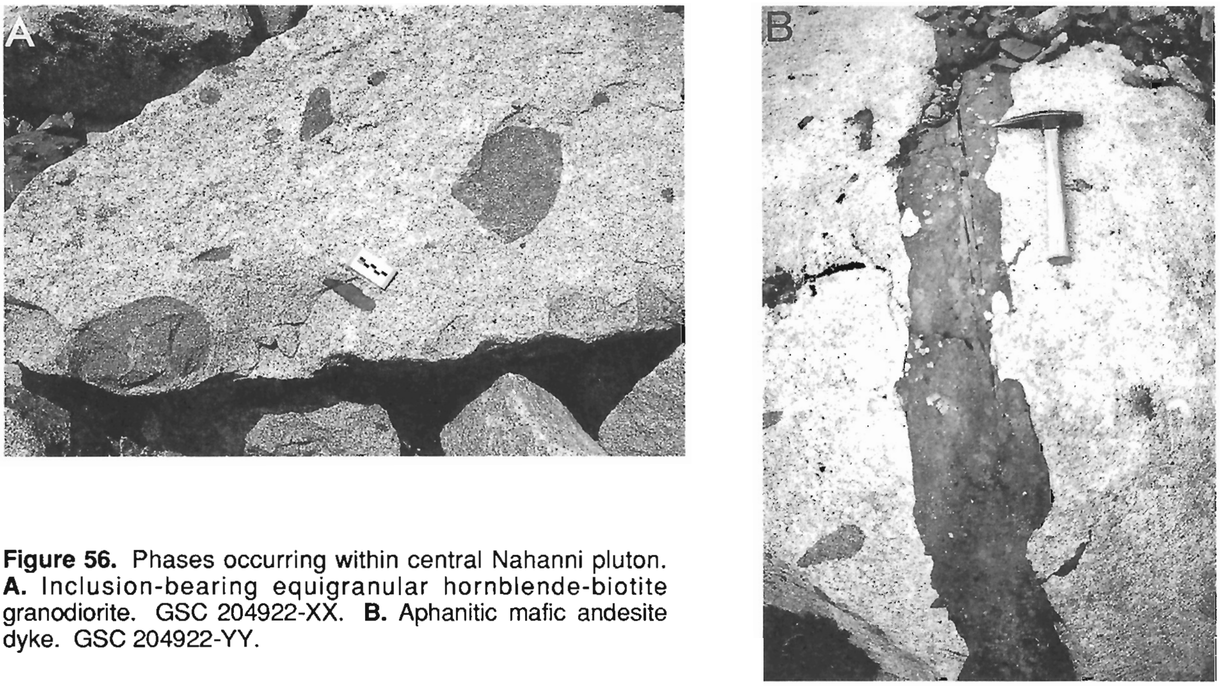


Figure 56. Phases occurring within central Nahanni pluton. **A.** Inclusion-bearing equigranular hornblende-biotite granodiorite. GSC 204922-XX. **B.** Aphanitic mafic andesite dyke. GSC 204922-YY.

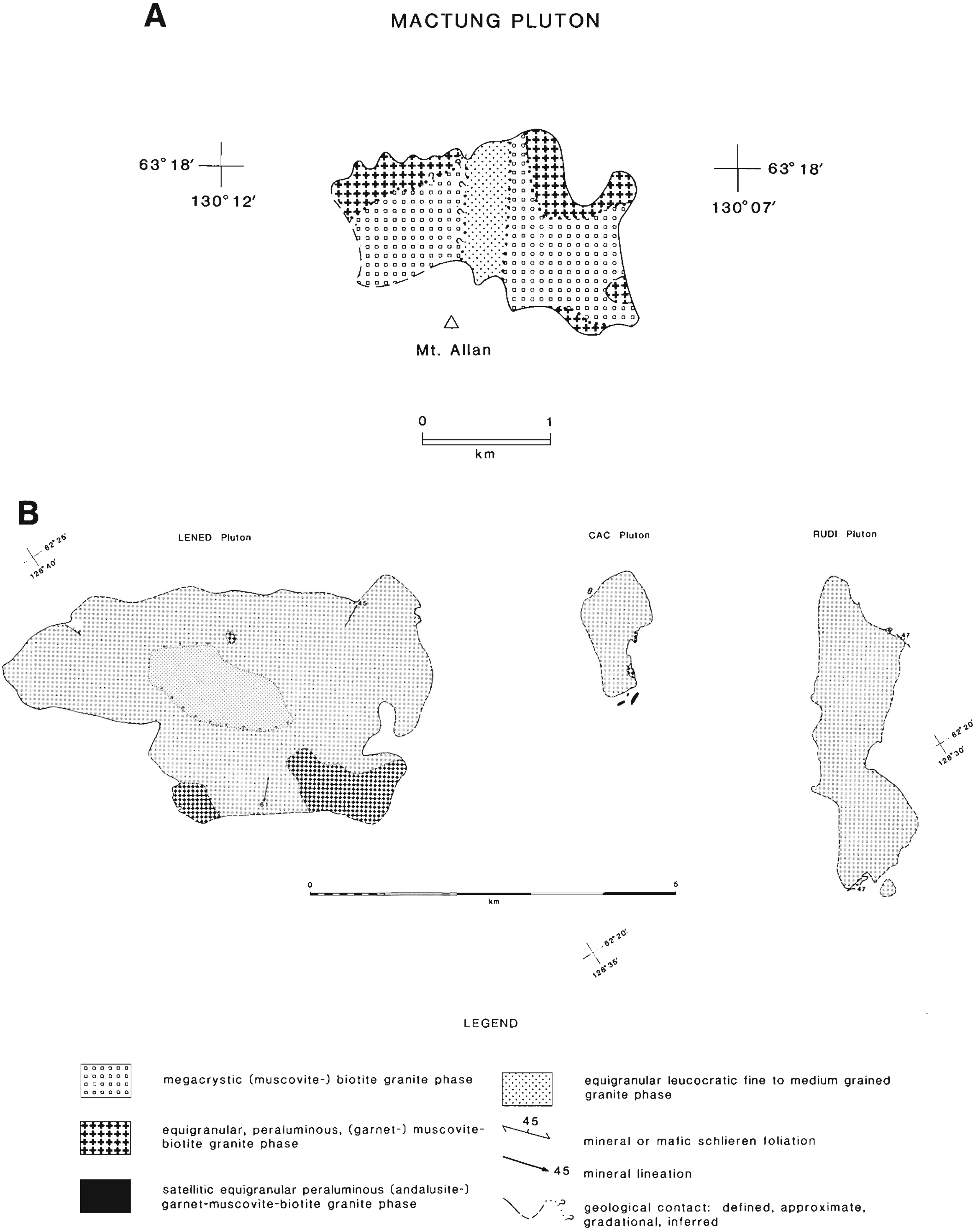


Figure 57. Geology of plutons associated with tungsten skarns. **A.** Mactung pluton. GSC 204922-ZZ. **B.** Plutons around Lened camp. GSC 204923.

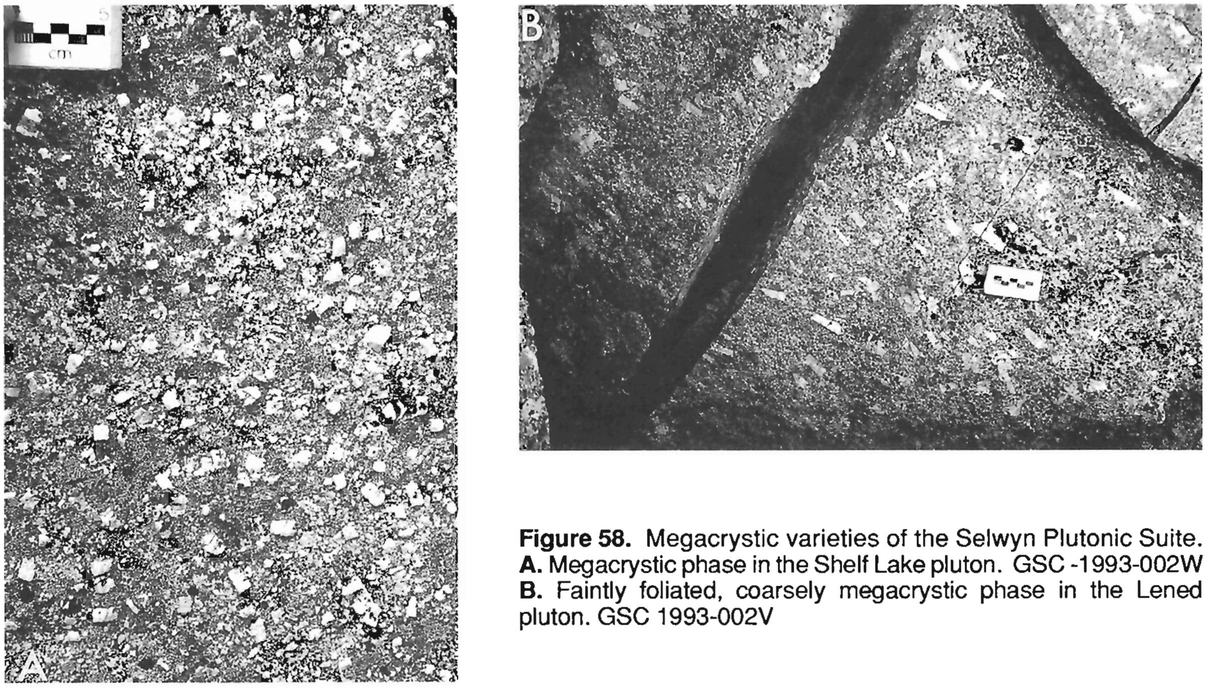


Figure 58. Megacrystic varieties of the Selwyn Plutonic Suite. **A.** Megacrystic phase in the Shelf Lake pluton. GSC -1993-002W **B.** Faintly foliated, coarsely megacrystic phase in the Lened pluton. GSC 1993-002V

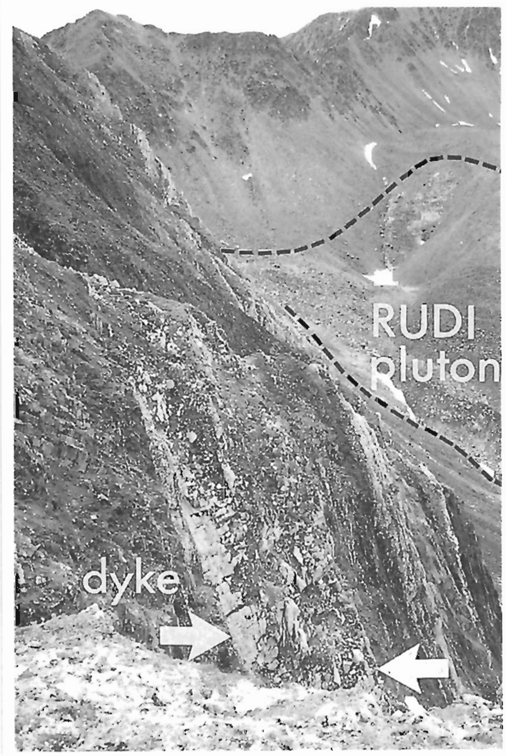


Figure 59. Satellitic, peraluminous, garnet- and muscovite-bearing biotite granite dyke near the northern margin of the Rudi pluton. K-Ar isotopic ages for muscovite and biotite from this peraluminous dyke are 84 to 87 Ma (see Fig. 63a). GSC 204923-A.

Scattered mafic inclusions (1% of rock) decrease in abundance from marginal to core phases. Aplite and pegmatite dykes are rare compared with localities to the north.

O'Grady Batholith, Emerald Lake plutons (Smit, 1984; Smit et al., 1985), and parts of the Keele Peak pluton (Cecile, 1986a) typify the alkali feldspar (K_2O-) rich granodiorite and quartz syenite variety. These contain euhedral alkali feldspar megacrysts, and interstitial plagioclase, hornblende (with or without biotite), magnetite, and titanite. Granodiorite and quartz syenite make up discrete phases but contacts are commonly gradational. Megacrystic alkali feldspar commonly outlines a planar fabric or trachytoid texture. In the O'Grady Batholith, intense steep foliation defined by alkali feldspar is characteristic of the transitional phase and defines a zone of high strain. The zone resulted from differential movement between nearly consolidated granodiorite along the margin of the pluton and quartz syenite of the batholith's core.

Mafic inclusions are rare (1-3% of rock) and most common in the O'Grady Batholith's marginal phase. Pelite and calc-silicate hornfels and fine grained, hornblende-, biotite-, and rarely, tourmaline-rich diorite inclusions predominate. Tourmaline-rich aplite and pegmatite dykes and intrusions crosscut the main phases and are particularly common along the western margin of the batholith.

Hornblende-bearing homogeneous intrusions

Type locality. The type locality for the homogeneous medium grained hornblende-bearing granodiorite variety is in the southern part of central Nahanni pluton (62°39'02"N, 128°37'32"W). Homogeneous massive inclusion-bearing hornblende-biotite granodiorite is characteristic of this area.

Biotite-hornblende-plagioclase porphyry dykes which are abundant near the southern margin of the pluton, crosscut it and its rusty contact aureole.

Northern and central Nahanni plutons typify the second variety of hornblende-bearing pluton (Fig. 52, 56). Both are composed of homogeneous massive, equigranular or seriate, medium grained hornblende-biotite granodiorite. Titanite or opaque minerals are almost never seen. This variety of granodiorite is similar to granodiorite phases in the alkali-feldspar-rich plutons (e.g. O'Grady Batholith). Heterolithic fine grained hornblende-biotite diorite inclusions are uncommon (1-5% of rock) but more widespread than in the O'Grady Batholith (Fig. 56A). Dykes are common in the plutons (Fig. 56B). Aphanitic and porphyritic (hornblende-, biotite-, and/or plagio-clase-phyric) andesite dykes predominate over aplite and pegmatite varieties. Hornblende, mafic inclusions, and mafic porphyry dykes are less common in the northern Nahanni pluton than in the central Nahanni pluton.

Scattered subeconomic skarn and vein showings are associated with the hornblende-bearing plutons. The showings contain the mineral associations (sphalerite-) pyrite-chalcopyrite-arsenopyrite (Anderson, 1983), molybdenite-chalcopyrite, and chalcopyrite- magnetite -pyrrtite-arsenopyrite and minor gold and tungsten (particularly in the O'Grady and Emerald Lake batholiths; Smit, 1984, p. 32; Smit et al, 1985).

Two-mica plutons

Type locality. The type locality, the MacTung pluton, (63°17′48″, 130°08′06″W; northeast of Cirque Lake; Fig. 53A) has the best and most extensive exposure of the composite nature, intrusive relations, intraplutonic dykes, and associated metallogeny of the two-mica plutons (Fig. 57A). Massive homogeneous inclusion-poor equigranular medium grained (garnet-) muscovite-biotite granite is intruded by leucocratic aplite. Westward and southward, the equigranular peraluminous granite grades into a megacrystic equivalent and, with increasing structural height, to aplitic leucocratic granite. These lithologies, intrusive relations, and the peraluminous nature (e.g. "primary" muscovite and garnet as an accessory mineral) of its marginal phase and satellitic dykes are typical of two-mica plutons associated with tungsten- and base metal-bearing skarns.

Diagnostic features of two-mica plutons include: small size; common composite nature (i.e. comprises mappable phases); a paucity of porphyritic mafic dykes but common peraluminous dykes (Fig. 59); the presence of muscovite; and common large feldspar megacrysts (Fig. 52 and 58; Table 1).

The two-mica plutons comprise two compositionally similar but texturally distinct granite or granodiorite phases; equigranular, locally peraluminous granite along a pluton's margin grades inward to a compositionally similar alkali feldspar megacrystic phase (Fig. 57 and 58; Tompson, 1978; Godwin et al., 1980; Anderson, 1982, 1983). Alkali feldspar megacrysts constitute 5 to 10% (locally up to 20%) of the rock. They may be randomly arranged, lineated or foliated, and reach lengths of 13 cm (2-5 cm average; Fig. 58B). Leucocratic, fine or medium grained, siliceous biotite granite phases, with smoky grey quartz patches or phenocrysts, are common in plutons cospatial with tungsten skarns.

Mafic inclusions are less common in the two-mica plutons than in the hornblende-bearing plutons. Fine grained heterolithic rarely layered mafic inclusions constitute much less than 1 volume percent. Generally, the inclusions are more mafic analogues of the host; hornblende is lacking.

Biotite is the sole essential mafic mineral. The accessory minerals muscovite, garnet, andalusite, and/or tourmaline, visible in hand specimen, preferentially occur within equigranular granite along a pluton's margin or in satellitic dykes (Fig. 59). These peraluminous phases are peculiar to intrusions cospatial with important tungsten skarns (Fig. 57).

Irregular aplite and pegmatite intrusions are abundant within two-mica plutons and also commonly occur along plutonic margins. Biotite porphyry and rare hornblende-clinopyroxene lamprophyre dykes occur locally in some plutons (e.g. Pelly River and Lened plutons; Table 1).

At MacTung (Dawson and Dick, 1978; Dick, 1979, 1980; Dick and Hodgson, 1982; Atkinson and Baker, 1986), the Lened camp (Glover and Burson, 1986), and CanTung (White, 1963; Blusson, 1968; Zaw, 1976; Archibald et al., 1978; Dick, 1980; Dick and Hodgson, 1982; Mathieson and Clark, 1984; Bowman et al., 1985), important W-Cu (Mo, Zn) skarns are associated with the two-mica plutons that contain peraluminous marginal or satellitic phases (Fig. 59; see also Mineral Deposits section and Appendix 2).

Transitional plutons

Type locality. The locality that best displays features typical of transitional plutons is in southern Nahanni pluton (62°34′18″N, 128°35′18″W). There, coarsely megacrystic biotite granite along the pluton margin (Fig. 58A) grades inward to seriate or equigranular hornblende-biotite granodiorite of the pluton's core. The hornblende-free granite is lithologically like the two-mica plutons and the hornblende-biotite granodiorite is a leucocratic equivalent of the Selwyn Plutonic Suite's hornblende-bearing end member.

Transitional plutons (Gun, southern Nahanni, and Shelf Lake plutons) share some features of both previously described plutonic types. They are white weathering, predominantly massive, and inclusion-bearing, seriate, medium grained biotite granodiorite. Aplite and pegmatite dykes are common. Biotite-plagioclase phyric mafic dykes occur rarely. Alkali feldspar is finer grained in seriate plutons (e.g. Gun and Shelf Lake plutons) than in megacrystic varieties (e.g. southern Nahanni pluton). Euhedral hornblende occurs in accessory amounts either scattered throughout the Gun pluton or restricted to a few localities in the centre of the southern Nahanni and Shelf Lake plutons.

Petrography

Threefold division of the Selwyn Plutonic Suite is also possible on petrographic attributes (Table 1). All varieties contain the essential minerals alkali feldspar, quartz, plagioclase, and biotite. The modal abundances of the felsic minerals define compositionally restricted, granite and granodiorite fields for all textural varieties of the three plutonic types (Fig. 60). Hornblende-bearing plutons are less siliceous and more diverse in composition than the two-mica plutons. Rare euhedral or subhedral apatite, zircon, allanite, and interstitial tourmaline accessory minerals occur throughout Selwyn Plutonic Suite. Except for the Emerald Lake pluton, parts of the Keele Peak pluton, and O'Grady pluton, the suite lacks primary opaque minerals or titanite (sphene). Irregular, slightly more calcic, preferentially altered cores in oligoclase occur in all three plutonic varieties but are more common in the hornblende-bearing plutons (e.g. O'Grady Batholith). Myrmekite is more abundant in two-mica plutons than in hornblende-bearing plutons but occurs in both.

Hornblende-bearing plutons

In hornblende-bearing plutons, euhedral or subhedral apatite, zircon, magnetite (O'Grady Batholith; Fig. 61A), clinopyroxene (O'Grady Batholith and transitional Gun pluton), plagioclase, hornblende, biotite, and titanite (O'Grady Batholith; Fig. 61A) are surrounded by anhedral or subhedral quartz and microperthitic alkali feldspar. Hornblende and biotite are altered to chlorite, epidote, titanite, and calcite; plagioclase is altered to fine grained sericite. Hornblende absorption is weak (Nahanni plutons) or strong (O'Grady Batholith). The amphibole pleochroic schemes are: α' = clear or pale brown, β = pale yellowish green, and γ' = medium green in northern and central Nahanni plutons; α' = light brown, β = dark olive-green, and γ' = dark to bluish green in O'Grady Batholith. Clinopyroxene occurs as irregular hornblende-rimmed cores in O'Grady Batholith or as biotite-rimmed subhedra in Gun pluton. Biotite's pleochroism (α' = pale brownish yellow; $\beta = \gamma'$ = dark chocolate brown) and comparative lack of inclusions (comprising uncommon subhedral zircon and apatite) typify the hornblende-bearing plutons.

Plagioclase in hornblende-bearing plutons is generally more calcic (andesine and oligoclase, An_{28} to An_{57}) than that in two-mica plutons. Complex normal and oscillatory zoning result in a decrease in anorthite content of about An_{12} from core to rim. Alkali feldspar in the O'Grady Batholith's crowded megacrystic phase is moderately or intensely turbid (Fig. 61A) and commonly contains vestiges of plagioclase in its core. Quartz extinction is undulose and subgrains are rare.

Two-mica plutons

In two-mica plutons, euhedral apatite, zircon, and monazite occur as inclusions in later formed subhedral plagioclase and biotite and in interstitial or subhedral quartz and alkali feldspar grains. Biotite's pleochroism (α'= pale brown; $\beta = \gamma'$ = reddish or rusty brown) and inclusion mineralogy are distinct from hornblende-bearing plutons. Round, fine grained zircon and monazite inclusions in biotite are outlined by common radiation damage haloes (Fig. 61B). Peraluminous phases along plutonic margins or satellitic to them characteristically contain early formed, inclusion-free, euhedral spessartine garnet and/or andalusite as accessory minerals (Fig. 61C). Zoned allanite and tourmaline are generally interstitial, although scattered euhedral allanite occurs. In a few places, tourmaline permeated disaggregated plagioclase, sericitized andalusite, and quartz. Late stage alteration includes: plagioclase to epidote and sericite; and biotite to epidote, chlorite, titanite, and fine grained opaque minerals.

Muscovite is interpreted to have a mixed origin on the basis of texture and mineral association. The predominant variety is "secondary" muscovite. This occurs as ragged, medium grained, subhedral laths in cores of plagioclase and alkali feldspar, or as equigranular grains invariably associated with (and an alteration product of) biotite (Fig. 61B). "Primary" muscovite is less common. It has no

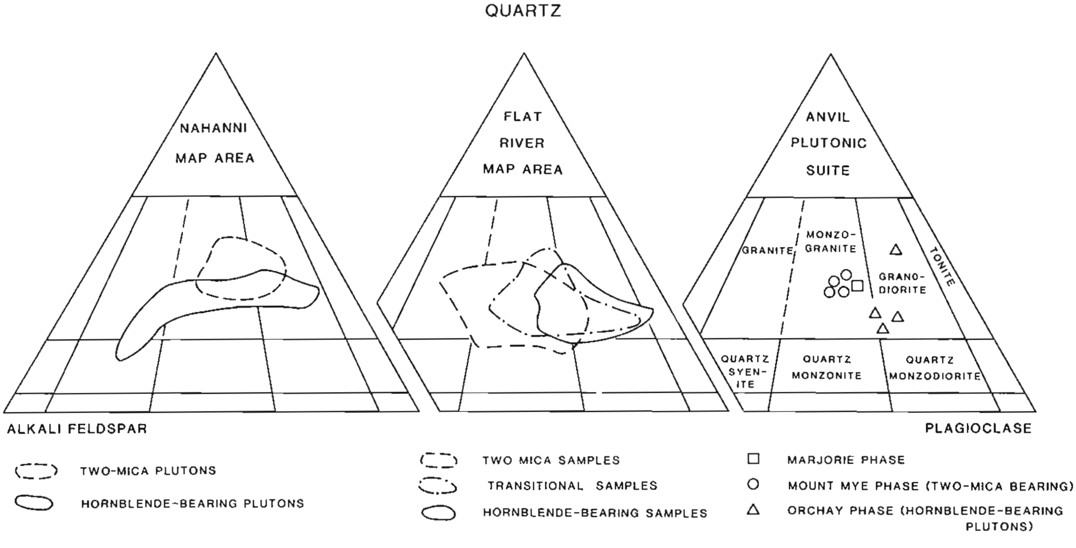


Figure 60. Modal quartz-plagioclase-alkali feldspar proportions for Selwyn Plutonic Suite (nomenclature after Streckeisen, 1973).

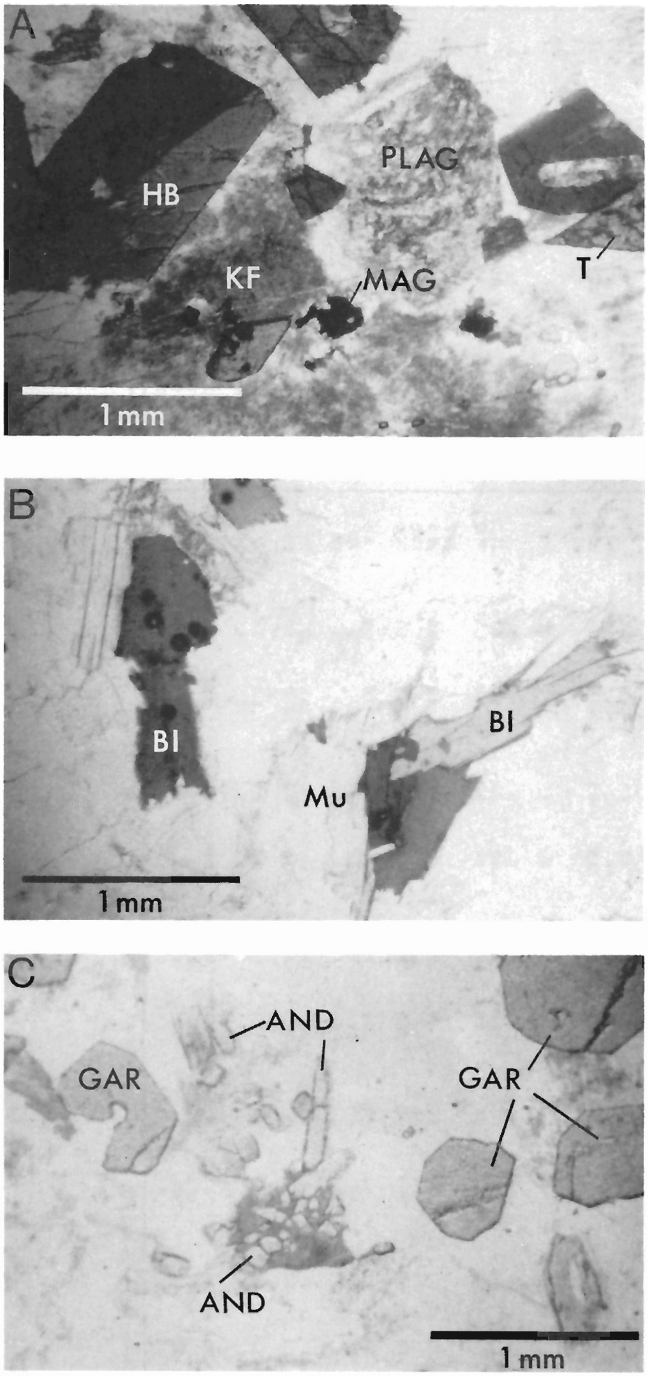


Figure 61. Photomicrographs (plane light) of the Selwyn Plutonic Suite. **A.** Typical assemblage of hornblende (HB), magnetite (MAG), titanite (T), plagioclase (PLAG), and turbid alkali feldspar (KF) in O'Grady Batholith. GSC 1993-002X **B.** Typical habit for inclusion-rich biotite (BI). The biotite contains zircon and monazite inclusions and radiation damage haloes, and is overgrown by secondary muscovite (MUSC) in Pelly River pluton. GSC 1993-002Z **C.** Inclusion-free euhedral garnet (GAR) and andalusite (AND) in satellitic intrusion associated with the Cac pluton. GSC 1993-002Y

preferred mineral association, is subhedral or euhedral, is locally coarser grained than accompanying biotite, and generally occurs in the more evolved, peraluminous aplite phases or intrusions.

Felsic minerals have characteristic compositions and textures. Plagioclase is predominantly oligoclase (An_{22} to An_{38}). Locally the oligoclase contains irregular or skeletal, slightly more calcic (up to An_{40-56}), preferentially altered cores. Normal and complex oscillatory zoning account for differences in composition from core to rim of about An_{12}. Alkali feldspar is commonly microperthitic and megacrystic. Biotite and plagioclase microlites form inclusion trails in the alkali feldspar, which mirror the latter's concentric internal zoning. Carlsbad twins predominate over rare microcline twins. Strain is more obvious in two-mica than in hornblende-bearing plutons and is indicated by localized mortar texture, common or abundant subgrains in aligned lensoid quartz, and bent plagioclase and mica.

Transitional plutons

Transitional plutons (Gun, southern Nahanni, and Shelf Lake plutons) share petrographic attributes of hornblende-bearing and two-mica pluton end members. Felsic mineral abundances indicate granite to granodiorite compositions intermediate in the Selwyn Plutonic Suite's overall range. Biotite is the predominant mafic mineral. The accessory minerals "secondary" muscovite, clinopyroxene, and hornblende, may be scattered throughout a particular pluton but generally account for less than 1 percent each of the modal mineralogy. Biotite pleochroism and the mineralogy and abundance of minerals included within biotite may vary within an individual pluton from that characteristic of hornblende-bearing plutons to that typical of two-mica plutons. Plagioclase grains vary from labradorite to oligoclase (An_{64-25}) among the transitional plutons and within a particular pluton. Zoning accounts for compositional changes of up to An_{20}. Myrmekite is developed at plagioclase-alkali feldspar contacts. Quartz extinction is undulose but otherwise the rocks are unstrained.

Geochemical composition and affinities

Major, minor, trace element, and stable and radiogenic isotopic compositions show the Selwyn Plutonic Suite is similar to other suites recognized in regions underlain by continental crust (e.g., Turekian and Wedepohl, 1961; Ewart, 1979; Miller and Bradfish, 1980; Hudson and Arth, 1983; White and Chappell, 1983; Table 2; Fig. 62). The suite has an overall evolved (rich in large ion lithophile elements such as Rb and Ba), restricted, silicic, metaluminous to peraluminous, radiogenic calc-alkaline composition low in CaO and MgO and high in K_2O. The Selwyn Plutonic Suite displays slight to moderate, irregular geochemical variation at all scales from individual plutons to the entire suite.

Hornblende-bearing plutons, compared with two-mica plutons, are less silicic (less than 72 weight percent SiO_2; Fig. 62A, B) and have smaller differentiation index values (D.I. less than 79 weight percent). They contain less K_2O

Table 2a. Average composition of Selwyn Plutonic Suite - two-mica plutons and transitional plutons

	TWO-MICA PLUTONS MAJOR ELEMENTS															TRANSITIONAL PLUTONS MAJOR ELEMENTS					
Pluton	MacTung		Mount Wilson		Clea		Pelly River		Lened		Cac		Rudi		Nar	Gun		Southern Nahanni		Shell Lake	
Sample No.	Average (9)	Standard Deviation	Average (2)	Standard Deviation	Average (4)	Standard Deviation	Average (9)	Standard Deviation	Average (3)	Standard Deviation	Average (2)	Standard Deviation	Average (2)	Standard Deviation	Single Sample	Average (7)	Standard Deviation	Average (3)	Standard Deviation	Average (4)	Standard Deviation
SiO_2	75.4	2.8	70.7	1.7	74.7	1.1	69.6	1.5	73.9	2.2	73.4	3.5	74.0	3.0	67.7	67.4	0.4	72.8	1.4	70.7	2.5
Al_2O_3	13.1	1.1	14.4	0.6	13.3	0.8	15.3	0.4	13.5	0.8	13.8	0.4	13.3	1.0	15.1	15.7	0.2	13.6	0.3	14.6	0.9
TiO_2	0.13	0.10	0.45	0.04	0.18	0.05	0.43	0.04	0.26	0.09	0.25	0.21	0.31	0.06	0.57	0.51	0.02	0.29	0.05	0.37	0.13
Fe_2O_3	0.8	0.9	1.5	1.7	0.1	0.1	0.6	1.0	0.0	0.1	0.5	0.6	0.2	0.0	0.3	0.3	0.1	0.2	0.2	0.4	0.2
FeO	0.8	0.8	1.3	1.8	1.3	0.3	2.1	0.9	1.9	0.5	1.5	2.1	2.0	0.5	3.4	2.7	0.2	1.9	0.3	2.3	0.7
MnO	0.05	0.01	0.06	0.01	0.05	0.01	0.05	0.01	0.06	0.01	0.06	0.01	0.06	0.01	0.04	0.06	0.00	0.05	0.01	0.06	0.02
MgO	0.34	0.19	1.29	0.12	0.32	0.07	1.39	0.38	0.62	0.18	0.51	0.47	0.68	0.12	1.72	1.46	0.04	0.82	0.21	1.08	0.31
CaO	1.46	0.49	3.09	0.25	1.12	0.17	2.85	0.29	1.81	0.42	1.95	0.66	2.14	0.35	4.29	4.25	0.17	2.21	0.35	2.57	0.67
Na_2O	2.3	0.3	2.0	0.1	3.1	0.4	2.0	0.2	2.9	0.2	2.8	0.2	2.4	0.1	1.7	2.5	0.0	2.7	0.3	2.6	0.3
K_2O	4.58	0.36	4.15	0.17	4.99	0.38	4.42	0.24	3.93	0.21	4.36	0.39	4.04	0.21	2.83	3.91	0.12	4.55	0.14	4.56	0.41
P_2O_5	0.06	0.03	0.11	0.01	0.09	0.03	0.12	0.01	0.15	0.02	0.11	0.09	0.14	0.04	0.12	0.12	0.02	0.11	0.03	0.23	0.04
H_2O^t	0.6	0.1	0.7	0.0	0.6	0.1	0.8	0.1	0.8	0.1	0.7	0.1	0.7	0.2	2.1	0.9	0.1	0.5	0.1	0.7	0.1
CO_2	0.1	0.1	0.1	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.3	0.1	0.1	0.2	0.1	0.2	0.2
Cl	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.00	0.02			0.03	0.02	0.03	0.02
F	0.05	0.02	0.07	0.01	0.06	0.02	0.07	0.01	0.05	0.02	0.04	0.03	0.06	0.00	0.11			0.07	0.01	0.07	0.02
S	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.01	0.00	0.01	0.00	0.01
Total	99.82		99.82		99.94		99.93		100.04		99.83		99.98		100.33	99.88		99.97		100.36	
								TRACE ELEMENTS										TRACE ELEMENTS			
Rb	208	53	165	63	357	38	133	15	205	15	230	24	214	16	138	169	4	237	45	184	37
Sr	150	63	226	37	80	45	229	40	193	66	203	108	232	73	276	286	10	252	55	305	108
Ba	314	227	610	85	192	132	628	77	413	183	396	473	455	304	880	670	39	493	230	810	280
U					10.7	7.0			4.6	0.1	21.1	18.7	8.1	5.7	3.4			10.8	3.6	6.0	1.5
Zr	74	46	149	54	97	15	142	31	117	52	119	75	126	37	170	163	16	141	25	148	53
Be	6.7	5.3			6.6	0.2	5.2	2.0	7.3	3.3	4.9	0.8	4.4	0.6		3.7	0.2	5.5	0.9	4.9	1.8
B	73	49	62	15	41	16	59	8	41	34	47	30	31	14	280			36	14	37	22
Li					111.5	27.6			103.7	19.1	75.5	16.3	106.5	16.3	38.0			65.0	20.4	84.7	64.6
As	1.4	0.8	4.2	3.8	7.9	9.6	1.8	1.1							75.4			1.3	0.4	1.1	0.1
Ag	0.1	0.1					0.1	0.1												0.1	0.0
Br					1	1			2	1	2	1	2	0	2			1	1	2	1
W	2	2	1	0	1	0	1	0	1	0	1	0	1	0	1			1	0	1	0
Sn					9.3	6.2			5.0	3.0	2.5	2.1	4.5	2.1	51.0			3.0	1.0		
Mo	1.9	0.4	1.5	0.7	1.3	0.5	2.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.3	0.5	2.0	1.0	2.5	1.0
Co	0.1	0.1													8.7	7.7	0.5	7.2	0.1	8.1	0.9
Cr	8.2	4.0	18.5	6.4	7.7	0.1	25.1	8.0	8.9	1.8			8.5	3.6	22.0	22.7	1.3	15.3	4.0	11.9	4.3
Ni							12.7	0.6							10.0	26.1	0.7				
V	27.3	7.0	43.0	14.1	27.0	0.0	38.7	8.5	32.0	6.2	34.0	27.0	28.5	2.1	70.0	27.4	1.5	40.0	0.0	52.8	20.8
Cu	4.9	0.9	7.0	0.0	7.0	1.3	9.2	4.9	5.8	1.3	5.2	0.0	3.9	0.9	8.0	13.6	9.3	5.1	1.1	5.0	1.7
Pb	61	9	33	1	38	3	44	4	39	3	44	13	37	0	15	38	6	42	8	31	4
Zn	29	10	51	3	44	9	55	10	36	11	33	16	41	13	42	52	4	33	4	34	10
La					60	1			62	17			59	18	76	30	3	68	13	89	38
Y					21.3	5.7			21.3	3.5	33.0	10.0	21.0	1.4	29.0	13.1	1.9	23.3	3.8	22.0	3.6
Yb	6.5	1.4	3.9	2.1	3.9	0.6	5.3	0.4	3.4	0.7	3.9	2.1	5.0	2.1	2.0	1.0	0.2	3.2	0.5	3.9	2.1
Nb					34	7			17	1	15	6	18	1	14	11	1	18	3	22	4
Rb/Sr	1.66	0.84	0.71	0.16	5.54	2.69	0.61	0.16	1.15	0.40	1.36	0.85	0.98	0.38	0.50	0.59	0.02	1.00	0.45	0.64	0.19
*K/Ba	193	129	57	6	312	208	60	7	90	35	340	414	94	58	27	49	3	95	59	51	14
*K/Rb	195	50	227	77	119	21	281	26	161	4	159	4	159	21	174	195	4	164	26	212	36
Ba/Rb	1.74	1.54	3.89	0.97	0.53	0.37	4.78	0.90	2.02	0.85	1.84	2.25	2.18	1.58	6.38	3.98	0.24	2.24	1.27	4.44	1.31

*K is parts per million K calculated from weight percent K_2O normalized volatile-free
b.d. = below detection limit

Table 2b. Average composition of Selwyn Plutonic Suite - hornblende-bearing plutons

				MAJOR ELEMENTS				
Pluton	Emerald Lake		O'Grady Batholith		Northern Nahanni		Central Nahanni	
Sample No.	Average (12)	Standard Deviation	Average (13)	Standard Deviation	Average (2)	Standard Deviation	Average (7)	Standard Deviation
SiO_2	64.3	4.8	65.1	2.0	68.4	1.8	66.4	4.3
Al_2O_3	14.7	0.4	13.9	0.6	15.6	0.2	15.4	0.6
TiO_2	0.54	0.22	0.60	0.07	0.46	0.01	0.57	0.14
Fe_2O_3	1.4	0.7	1.1	0.3	0.3	0.1	0.7	0.5
FeO	3.5	1.2	3.1	0.4	2.9	0.1	3.3	0.8
MnO	0.08	0.03	0.09	0.01	0.07	0.01	0.07	0.02
MgO	1.60	1.00	2.16	0.68	1.40	0.16	2.38	1.39
CaO	3.43	1.36	4.24	0.54	3.38	0.18	4.17	1.13
Na_2O	2.4	0.4	2.1	0.4	2.8	0.4	2.2	0.3
K_2O	6.64	0.80	5.76	1.18	3.83	0.08	3.49	0.47
P_2O_5	0.26	0.17	0.25	0.04	0.11	0.01	0.12	0.03
H_2O^t	0.9	0.2	0.7	0.2	0.6	0.0	0.9	0.3
CO_2	0.1	0.0	0.1	0.2	0.1	0.1	0.1	0.1
Cl			0.03	0.02	0.04	0.02	0.03	0.02
F			0.12	0.02	0.10	0.04	0.07	0.01
S			0.02	0.03	0.07	0.05		
Total	99.70		99.41		99.88		99.89	
				TRACE ELEMENTS				
Rb	322	45	325	66	169	2	83	17
Sr	690	183	389	82	301	7	293	40
Ba			848	341	795	7	817	111
U	31	11	18.0	7.0	5.1	0.1		
Zr			217	22	157	1	94	19
Be			7.2	2.8	3.7	0.7		
B	36	24	202	202	29	7	67	14
Li	53	25	51	11	57	28		
As	2.5	0.5	3.6	1.9	1.1	0.1	2.5	2.8
Ag			0.2	0.1			0.1	0.0
Br			1	1	2	0		
W	5	3	3	3	1	0	1	0
Sn			8	3				
Mo	5	2	3	2	3	1	2	0
Co			13	5	16	1		
Cr			40	31	23	0	49	71
Ni			20	7	17	1		
V			89	28	82	0	46	16
Cu	20	11	16.3	7.9	13.4	7.9	11	9
Pb	10	4	40	7	30	7	21	12
Zn	22	7	56	5	41	7	55	12
La			110	24	105	7		
Y			26.8	4.5	17.0	2.8		
Yb					2.2	0.1	4.8	0.4
Nb			24	6	15	1		
Rb/Sr	0.51	0.18	0.85	0.19	0.56	0.02	0.29	0.08
*K/Ba			77.2	69.3	40.4	0.2	35.9	1.8
*K/Rb	175	23	151	24	190	0	360	44
Ba/Rb			2.65	1.14	4.72	0.02	10.03	1.04

*K is parts per million K calculated from weight percent K_2O normalized volatile-free

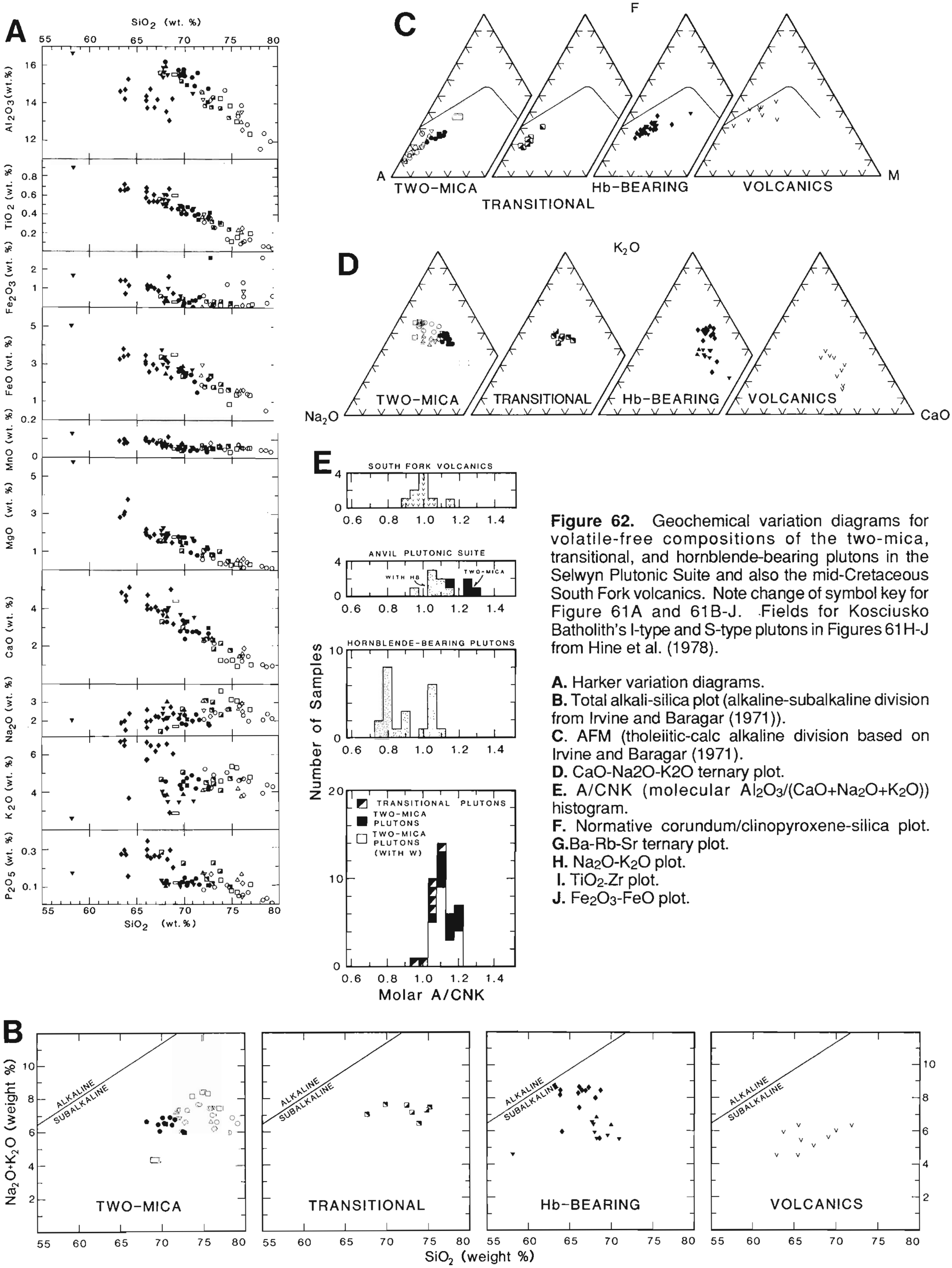
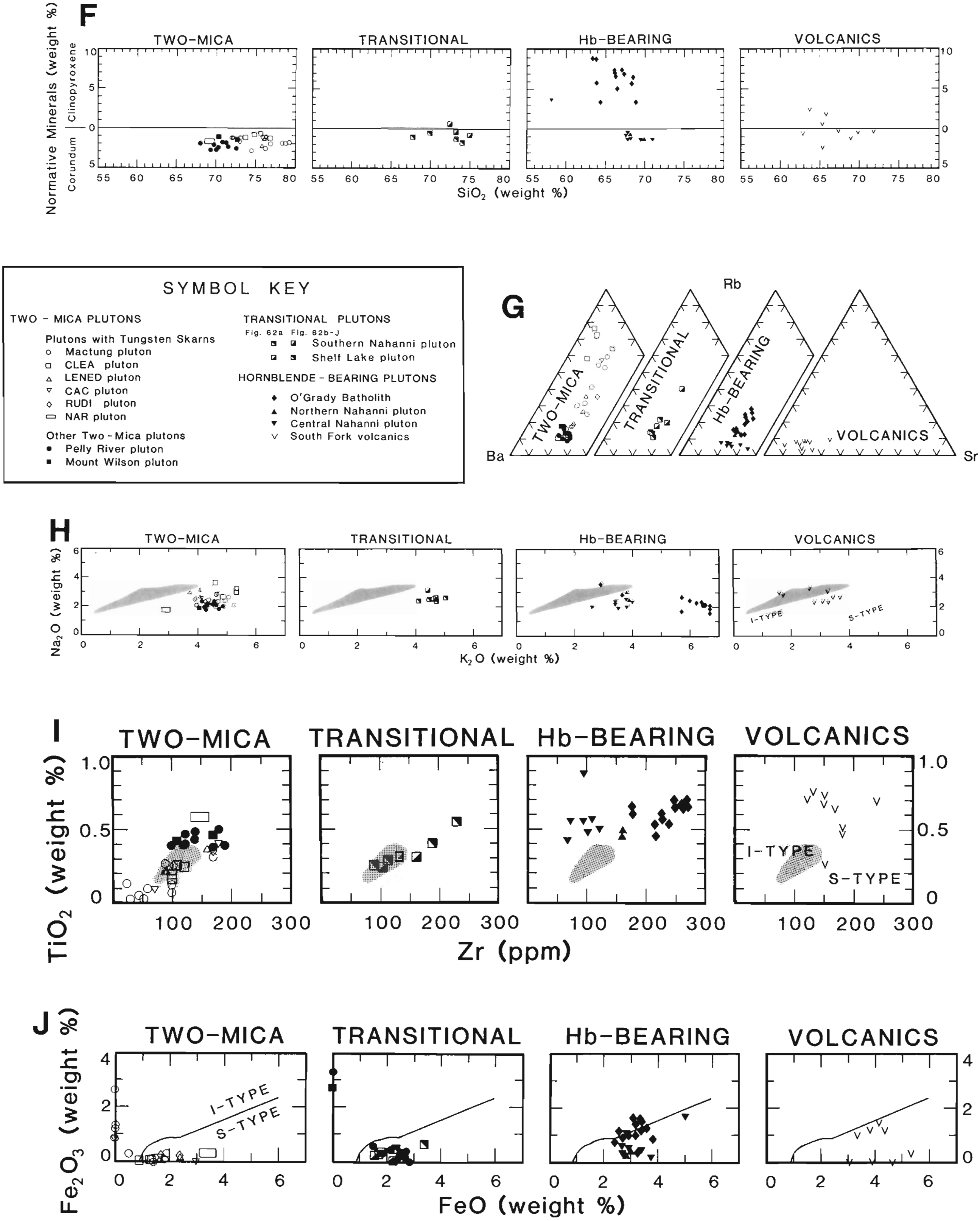
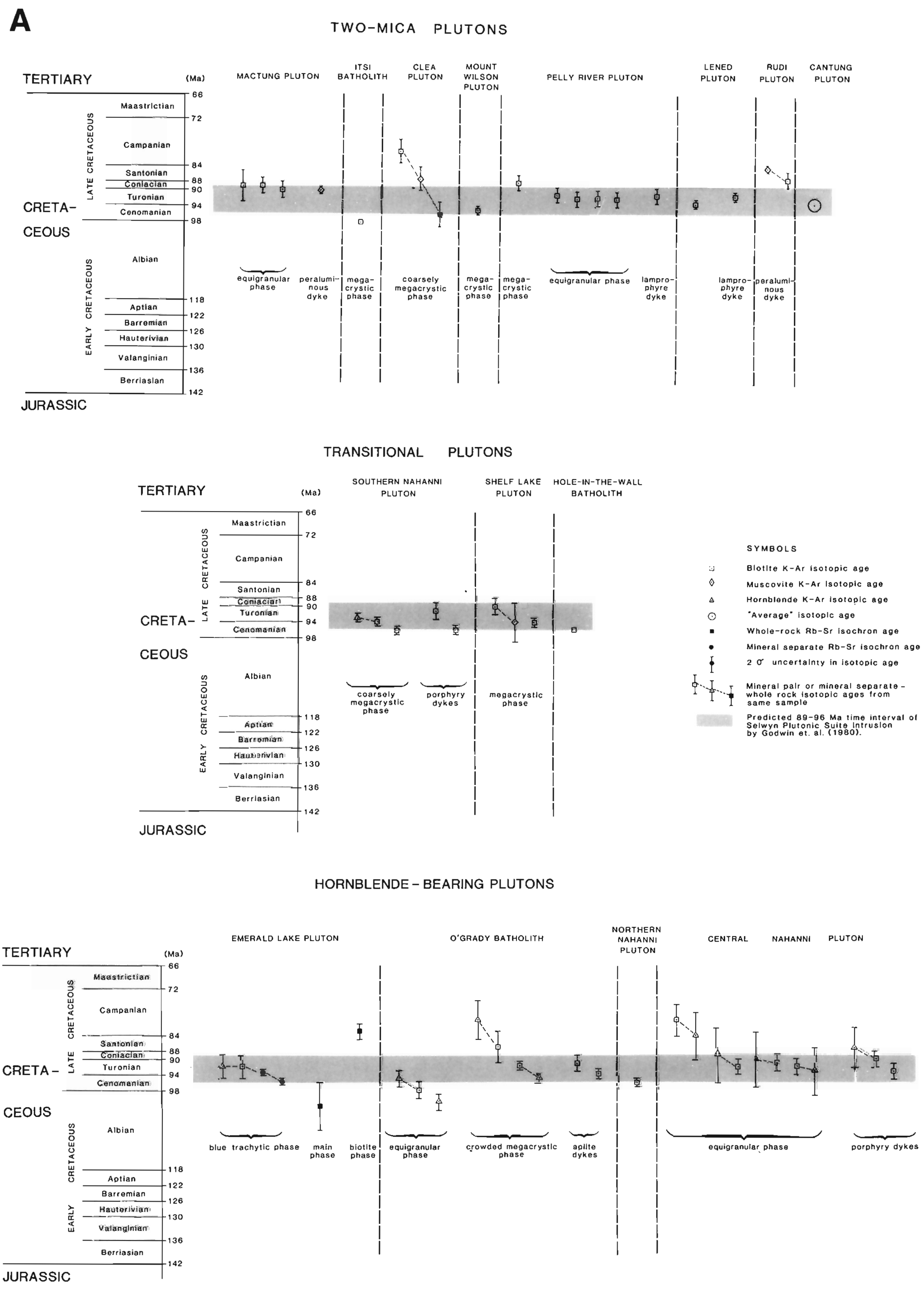


Figure 62. Geochemical variation diagrams for volatile-free compositions of the two-mica, transitional, and hornblende-bearing plutons in the Selwyn Plutonic Suite and also the mid-Cretaceous South Fork volcanics. Note change of symbol key for Figure 61A and 61B-J. Fields for Kosciusko Batholith's I-type and S-type plutons in Figures 61H-J from Hine et al. (1978).

A. Harker variation diagrams.
B. Total alkali-silica plot (alkaline-subalkaline division from Irvine and Baragar (1971)).
C. AFM (tholeiitic-calc alkaline division based on Irvine and Baragar (1971).
D. CaO-Na2O-K2O ternary plot.
E. A/CNK (molecular $Al_2O_3/(CaO+Na_2O+K_2O)$) histogram.
F. Normative corundum/clinopyroxene-silica plot.
G. Ba-Rb-Sr ternary plot.
H. Na_2O-K_2O plot.
I. TiO_2-Zr plot.
J. Fe_2O_3-FeO plot.


F
TWO-MICA
TRANSITIONAL
Hb-BEARING
VOLCANICS
Normative Minerals (weight %)
Clinopyroxene
Corundum
10
5
0
5
55 60 65 70 75 80
SiO$_2$ (weight %)
SYMBOL KEY
TWO - MICA PLUTONS
Plutons with Tungsten Skarns
○ Mactung pluton
□ CLEA pluton
△ LENED pluton
▽ CAC pluton
◇ RUDI pluton
▭ NAR pluton
Other Two - Mica plutons
● Pelly River pluton
■ Mount Wilson pluton
TRANSITIONAL PLUTONS
Fig. 62a Fig. 62b-J
◪ ◩ Southern Nahanni pluton
◩ ◪ Shelf Lake pluton
HORNBLENDE - BEARING PLUTONS
◆ O'Grady Batholith
▲ Northern Nahanni pluton
▼ Central Nahanni pluton
V South Fork volcanics
G
Rb
Ba
Sr
TWO-MICA
TRANSITIONAL
Hb-BEARING
VOLCANICS
H
TWO-MICA
TRANSITIONAL
Hb-BEARING
VOLCANICS
Na$_2$O (weight %)
0 2 4 6
K$_2$O (weight %)
I-TYPE
S-TYPE
I
TWO-MICA
TRANSITIONAL
Hb-BEARING
VOLCANICS
TiO$_2$ (weight %)
1.0
0.5
0
100 200 300
Zr (ppm)
I-TYPE
S-TYPE
J
TWO-MICA
TRANSITIONAL
Hb-BEARING
VOLCANICS
Fe$_2$O$_3$ (weight %)
4
2
0
0 2 4 6
FeO (weight %)
I-TYPE
S-TYPE


A
TWO-MICA PLUTONS
TERTIARY
(Ma)
MACTUNG PLUTON
ITSI BATHOLITH
CLEA PLUTON
MOUNT WILSON PLUTON
PELLY RIVER PLUTON
LENED PLUTON
RUDI PLUTON
CANTUNG PLUTON
LATE CRETACEOUS
EARLY CRETACEOUS
CRETA- CEOUS
Maastrictian
Campanian
Santonian
Coniacian
Turonian
Cenomanian
Albian
Aptian
Barremian
Hauterivian
Valanginian
Berriasian
JURASSIC
66
72
84
88
90
94
98
118
122
126
130
136
142
equigranular phase
peraluminous dyke
megacrystic phase
coarsely megacrystic phase
megacrystic phase
megacrystic phase
equigranular phase
lamprophyre dyke
lamprophyre dyke
peraluminous dyke
TRANSITIONAL PLUTONS
SOUTHERN NAHANNI PLUTON
SHELF LAKE PLUTON
HOLE-IN-THE-WALL BATHOLITH
coarsely megacrystic phase
porphyry dykes
megacrystic phase
SYMBOLS
Biotite K-Ar isotopic age
Muscovite K-Ar isotopic age
Hornblende K-Ar isotopic age
"Average" isotopic age
Whole-rock Rb-Sr isochron age
Mineral separate Rb-Sr isochron age
2 σ uncertainty in isotopic age
Mineral pair or mineral separate - whole rock isotopic ages from same sample
Predicted 89-96 Ma time interval of Selwyn Plutonic Suite intrusion by Godwin et. al. (1980).
HORNBLENDE - BEARING PLUTONS
EMERALD LAKE PLUTON
O'GRADY BATHOLITH
NORTHERN NAHANNI PLUTON
CENTRAL NAHANNI PLUTON
blue trachytic phase
main phase
biotite phase
equigranular phase
crowded megacrystic phase
aplite dykes
equigranular phase
porphyry dykes

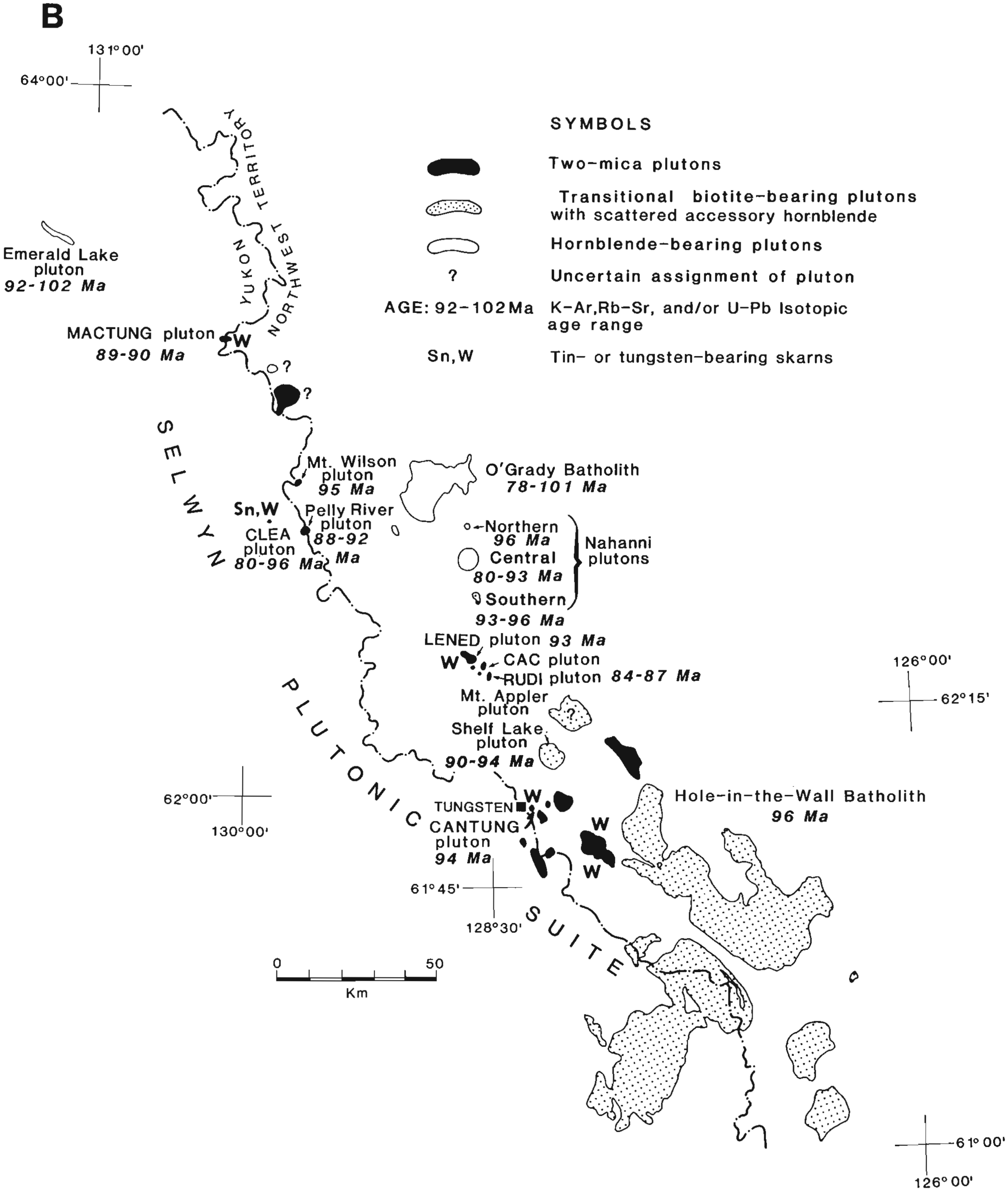


Figure 63 a and b. Summary diagram for geochronometry of the Selwyn Plutonic Suite. Data are from the compilation of Anderson (1983) and unpublished data (see Table 3) and time scale of Armstrong (1978).

Table 3. Isotopic age determinations forSelwyn Plutonic Suite

Unit[1]	K-Ar Determination Number	Sample Number	Age (Ma)	Material Dated[2]	Comments (Reference)[3]
TWO-MICA PLUTONS					
MacTung pluton					
equigranular phase	GSC 73-74	FJ68-320-2	89 ± 4	Bi	(Ref. No. 7, p. 26)
mafic equigranular phase	GSC 87-130	ANMT-81-8-1	89 ± 2	Bi	(Ref. No. 5, p. 175)
peraluminous equigranular phase	GSC 87-131	ANMT-81-5-6	90 ± 2	Bi	(Ref. No. 5, p. 175)
peraluminous satellitic dyke	GSC 87-133	ANMT-82-331-1	90 ± 1	Mu	(Ref. No. 5, p. 180)
Itsi batholith					
	AK 125	same	98 ± 5	Bi	University of Alberta K-Ar determination (Ref. No. 2, p. 459)
Clea pluton					
megacrystic phase	KTP-Bi	same	80 ± 3	Bi	University of British Columbia K-Ar determination (Ref. No. 4, p. 92)
same as above	KTP-Mu	same	87 ± 3	Mu	same as above (Ref. No. 4, p. 92)
megacrystic phase	KTP-WR KTP-Bi KTP-Mu	same	96 ± 3	WR, Bi, Mu	University of British Columbia Rb-Sr whole-rock-mineral isochron (Ref. No. 4, p. 92)
Mount Wilson pluton					
megacrystic phase	GSC 87-113	ANMW-82-328-1	95 ± 1	Bi	(Ref. No. 5, p. 168)
Pelly River pluton					
equigranular phase	GSC 87-90	GGAA-80-21a-2	92 ± 2	Bi	(Ref. No. 5, p. 164)
equigranular phase	GSC 87-101	ANPR-81-22-8	92 ± 2	Bi	(Ref. No. 5, p. 166)
equigranular phase	GSC 87-102	ANPR-81-25-1	92 ± 2	Bi	(Ref. No. 5, p. 166)
equigranular phase	GSC 87-103	ANPR-82-27-7	91 ± 2	Bi	(Ref. No. 5, p. 166)
megacrystic phase	GSC 87-98	ANPR-81-32-5	88 ± 2	Bi	(Ref. No. 5, p. 165)
biotite lamprophyre	GSC 87-112	ANPR-81-30-2	91 ± 2	Bi	(Ref. No. 5, p. 168)
Lened pluton					
coarsely megacrystic phase	GSC 87-121	ANLD-82-274-1	93 ± 1	Bi	(Ref. No. 5, p. 169)
biotite lamprophyre dyke	GSC 87-129	ANLZ-82-278-1	91 ± 1	Bi	dyke crosscuts skarn (Ref. No. 5, p.171)
Rudi pluton					
peraluminous satellitic dyke	GSC 87-122	ANRU-82-241-3	87 ± 2	Bi	(Ref. No. 5, p. 170)
same as above	GSC 87-123	"	84 ± 1	Mu	(Ref. No. 5, p. 170)
CanTung pluton					
	AHC-11	same	94 ± 3	Bi	Queen's University K-Ar determination (Ref. No. 1, p. 1207)
TRANSITIONAL PLUTONS					
Gun Pluton					
equigranular phase	ATM-85-15	same	106 ± 8.0	Bi	University of British Columbia K-Ar determination (Gareau, 1986, p. 28)
equigranular phase	AT-85-98-3	same	94.2 ± 6.6	Bi	University of British Columbia K-Ar determination (Gareau, 1986, p. 28)
equigranular phase	ATM-85-15	same	99 ± 6.0	WR, Bi, KF, Plag	University of British Columbia Rb-Sr determination (Gareau, 1986, p. 29)
equigranular phase	ATM-85-98-3	same	97 ± 12	WR, Bi, KF, Plag	University of British Columbia Rb-Sr determination (Gareau, 1986, p. 29)
Southern Nahanni pluton					
coarsely megacrystic phase	GSC 87-120	ANSS-82-298-1	96 ± 1	Bi	(Ref. No. 5, p. 169)

Table 3. Continued

Unit[1]	K-Ar Determination Number	Sample Number	Age (Ma)	Material Dated[2]	Comments (Reference)[3]
Southern Nahanni pluton (cont'd.)					
coarsely megacrystic phase	GSC 87-124	ANSS-82-300-1	94 ± 1	Bi	(Ref. No. 5, p. 170)
same as above	GSC 87-125	"	93 ± 1	Hb	(Ref. No. 5, p. 170)
porphyry dyke	GSC 87-89	GGA-79-44E-1	91 ± 2	Bi	(Ref. No. 5, p. 163)
porphyry dyke	GSC 87-119	ANSS-82-293-1	96 ± 1	Bi	(Ref. No. 5, p. 169)
Shelf Lake pluton					
megacrystic phase	GSC 87-93	GGAA-80-102b-1	90 ± 2	Bi	(Ref. No. 5, p. 164)
same as above	GSC 87-94	"	94 ± 5	Mu	(Ref. No. 5, p. 164)
megacrystic phase	GSC 87-128	ANFL-82-312-6	94 ± 1	Bi	(Ref. No. 5, p. 170)
Hole-In-The-Wall Batholith					
	AK-107	same	96 ± 5	Bi	University of Alberta K-Ar determination (Ref. No. 2, p. 459)
HORNBLENDE-BEARING PLUTONS					
Emerald Lake pluton					
blue trachytic phase	X-5	same	92 ± 3	Bi	University of British Columbia K-Ar determination (Ref. No. 6)
same as above	same as above	"	92 ± 3	Hb	same as above
same as above	X-5(-Bi)	"	156 ± 30	WR, Hb, Plag, K-spar	U.B.C. Rb-Sr whole-rock-mineral isochron age (Ref. No. 6)
same as above	X-5	"	93.5 ± 0.5 95.6 ± 0.8	zircon	University of British Columbia U-Pb determination (Ref. No. 6)
main phase	X-2	X-2	102 ± 6	WR, Hb, Plag, K-spar	University of British Columbia Rb-Sr whole-rock-mineral isochron age (Ref. No. 6)
biotite phase	X-6	X-6	83 ± 2	WR, Bi, Plag, K-spar	same as above (Ref. No. 6)
same as above	X-6(-Bi)	"	76 ± 5	WR, Plag K-spar	same as above (Ref. No. 6)
O'Grady batholith					
equigranular phase	GSC 87-114	ANOG-82-130-1	101 ± 2	Hb	(Ref. No. 5, p. 168)
equigranular phase	GSC 87-116	ANOG-82-232-1	98 ± 2	Bi	(Ref. No. 5, p. 168)
same as above	GSC 87-117	"	95 ± 2	Hb	(Ref. No. 5, p. 169)
crowded megacrystic phase	GSC 67-65	BU66-27-5	80 ± 5	Hb	(Ref. No. 7, p. 37)
same as above	GSC 67-66	"	87 ± 4	Bi	(Ref. No. 7, p. 37)
crowded megacrystic phase	GSC 87-92	GGAB-81-31a-2	78 ± 4	Hb	(Ref. No. 5, p. 164)
crowded megacrystic phase	GSC 87-126	ANOG-82-138-1	92 ± 1	Bi	(Ref. No. 5, p. 170)
same as above	GSC 87-127	"	95 ± 1	Hb	(Ref. No. 5, p. 170)
aplite intrusions	GSC 87-97	GGAB-80-31b-1	91 ± 2	Bi	(Ref. No. 5, p. 165)
aplite intrusions	GSC 87-115	ANOG-82-166-2	94 ± 1	Bi	(Ref. No. 5, p. 168)
Northern Nahanni pluton					
equigranular phase	GSC 87-95	ANNN-82-177-3	96 ± 1	Bi	(Ref. No. 5, p. 169)
Central Nahanni pluton					
equigranular phase	GSC 87-95	ANSN-81-46-2	80 ± 4	Bi	(Ref. No. 5, p. 164)
same as above	GSC 87-96	"	84 ± 6	Hb	(Ref. No. 5, p. 165)
equigranular phase	GSC 87-99	ANSN-81-42-3	91 ± 2	Bi	(Ref. No. 5, p. 165)
same as above	GSC 87-100	"	90 ± 7	Hb	(Ref. No. 5, p. 165)
equigranular phase	GSC 87-108	ANSN-81-54-2	92 ± 2	Bi	(Ref. No. 5, p. 167)
same as above	GSC 87-109	"	89 ± 7	Hb	(Ref. No. 5, p. 167)
equigranular phase	GSC 87-110	ANSN-81-38-1	92 ± 2	Bi	(Ref. No. 5, p. 167)
same as above	GSC 87-111	"	93 ± 6	Hb	(Ref. No. 5, p. 168)
porphyry dyke	GSC 87-104	ANSN-81-58-1	90 ± 2	Bi	(Ref. No. 5, p. 166)
same as above	GSC 87-105	"	87 ± 5	Hb	(Ref. No. 5, p. 166)
porphyry dyke	GSC 87-106	ANSN-81-43-2	93 ± 2	Bi	(Ref. No. 5, p. 167)

[1] after Anderson (1982, 1983)

[2] Abbreviations are: Bi = biotite; Hb = hornblende; KF = alkali feldspar; Mu = muscovite; Plag = plagioclase; and WR = whole rock.

[3] References are: 1) Archibald et al., 1978; 2) Baadsgaard et al., 1961a; 3) Gareau, 1986; 4) Godwin et al., 1980; 5) Anderson *in* Hunt and Roddick, 1987; 6) Smit et al., 1985, 7) Wanless et al., 1970; 8) Wanless et al., 1974.

(less than 4 weight percent except for O'Grady Batholith; Fig. 62H) and are depleted in total alkalis compared with total iron and MgO (e.g. Fig. 62C) relative to two-mica plutons. Two-mica plutons are comparatively evolved (D.I. greater than 72 weight percent) and depleted in CaO, total iron, MgO, and TiO_2 compared with hornblende-bearing types (Fig. 62A, C, D, I, J). Hornblende-bearing plutons are diopside-normative or contain less than 1.5 weight percent normative corundum (Fig. 62F). Their generally metaluminous Shand indices (molar $Al_2O_3/(CaO + Na_2O + K_2O)$ or A/CNK) are less than 1.08 (Fig. 62E) whereas two-mica plutons are almost invariably corundum-normative (up to 4 weight percent normative corundum) and peraluminous.

Trace element differences also distinguish the two end member plutonic types (Table 2). Hornblende-bearing plutons have greater Cr, Ni, V, Sr, Ba, La, and Y contents and slightly larger K/Rb and Ba/Rb ratios. They also have smaller Rb contents and smaller Rb/Sr and K/Ba ratios than two-mica plutons (e.g. Table 2 and Fig. 62G; cf. Sinclair, 1986). Transitional plutons have major, minor, and trace element compositions intermediate between hornblende-bearing and two-mica plutons.

Radiogenic and stable isotope values also discriminate between the two plutonic end members in the suite (Anderson et al., 1983; Pigage and Anderson, 1985). Initial $^{87}Sr/^{86}Sr$ ratios for the suite, calculated from isochrons, or from whole rock Rb-Sr data and independent estimates of isotopic age, range from 0.7090 to 0.7405. The hornblende-bearing plutons have the lower initial Sr ratios, generally less than 0.720 (Anderson et al., 1983; Smit et al., 1985; Pigage and Anderson, 1985). The Gun pluton, representative of the transitional plutons, has a medial initial $^{87}Sr/^{86}Sr$ ratio of 0.7316 (Gareau, 1986). Median, whole rock $\delta^{18}O$ values for hornblende-bearing plutons (range of 9.1-10.1^{o}/oo) are lower than those for two-mica plutons (range of 8.9-13.1^{o}/oo) but predominantly 10-12^{o}/oo) (Anderson et al., 1983 and J.R. Bowman, unpublished data 1983; Dagenais, 1984; Dagenais and Muehlenbachs, 1984).

Many of the petrographic and geochemical characteristics of the Selwyn Plutonic Suite suggest the application of terms I-type to the hornblende-bearing plutons and S-type to the two-mica plutons (Chappell and White, 1974; White and Chappell, 1983). The Selwyn Plutonic Suite and other mid-Cretaceous metaluminous and peraluminous plutons that define the metamorphic and plutonic welt of the Omineca Belt, are the closest, albeit imperfect, Cordilleran equivalents of I- and S-type Lachlan fold belt plutonism (Anderson, 1988; Woodsworth et al., in press). There is not a rigorous correspondence between the Selwyn Plutonic Suite's composition and some of the geochemical characteristics of I- and S-type granites (e.g. Fig. 62H, I, J). The Selwyn Plutonic Suite underlies at least an order of magnitude less area than the comparable I- and S-type plutons in the Lachlan fold belt (Chappell and Stephens, 1988; White and Chappell, 1988). However, the terms are useful in a descriptive sense for the Selwyn Plutonic Suite and as exploration guides (e.g. the association of hornblende-bearing I-type plutons with chalcophile (Mo-Cu-As) and gold showings, compared with the association of hornblende-free two-mica S-type plutons with granophile W-base metal skarn deposits) (Anderson, 1983, 1988).

The influence of an old radiogenic sialic crust as protolith and/or contaminant, indicated by the suite's stable and radiogenic isotopic character, is significant in the generation of all three plutonic types. It masks any geochemical vestige of potential primitive, igneous-type parent for even the least evolved hornblende-bearing pluton in the suite. No mafic or ultramafic phases occur in the suite, unlike the mafic and ultramafic phases common to the coeval mid-Cretaceous Tombstone plutonic suite to the northwest (Anderson, 1987).

The hornblende-bearing O'Grady, Emerald Lake, and Keele Peak plutons are intermediate in mineralogy, geochemical composition, and associated metallogeny between I- and A-type granitoids (e.g. Collins et al., 1982).

Contact metamorphism

Metamorphic aureoles are accompanied by obvious, rusty, pyritiferous alteration in noncalcareous country rock protoliths up to 3 km in width. The rusty alteration occurs in granitic rock where the country rock is limestone. Intrusive contacts are steep and discordant. Commonly, compositional layering in hornfels dips radially away from the plutons. Where the country rock or hornfels layering is gently dipping, as along the southwestern margin of the O'Grady Batholith and around the MacTung, Clea, Lened, Cac, and Rudi plutons, a gently dipping intrusive contact or the roof of the pluton is indicated.

Felsenmeer and the discontinuity of horizons of appropriate bulk composition hamper mapping of isograds within aureoles. In pelites, the first appearance of andalusite (and commonly biotite) occurs within one half kilometre of the intrusive contact, well within the rusty aureole. In carbonate country rock, alternating green, diopside-rich and reddish-brown, garnet-rich (± talc ± calcite ± tremolite) compositional layering appears concordant with unmetamorphosed strata. Rare diopside-, garnet-, and plagioclase-rich skarns crosscut the compositional layering. Andalusite-bearing hornfels and known stratigraphic thicknesses indicate an epizonal to mesozonal 3.3 to 11.6 km emplacement depth (see section on Regional Metamorphism; Turner, 1981; Anderson et al., 1983). The broad estimate of depth is consistent with sharp discordant intrusive contacts, narrow aureoles, and iron-bearing muscovite in the two-mica plutons, which suggest high level intrusion.

Age and lithocorrelation

Stratigraphic constraints on the age of the Selwyn Plutonic Suite are poor. It sharply intrudes and metamorphoses folded strata ranging in age from latest Proterozoic (Vampire Formation) to Triassic (Jones Lake Formation) in the southeastern, central, and northwestern parts of the map area. No strata younger than the intrusions were recognized in the map area. Coeval volcanics occur in Sheldon Lake and Tay River map areas (Wood, 1981; Wood and Armstrong, 1982, Pigage and Anderson, 1985; Gordey and Irwin, 1987).

The reliable mineral K-Ar, whole rock and whole rock-mineral Rb-Sr isochron, and U-Pb isotopic ages for the suite (54 determinations) range from 80 to 106 Ma and average 92.4 ± 10.9 (2σ) Ma (Pigage and Anderson, 1985; Smit et al., 1985; Gareau 1986; Anderson *in* Hunt and Roddick, 1987, p. 163-180; see Fig. 63 and Table 3 for additional references).

Aplite, lamprophyre, porphyry, and peraluminous dykes, which crosscut the plutons or are cospatial with the plutons and intrude the contact aureole, yield K-Ar isotopic ages (12 determinations) that have a similar range (84-96 Ma) and average (90.4 ± 6.4 Ma (2σ)) which indicate that emplacement of the Selwyn Plutonic Suite must be earlier. The average isotopic age for the suite's plutons and dykes is 92.1 ± 10.3 (2σ) Ma (66 determinations).

No single isotopic system provides an unequivocal emplacement age for a given pluton. K-Ar mineral isotopic ages only provide estimates for a particular intrusion's time of cooling. Analytical details for the K-Ar geochronometry in Table 3 are given by Anderson (*in* Hunt and Roddick, 1987, p. 163-180). Evidence for intraplutonic discordant mineral pairs in K-Ar (Fig. 63a), inherited Pb in the zircon U-Pb, and errochrons in the whole rock and whole rock-mineral Rb-Sr isotopic systems, to be detailed in other publications, suggest that the isotopic systems for the apparently simple posttectonic plutons of the Selwyn Plutonic Suite are surprisingly poorly behaved and unpredictable (e.g. Anderson et al., 1983; Anderson *in* Hunt and Roddick, 1987, p. 163-180). The oldest reliable K-Ar isotopic ages for hornblende in plutons and for hornblende or biotite in crosscutting dykes are likely the best estimates for the minimum age for the Selwyn Plutonic Suite and suggest a youngest age range of 93 to 101 Ma for the suite's intrusion. The age range is in accord with reliable Rb-Sr isochron ages (e.g. Tompson, 1978: Godwin et al., 1980; Smit et al., 1985; Gareau, 1986) and a U-Pb isotopic age for the Emerald Lake pluton (Smit et al., 1985; Table 3). Isotopic ages for the suite's three plutonic varieties and for constituent phases in individual plutons are indistinguishable. Archibald's (unpublished Union Carbide Company report, 1980, 1981) K-Ar ages for northern and southern Nahanni, Mount Appler, Lened, Cac, Rudi, and Shelf Lake plutons are similar to the overall range of the Selwyn Plutonic Suite and to the isotopic ages reported here for a particular pluton.

The suite is coeval and cospatial with the important tungsten skarns in the area. A sample of one biotite lamprophyre dyke was collected in drill core where intrusive relations suggest that the dyke crosscuts garnet skarn associated with tungsten mineralization at the Lened camp (K. Glover, pers. comm., 1982; K-Ar isotopic analysis GSC 87-129). The mid-Cretaceous K-Ar isotopic age (91 ± 1 Ma) for the dyke's biotite is identical to that for another lamprophyre dyke (determination GSC 87-112) and for porphyry dykes in other plutons. The isotopic age confirms that the skarn mineralization is no younger than the mid-Cretaceous two-mica plutons that are cospatial with it. The dyke's isotopic age is concordant with or slightly younger than the 92 to 95 Ma ages determined by Archibald et al. (1978) for biotite- and amphibole-bearing skarn at CanTung. The dyke's isotopic age is coeval with mid-Cretaceous ages determined for sericitic alteration of the Lened, Cac, and Rudi plutons near subparallel quartz-tourmaline veins (Archibald, unpublished Union Carbide Company report 1980).

Lithologically and petrologically similar mid-Cretaceous intrusions, here included in the Selwyn Plutonic Suite, are recognized to the northwest and southeast of the Nahanni map area (Table 1; Figs. 52 and 63b), and southwest of the map areas (Anvil plutonic suite; Pigage and Anderson, 1985). Plutons that have been studied, at least in reconnaissance, and are included in the suite are: plutons in the southwestern Sekwi Mountain map area (NTS 105P; Blusson, 1971, p. 15, unit 31; J.G. Abbott, pers. comm., 1982); Emerald Lake (Smit, 1984; Smit et al., 1985) and parts of Keele Peak (Cecile, 1986a) plutons in Niddery Lake map area (NTS 105O); the Itsi batholith (Baadsgaard et al., 1961a,b) and Gun pluton (Gareau, 1986) partly in Sheldon Lake map area (NTS 105J; Gordey and Irwin, 1987); CanTung pluton and nearby stocks (Blusson, 1968; Archibald et al., 1978; Bowman et al., 1985) in Frances Lake map area (NTS 105H); Hole-in-the-Wall and Coal River batholiths in Flat River map area (NTS 95E; Gabrielse, 1967; Gabrielse et al., 1973); and Mount Appler pluton (Mako, 1981, p. 87; Mako and Shanks, 1984) in Glacier Lake map area (NTS 95L; Gabrielse et al., 1973). Emerald Lake pluton is lithologically, structurally, petrographically, geochemically, and isotopically very similar to the coeval O'Grady Batholith. Orchay and Mount Mye phases of the Anvil plutonic suite are the Anvil Range representatives of the hornblende-bearing and two-mica plutonic varieties in the eastern Selwyn Mountains (Pigage and Anderson, 1985).

REGIONAL METAMORPHISM

Strata in Nahanni map area are of subgreenschist facies metamorphic grade. The most obvious mineral changes are pressure solution and the growth of fine grained mica and other minerals outlining slaty cleavage. Estimating temperatures attained by pelitic rocks of such low grade is difficult, the most common methods employing the alteration of organic matter, including microfossils, and the structural and compositional state of sheet silicates (Turner, 1981). Only the former has been considered in this study, and this only briefly. Maximum pressure in the Nahanni area has been estimated by considering maximum depth of burial.

Temperature

Epstein et al. (1977) have shown that the colour of conodonts changes progressively from pale yellow through black to white with increasing temperature, and have devised a colour alteration index (CAI) for which conodont colour has been calibrated against temperature and time. Inconsistencies in judging CAI values can occur because of the variation in shape and size and thus colour found in any collection of conodont elements.

Conodonts from Nahanni map area have CAI values ranging from 5 to 7 (Fig. 64). Values between 6 and 7 are abnormally high and occur next to granitic intrusions. Values of 5 to 6, and most commonly 5 are found across the map area from Summit Lake, southwest of which there are no data, to its northeastern corner. The age of these collections ranges from Early Ordovician to Triassic. The indices do not vary systematically with stratigraphic position (i.e. conodont age), nor geographically across the map area (Fig. 64). Byomparison with the chart of Epstein et al. (1977, Fig. 9, p. 11) temperatures from 300 to 325°C are indicated for durations of heating from 100 to 10 million years respectively for a CAI of about 5. The duration of elevated temperatures used presumes that the conodonts obtained their colour during a relatively short-lived Cretaceous heating event (see below).

Optical properties of the skeletal materials of graptolites, including reflectance, bireflectance, refractive index, and absorptive index vary systematically with temperature (Goodarzi and Norford, 1985) and allow an estimate of maximum temperature reached during burial. However, the CAI of conodonts collected with the graptolites is used as temperature calibration so that independent estimate of temperature from the graptolites alone is not possible. Two graptolite collections from Nahanni map area have optical properties consistent with the CAI=5 values in the area (B.S. Norford, pers. comm., 1985).

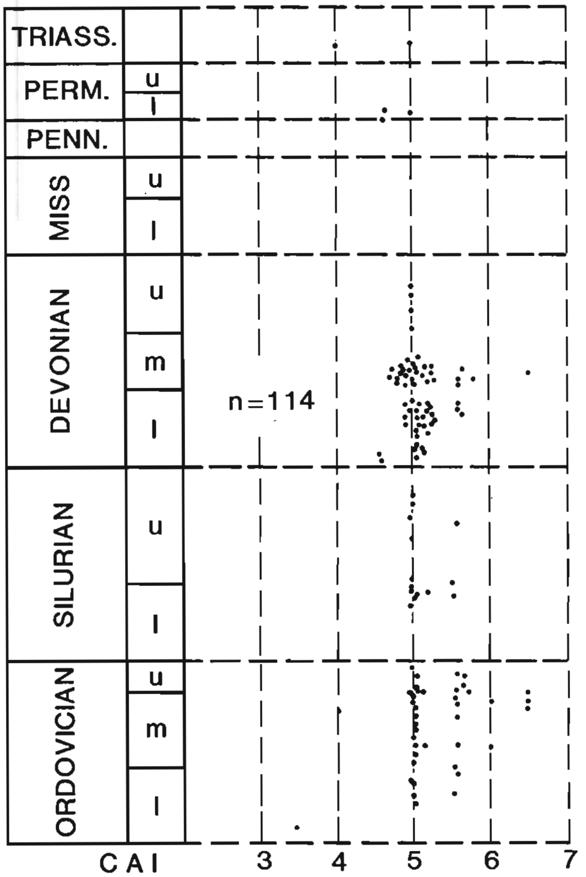


Figure 64. Conodont alteration indices (CAI) as a function of age. The uniformity of CAI values from 5 to 6 across Nahanni map area regardless of age results from regional high heat flow accompanying the intrusion of mid-Cretaceous post-tectonic plutons. Values of 6 and higher are found within the contact aureole of these plutons.

Macqueen and Barker (1981), in an investigation of the breakdown of organic matter associated with shale-hosted lead-zinc deposits in Nahanni map area (the XY and Vulcan properties), suggest temperatures exceeded 200°C.

Pressure

An estimate of maximum pressure using mineralogical analysis was not attempted. Mineral assemblages in low-grade pelitic and carbonate rocks can be stable over a wide range of pressure. However, a pressure estimate can be obtained by estimating the maximum depth of burial; lithostatic pressure increases at a rate of 250 to 300 bars/km depending on rock density. For example, the Steel Formation was buried to a depth of about 3.3 km (using maximum thicknesses of overlying formations) by the end of the Triassic. Jurassic and earliest Cretaceous strata are not preserved and there is no control over what might have been their thickness. However, even allowing a further 1.5 km of burial, the Steel Formation was no deeper than about 4.8 km before the mid-Cretaceous. By this time, cover strata were likely eroding through uplift related to deformation and granitic intrusion. A depth of burial of 4.8 km is roughly equivalent to a lithostatic load of only 1.5 kb. Using the same rationale, it is unlikely that even the deepest buried strata now at surface (lower Hyland Group; 9.7 km burial depth) were subjected to burial pressures greater than about 2.8 kb. The effect of Jurassic to Early Cretaceous deformation in producing an additional tectonic load, e.g. by overthrust sheets, was probably slight. Even allowing another 1 km of tectonic load, the total maximum pressure attained in the map area was probably less than 3.2 kb. The andalusite developed within contact aureoles of granitic rocks (see section on Selwyn Plutonic Suite) implies pressures no greater than about 3.5 kb during pluton emplacement (Turner, 1981).

Age of metamorphism

The distribution of conodont CAI values with respect to stratigraphic position can give an indication as to when the temperature was elevated. If the CAI values resulted only from burial-related heating, rocks of about the same age (and buried to similar depth) should have about the same CAI values. The younger the age of the host sediment (the less burial it has undergone), the lower should be the conodont CAI value. In the Nahanni area however, conodont CAI values are similar (from 5 to 6) regardless of their stratigraphic position. Therefore, different stratigraphic levels have been juxtaposed through deformation before temperatures were elevated. The differences in CAI expected through surface sampling have been masked by a postdeformation regional heating event. The likeliest time for this event was during intrusion of the widespread mid-Cretaceous granitic rocks. The effects of contact metamorphism are described in the section on Granitic Rocks.

TECTONICS

The geometry, lithology, and distribution of formations has been affected by several tectonic events of Paleozoic and Mesozoic age ranging from simple uplift and/or tilting and erosional bevelling, to folding and faulting. Examples related to simple uplift include the regional disconformities beneath the Mount Christie (Lower Permian) and Jones Lake (Upper Triassic) formations, and the local(?) sub-Funeral and sub-Grizzly Bear unconformities (Devonian). Major tectonic events are recorded by: 1) the thick clastics of the late Precambrian Hyland Group; 2) Middle Cambrian facies trends and a regional sub-Upper Cambrian unconformity; 3) thick clastics of the Devono-Mississippian Earn Group; and 4) Mesozoic orogeny. All major pre-Mesozoic events are inferred to result from crustal extension.

Pre-Mesozoic tectonism

Hyland Group synsedimentary tectonics

The thick submarine fan sediments of the Hyland Group are the product of rapid uplift of source areas, and subsidence of a depositional basin that accumulated at least three kilometres of sediment. The mode of uplift is uncertain, largely because the location of the clastic source areas remains unidentified. It seems unlikely that the clastics were deposited in a foredeep in front of a growing compressional belt, because the clastics themselves remained undeformed. Rapid block uplift, perhaps related to strike-slip faulting, or regional extension is probable. Rifting of latest Precambrian to earliest Cambrian age has been proposed on the basis of tectonic subsidence curves for the southern Canadian Cordillera (Bond and Kominz, 1984). There, sediments similar to the Yusezyu Formation in age and lithology (albeit with mafic volcanics) have been interpreted as a rift succession.

Within Nahanni map area no structures of Hyland Group age have been identified.

Cambrian tectonism

Middle Cambrian facies boundary

The boundary between shallow water carbonate of the Avalanche Formation and coeval slope to basinal limestone of the Rockslide Formation trends northeast in Nahanni and adjacent Glacier Lake map areas (see Fig. 16). This orientation is at right angles to northwesterly trends of the shelf margin both before and after Middle Cambrian time. Regional evidence of Middle Cambrian faulting (below) suggests this dramatic change could also be fault-controlled. However, surface evidence of Middle Cambrian faulting at the facies boundary is lacking.

Middle Cambrian faulting related to extension has been invoked to explain facies changes both in northwestern Selwyn Basin, and in northern British Columbia. In the first region, Cecile (1982) considers the Misty Creek Embayment to have formed by faulting in an extensional regime that began in Middle Cambrian time. In northern British Columbia, Fritz (1979b) describes rapid Middle Cambrian facies changes, coarse conglomerate, and graben formation that is related to Middle Cambrian extension (H. Gabrielse, pers. comm., 1988).

Sub-Upper Cambrian unconformity

The unconformity at the base of the Rabbitkettle and Haywire formations correlates with a sub-Upper Cambrian erosional interval over much of the Mackenzie, northern Rocky, Pelly, and Cassiar mountains (Gabrielse et al., 1973). Several pre-Rabbitkettle structures, which are indicative of local faulting, tilting, and long-wavelength buckling, have been identified.

Southwest of Summit Lake the rapid lateral thinning of the Gull Lake Formation reflects pre-Rabbitkettle warping, as do sub-Rabbitkettle angular relations in Flat River map area to the southeast (Gabrielse et al., 1973). An angular unconformity beneath the Rabbitkettle-equivalent Broken Skull Formation (Haywire Formation of this report) is pictured on South Nahanni Anticline by Gabrielse et al. (1973).

Three kilometres northeast of Summit Lake, the upper member of the Gull Lake Formation is truncated beneath the Rabbitkettle Formation next to a pre-Rabbitkettle normal or reverse fault with as much as 200(?) m of stratigraphic separation.

The March Fault (Fig. 65) marks the northeastern limit of the Gull Lake Formation. Two alternative explanations for this distribution each involve pre-Rabbitkettle structure. One is that pre-Cambro-Ordovician movement along the fault exposed the northeastern block to pre-Rabbitkettle erosion (Fig. 65B1). Alternatively, pre-Rabbitkettle buckling and erosion without faulting could have been the cause (Fig. 65B2). Mesozoic contraction led to either reactivation of this fault (Fig. 65C1) or to foreshortening of originally more gradational stratigraphic changes (see Fig. 65C2).

In northern Nahanni map area, deposition was continuous through the Middle to Late Cambrian. The only record of pre-Rabbitkettle disturbance may be the influx of quartz sand, the base of which defines the Rockslide-Rabbitkettle contact. The unconformity is also absent in Selwyn Basin strata to the northwest in Bonnet Plume Lake (106B) map area where Cecile (1982) describes Middle and Upper Cambrian beds in depositional continuity.

The underlying cause of sub-Upper Cambrian movements that produced the above features is uncertain. These movements predate the Rabbitkettle Formation and postdate the Gull Lake Formation, and so are of about Middle Cambrian age. They may be related to Middle Cambrian extension as described above. Broad warping or tilting of sub-Rabbitkettle strata could be accommodated by local components of strike slip and/or compression in an overall extensional regime.

Earn Group synsedimentary tectonics

In Late Devonian time there was a sudden influx of westerly-derived chert-quartz-rich clastics along much of the Canadian Cordillera (Fig. 8). Uplift of source areas has variously been related to strike-slip faulting (Eisbacher, 1983), extension (Tempelman-Kluit, 1979), and regional compression and orogenesis (Gabrielse, 1976). A recent Cordilleran-wide synthesis of the clastic succession has been presented by Gordey et al. (1987). Local acid volcanism (Pelly Mountains; Mortensen, 1982), the occurrence of steep-dipping normal or reverse syndepositional faults, widespread and exhalative barite and barite-Ag-Pb-Zn mineralization, and the general lack of compressional structures favour an extensional or transtensional regime. It is possible that this extension was associated with a stress system that featured strike-slip faulting; however, as yet, no major through-going Devonian strike-slip fault has been identified (see Cecile's (1984b) response to Eisbacher (1983)). Although the regional extent of Devono- Mississippian clastics may suggest deposition within a foredeep basin, there is no evidence of a mountain belt that resulted from coeval foreshortening of the western Canadian Cordillera.

Because uplift occurred in a deep(?) marine setting (i.e. the older Selywn Basin area) only local areas may have been elevated above sealevel to supply detritus. Whether extension occurred in response to lateral crustal stretching or to regionally distributed crustal shear is not known. If the latter, or if stretching were inhomogeneous, associated small strike-slip faults and local compressional deformation might be expected.

In Nahanni map area several structures of Devono-Mississippian age are recognized. About 8.6 km north of Summit Lake, apparently enigmatic relationships are explained by a steep fault of Earn Group age. Across this fault (Fig. 66C and 67), Portrait Lake shale and chert (north side) is juxtaposed against Prevost shale, siltstone, and sandstone (south side), and all are overlain by Prevost massive chert-pebble conglomerate. Prevost beds on the north side may have been present, but eroded before conglomerate deposition. Alternatively, the fault may represent a syndepositional normal fault against the south side of which turbidites were ponded and on the north side of which deposition was relatively starved. The conglomerate, possibly with some channelling at its base, was subsequently deposited over both.

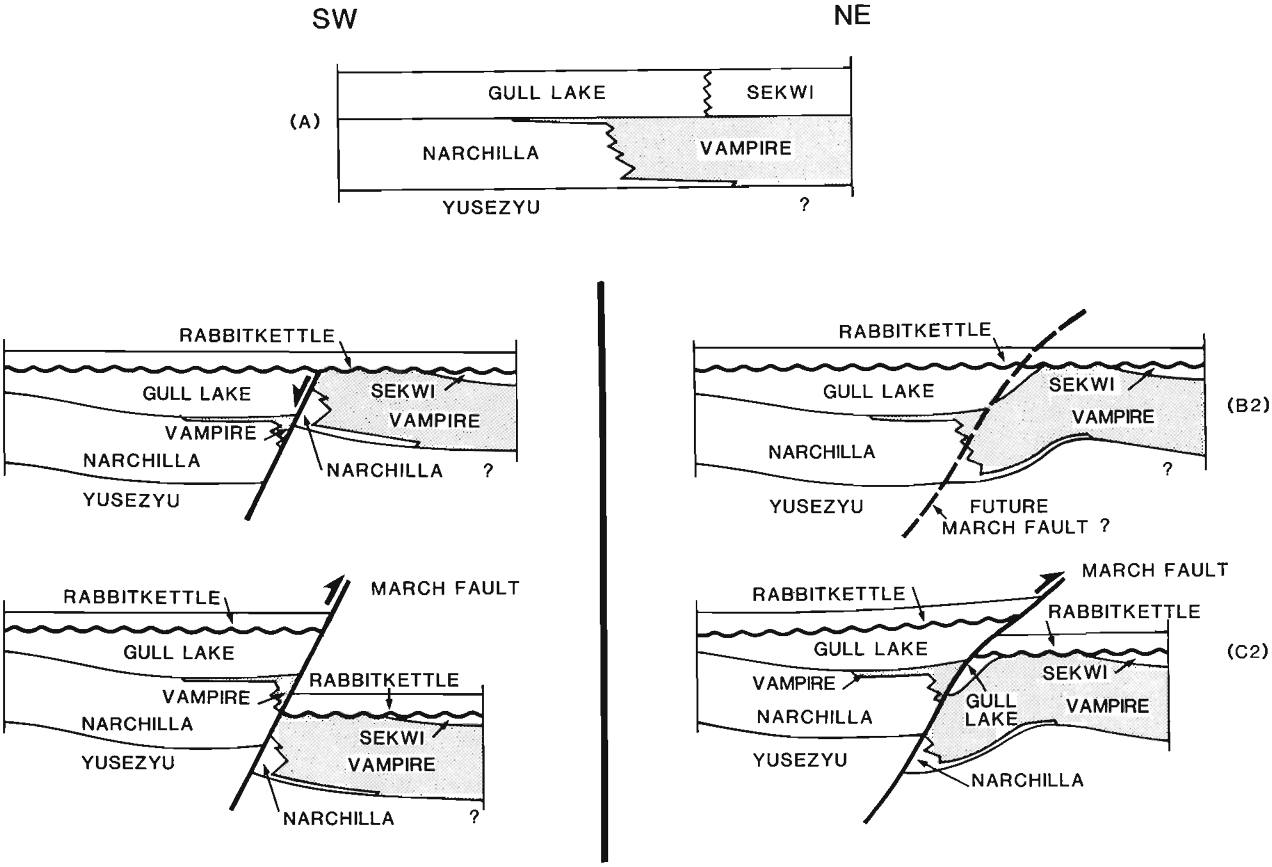


Figure 65. (Below) Diagrammatic sketches of stratigraphic relations across March Fault and an explanation for the lack of Gull Lake strata northeast of the fault. The effects of Mesozoic folding are not shown. The pre-Rabbitkettle distribution of strata is shown in (A). Gentle warping (B2) or faulting (B1) beneath the sub-Rabbitkettle unconformity led to uplift and removal of the Sekwi-Gull Lake facies transition. The March Fault may have formed through reactivation of the older normal fault (C1) or may be coincident with the earlier warping (C2).

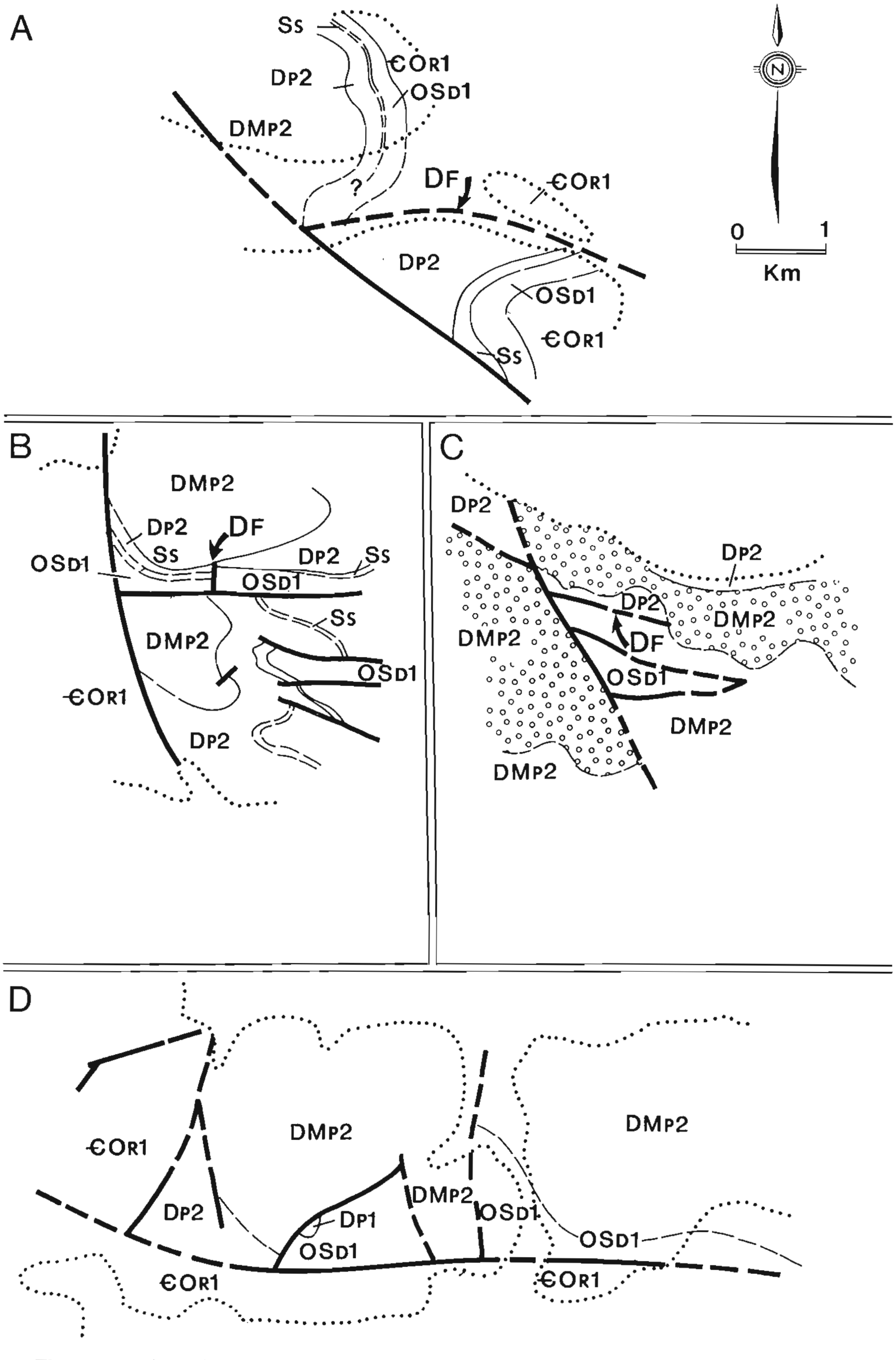


Figure 66. Sketch maps of four different areas in central Nahanni map area (locations given in text) showing evidence of possible Devonian faults (labelled DF). €OR1-Rabbitkettle; OSD1-Duo Lake; SS-Steel; DP1,2-Portrait Lake; **DMP2**-Prevost (acronyms follow legend for geological map); pattern - sandstone and conglomerate; dotted line - limit of exposure; dashed line - contact approximate; solid line - contact defined. North arrow and bar scale apply to all figures. Relationships implying Devonian faulting include: **(A)** abrupt change of thickness of DP2 across fault DF; **(B)** fault DF truncate at base of **DMP2**; **(C)** fault DF separating DP2 and **DMP2** is overlain by conglomerate of **DMP2**; **(D)** rapid changes in stratigraphic level beneath **DMP2** (and the occurrence of debris flow deposits (diamictite-DP1)) suggest Devonian faulting although such faults in this area cannot be identified.

About 12 km northeast of the northwest end of Summit Lake (Fig. 66A), the Rabbitkettle Formation is overlain by a thick section of the Road River Group and Portrait Lake Formation, but across a valley to the northwest, sub-Prevost strata are only one third or less as thick. This significant reduction occurs across a sub-Prevost fault beneath the valley cover. Missing strata on the northwestern side of the fault formed an uplifted block and were bevelled at the sub-Prevost unconformity.

About 2 km north of the head of Placer Creek, contact relationships indicate a north-trending steep sub-Prevost fault having several tens of metres of stratigraphic throw (Fig. 66B). There, the basal contact of the Portrait Lake Formation is offset in an east-side-up sense, but the base of the Prevost Formation is not disturbed. In addition, the Steel Formation is present on the west side of the fault, but is not exposed on its east side. Earlier east-side-up movement may also have occurred, leading to erosional bevelling of the Steel Formation beneath the Portrait Lake Formation.

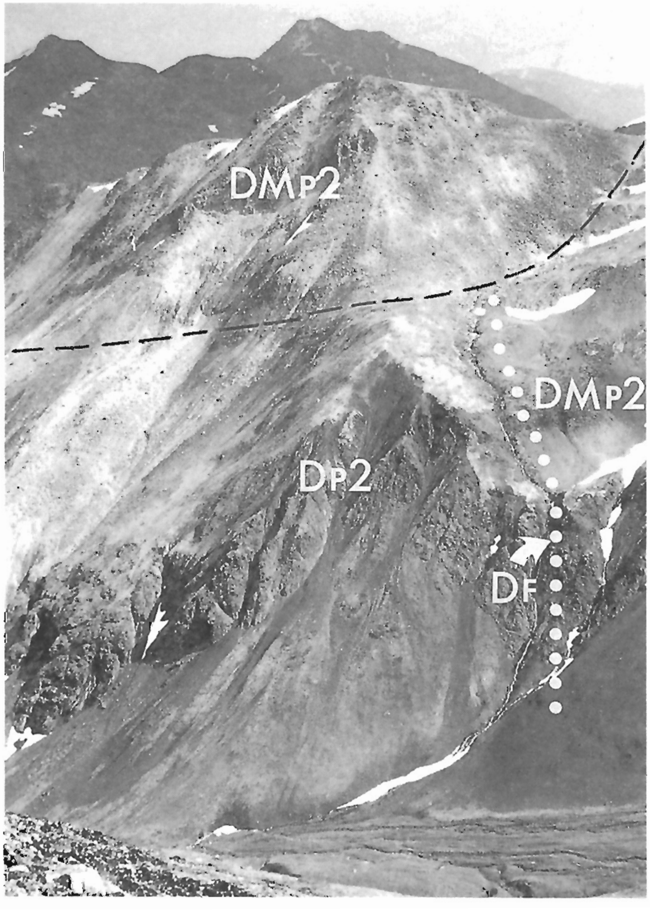


Figure 67. Possible syndepositional fault shown in Figure 66C. Symbols correspond to those of Figure 66. Photo shows east-looking view of ridge 8.5 km north of the northern end of Summit Lake. Bluish-black weathering Portrait Lake shale and chert (**D**P2) is juxtaposed across a steeply-dipping fault (DF) against brown weathering Prevost shale, and both are in turn overlain by Prevost chert-pebble conglomerate (**DM**P2). GSC 204923-B.

About 9.5 km northeast of the head of Placer Creek, complicated map relationships indicate Devonian structure (Fig. 66D). There, the Steel Formation is locally absent through both sub-Prevost and sub-Portrait Lake erosion. At one locality, poorly preserved graptolites were found in Duo Lake Formation shale a few tens of metres stratigraphically beneath cliffy exposures of brown weathering Portrait Lake(?) pebbly mudstone. Clasts within the mudstone are well rounded, consisting of chert and siliceous argillite ranging up to 10 cm in diameter. The stratigraphic level of sub-Prevost beds changes rapidly along strike, possibly through control by unidentified sub-Prevost faults, from the Duo Lake Formation to the Portrait Lake Formation (Fig. 66D).

About 6.5 km southeast of Island Lake, irregularly distributed subangular blocks of crinoidal limestone belonging to the Grizzly Bear Formation (the largest with a surface exposure of 10 by 6 m) are suspended in Prevost shale (see also Mako and Shanks, 1984). One block yielded Middle Devonian (Eifelian, australis zone) conodonts. The large size of the blocks indicates they may have slumped from a fault scarp into the Prevost Formation shale. The actual fault has not been discovered. Cover of Prevost strata, intrusive rocks, and recent erosion all hinder its recognition.

Extensional tectonics and the development of the northern Cordilleran miogeocline: summary

Pre-mid-Jurassic sedimentation within the Cordilleran miogeocline has been compared to that of a "passive" continental margin that has undergone intermittent extension (see Thompson et al., 1987 for summary). In the northern Cordillera, the oldest successions of passive margin character (i.e. thick marine sediments) are the Wernecke (>1200 Ma) and Mackenzie Mountain (1200-750 Ma) supergroups. However, the base of these successions are not exposed and their rift beginnings are not documented. The Windermere Supergroup contains well-documented evidence of syndepositional tectonics (Eisbacher, 1981) and represents an extensional event about 750 Ma ago. In the Selwyn Basin, thick turbiditic sandstone of latest Precambrian age (Hyland Group, this volume) as well as shallow marine to fluvial sandstone of the Backbone Ranges Formation in Mackenzie Mountains to the east are likely related to an extensional event. This event has been inferred by Bond and Kominz (1984) in the southern Canadian Cordillera. In the uppermost Lower Cambrian, deep water facies of the Misty Creek Embayment and Richardson Trough (Cecile, 1982), and the abrupt northward shale-out in southern Yukon all developed across Lower Cambrian relatively shallow water facies; a result of subsidence related to probable crustal extension. Alkalic basaltic (rift?) volcanism occurred intermittently in many parts of the Selwyn Basin area in lower to mid-Paleozoic time (e.g. Cecile, 1982). In the Late Devonian-Mississippian an extensional(?) event gave rise to widespread chert-quartz clastics (Earn Group, this volume; Gordey et al., 1987).

In the northern Cordillera the number and diversity of early Paleozoic tectonic elements including arches, basins, and embayments (Fig. 6) reflect large scale uneven crustal boudinage. Areas that maintained relatively thick crust became arches or paleotopographic highs. Regions that underwent crustal thinning subsided and became sites of thick sediment accumulation. The Selwyn Basin and the thick platform carbonates of Mackenzie Platform margin as well as Redstone and Ogilvie arches likely developed in response to major Eocambrian extension.

Whether any of these extension events formed oceanic crust is unknown. Very high initial strontium ratios from the mid-Cretaceous Selwyn Plutonic Suite (described in this volume) suggest much of the deep basement of the Selwyn Basin area, as far west as Tintina Fault, consists of old sialic continental crust (Godwin et al., 1980).

Mesozoic orogeny

The present map pattern in Nahanni map area is the result of shortening during mid-Jurassic to Paleocene orogeny. Deformation apparently resulted from arc-continent collision at the edge of the miogeocline (see Regional Setting) and migrated across Selwyn and Mackenzie mountains toward the craton. The effect that older structures, as described previously, may have had on the geometry and development of the Mesozoic ones is largely unknown.

The map area can be divided into two domains of contrasting structural style (Fig. 9). The Selwyn Fold Belt to the southwest features northwest-trending, open to locally tight folds and associated axial-planar slaty cleavage (Fig. 68, 69, and 70). Its underlying strata are incompetent clastics, chert, and minor limestone of the Selwyn Basin as well as overlying Devonian to Triassic clastics and chert. To the northeast the competent carbonates of the Mackenzie Platform are buckled into open folds, cut by thrust faults, and lack slaty cleavage (Fig. 71); these elements define the Mackenzie Fold Belt. Both areas display numerous steep-dipping normal and/or reverse faults whose kinematic relations to folding and thrusting are uncertain.

Figure 68. Oblique areal view southeasterly toward Mount Pike, showing distribution of strata, Little Owls Anticline, and other unnamed structures. Mountainous, yet recessive topography is typical of Selwyn Mountains, which are largely underlain by chert and clastic strata. Map units shown include the Yusezyu (ⱣY), Narchilla (ⱣЄN), Gull Lake (ЄG), and Rabbitkettle (ЄOR1) formations and the Road River Group (OSR). Dots indicate downthrown side of fault that trends through Gull Lake (Canadian Government photo T11-75R). GSC 204923-C.

Selwyn Fold Belt

Folds

In Selwyn Fold Belt, folds trend northwest and plunge gently in the same direction. One phase of folding has been recognized, and associated with it is a well-developed axial-plane slaty cleavage. Although there is a continuum in fold size, three different scales of folds, described below as large, medium, and small scale, are prominent.

Wilson Syncline, Lened Syncline, Fork Anticline, Summit Syncline, Steel Syncline, Little Owls Anticline, Woodside Syncline, and Yusezyu Anticline (Fig. 2B) are examples of large-scale folds. These are upright, closed to open (Ramsay, 1967) structures which control much of the map pattern. They have strike lengths of up to 30 to 40 km, amplitudes on the order of 1 to 2 km, and half-wavelengths from 5 to 9 km. Hinge zones are rounded (e.g. Steel Syncline) to subangular (e.g. Fork Anticline). Limb dips commonly do not exceed 60 degrees but locally are vertical or overturned.

These major structures are linked by medium-scale folds. These have strike lengths of up to 13 km, amplitudes of up to 500 m, and half-wavelengths of up to about 1 km. Other than size, their geometry is similar to that of the large-scale folds.

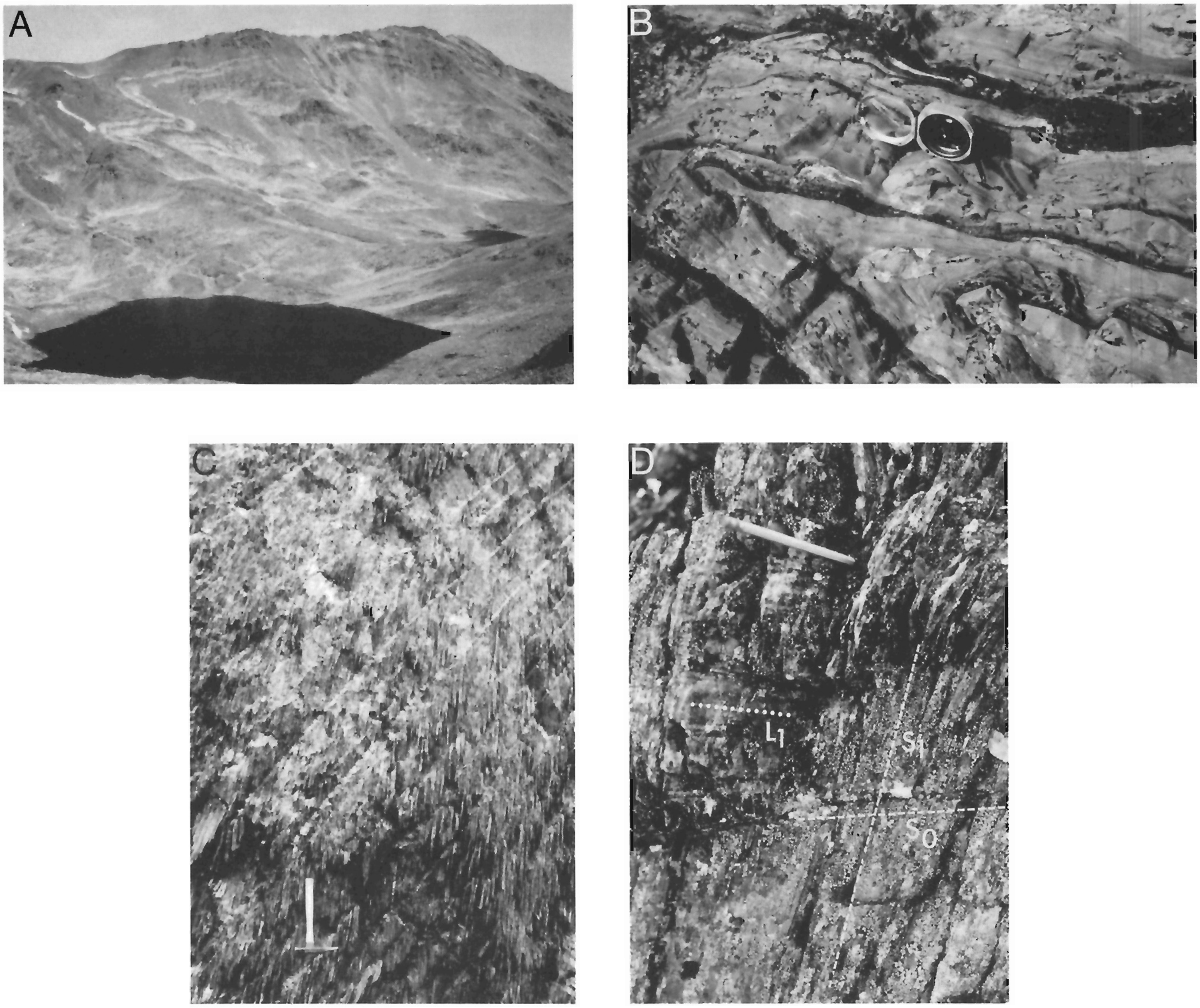


Figure 69. Some structural features of Selwyn Fold Belt. **A.** Southwest-verging, west-northwest-plunging overturned folds in Yusezyu Formation sandstone and shale. Photo shows northwest-looking view of ridge about 4 km east of Little Owls Mountain. GSC 204923-D. **B.** Small-scale tight fold in Steel Formation argillite. Photo of water-polished outcrop along Pelly River, about 20 km north of Gull Lake. GSC 204923-E. **C.** Vertical cleavage in Rabbitkettle limestone 2 km south of Island Lake. Dip of bedding is 45 degrees to left. GSC 204923-F. **D.** Steeply dipping slaty cleavage (labelled S_1) in Prevost Formation 10 km northeast of Summit Lake. Bedding (S_o) is subhorizontal, parallel to parting. Pencil is placed parallel to cleavage-bedding intersection lineation (L_1). GSC 204923-G.

The third and smallest folds are of outcrop-scale. These may be open to tight. Their apparent scarcity may be partly attributed to the scree-covered exposure typical of the Selwyn Fold Belt.

The fold class (Ramsay, 1967) of the above structures varies with the competence of the folded layers. At outcrop scale, single beds or groups of beds of competent chert or sandstone may be buckled to form parallel or flattened parallel folds (class 1B and 1C of Ramsay, 1967). Conversely, incompetent cleaved pelite is thickened in hinge zones to form folds of similar or modified similar form (class 2 and 3 of Ramsay, 1967). For the two prominent map-scale fold types, the overall dominance of cleaved pelitic units suggests they may be of similar or modified similar form (class 2 and 3 of Ramsay, 1967).

A small part of the Selwyn Fold Belt, over which fabric data are numerous, has been analyzed by stereographic projection (Fig. 70). Over the area indicated cleavage consistently dips moderately to steeply north-northeast, although some southwest dips have been recorded.

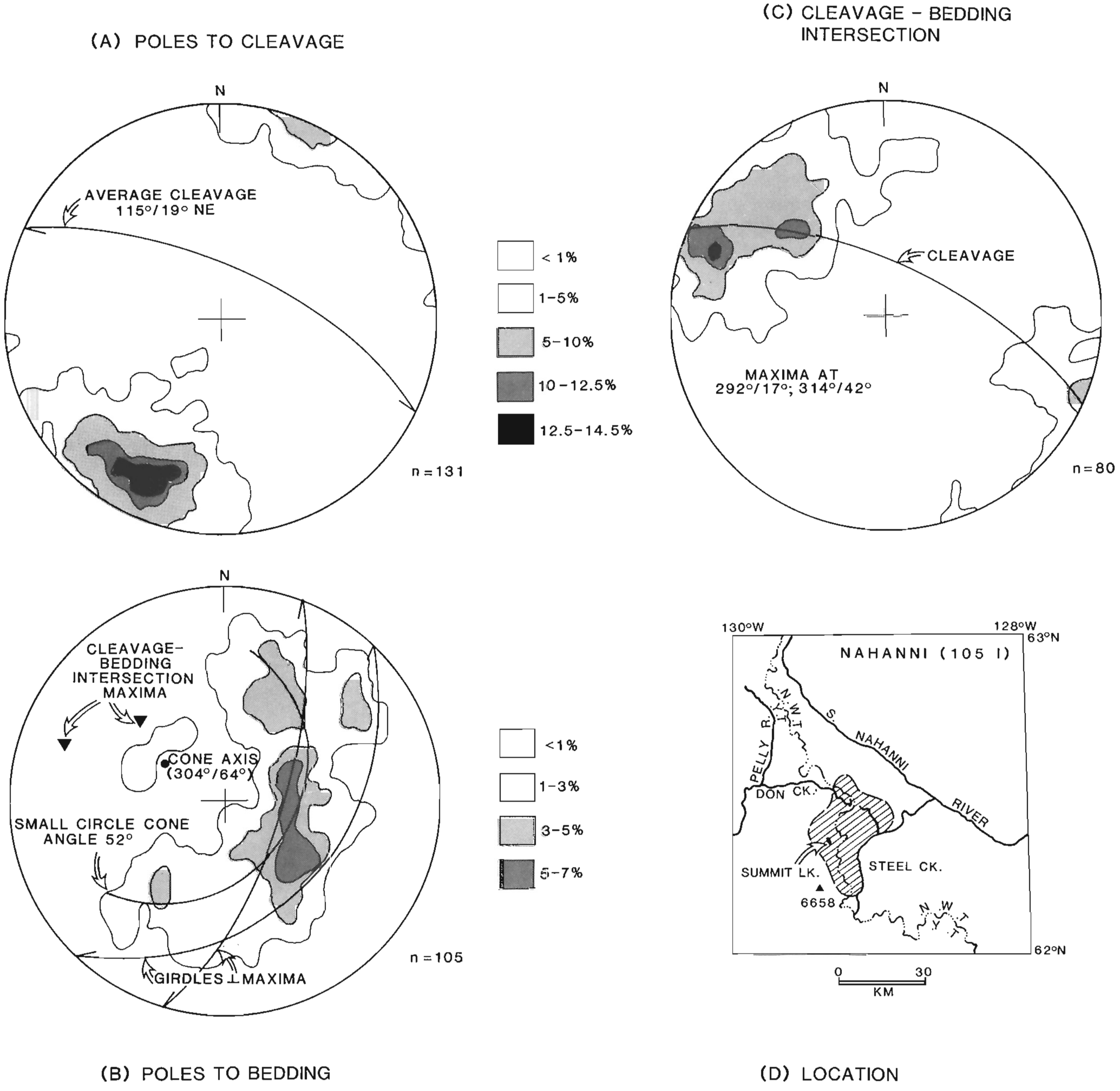


Figure 70. Mesoscopic fabric data for a part of Selwyn Fold Belt. Poles to cleavage **(A)** form a single maximum. Poles to bedding **(B)** form an irregular girdle that may be explained by noncylindrical, possibly conical, folding. Cleavage-bedding intersection lineation **(C)** plunges gently to moderately northwest. See text for discussion.

Cleavage-bedding intersection lineations trend and plunge gently to moderately west-northwest. The fact that the poles to bedding do not clearly define a great circle may be explained by a departure from noncylindrical folding that might be expected over a large area. A small circle can be drawn through poles to bedding that satisfies much of the data and that suggests a conical fold geometry. However, more fabric data combined with analysis of individual folds is required to bear this out. The northeast-dipping cleavage, and associated weak southwest vergence of folds persists beyond the area analyzed to the southwestern corner of the map area. To the northeast, near the South Nahanni River, fabric measurements are few, but cleavage is near vertical and folds are upright (see cross section AD).

Faults

Faults within Selwyn Fold Belt are of diverse trend, and judging by intersection with topography, are mostly steeply dipping. Two orientations are prominent. One of these is north to northeast, oblique to the fold trend. Faults of this orientation usually have strike lengths less than 10 km and stratigraphic separations less than 400 m. All their apparent offsets can be accounted for by dip-slip movement, although strike-slip motion cannot be anywhere ruled out.

The other prominent trend is northwest, parallel to the trend of folds. Some of these faults are interpreted as thrusts and described separately below. The remaining faults of this set have strike lengths of up to 18 km, and stratigraphic throws of up to 600 m. Their apparent offsets can be accounted for by dip-slip movement, although as for the north-trending set, strike-slip motion cannot be dismissed.

The March, Appler, and Honeymoon faults in Selwyn Fold Belt (Fig. 2B) are recognized as thrust faults by a combination of the following: 1) long length; 2) parallelism with the fold trend; 3) the persistence or gradual cutting of stratigraphy along the fault trace; and 4) the emplacement of older above younger strata. The March Fault, a northeast-verging thrust with a strike length of at least 40 km, is one of the longer faults in the map area. Its hanging wall cuts through the northeastern limb of Fork Anticline. Toward its northwestern end where it dies out in the core of this fold, the

Figure 71. Oblique areal view of Mackenzie Fold Belt looking north toward Broken Skull River and showing Sapper Fault, Sapper Anticline, Broken Skull Fault, and other unnamed structures. Dextral displacement is indicated for Broken Skull Fault. Rugged mountainous topography is typical of Mackenzie Mountains, where underlying strata are largely resistant carbonate. Map units shown include the Vampire (PЄV), Sekwi (ЄS), Rockslide (ЄR), Rabbitkettle (ЄOR2), Broken Skull (ЄOBS), and Haywire (ЄSH) formations (Canadian Government photo T9-146L). GSC 204923-H.

fault has a linear trace and is near vertical. Southeast of Fork Creek the March Fault dips moderately southwest. Its continuation along the Little Highland valley, further to the southeast, is uncertain. Its presence there could account for the juxtaposition of distinctly purplish-grey (lower?) Narchilla slates on the southwest with the dark brown weathering slates of the (upper?) Vampire Formation on the northeast. Stratigraphic separation across the fault reaches a maximum of about 800 m near Fork Creek where the Narchilla Formation is juxtaposed next to the Rabbitkettle Formation. Middle(?) Cambrian movement along, or folding near March Fault may be indicated by the lack of Gull Lake strata on its northeastern side (see section on Sub-Upper Cambrian unconformity).

The Appler Fault near South Nahanni River places the Vampire Formation against the Rabbitkettle Formation over a strike length of about 21 km. Its near-straight surface trace indicates a steep, possibly southwest dip. Stratigraphic separation is from about 100 to 200 m. The Appler Fault terminates at its southeastern end in the core of an anticline. Its continuation northwest of Rudi pluton is broken by several north- to northeast-trending normal faults, before it apparently dies out within the Vampire Formation.

Northeast of Appler Fault, the Honeymoon Fault emplaces the Rabbitkettle Formation against the Prevost Formation. Its convex-southwest trace suggests it may be a northeast-dipping thrust fault, a geometry consistent with southwestward emplacement of older over younger strata. The hanging wall of the fault cuts the forelimb of a small northwest-plunging anticline. Maximum stratigraphic separation is on the order of 300 m. The Honeymoon Fault ends to the northwest by diminishing displacement within Prevost shale. To the southeast it dies out within the Rabbitkettle Formation.

Mackenzie Fold Belt

Folds

In northeastern Nahanni map area the map pattern is dominated by northwest-trending , doubly-plunging, open folds that include South Nahanni Anticline, Margaret Syncline, Sapper Anticline, Black Wolf Syncline, and O'Grady Anticline (Fig. 2B). Lengths of these folds vary from 25 to 60 km, amplitudes are about 1500 m, and half-wavelengths about 8 km. Most are upright and symmetrical. Hinge zones are rounded and limb dips average about 40 degrees. Sapper Anticline (Fig. 71) locally shows northeast vergence with its northeastern limb in places vertical to overturned. O'Grady Anticline is a northwest trending, large, doubly-plunging box fold, about 30 km long. Its flat-lying crest is flanked on either side by limbs with dips averaging about 50 degrees. The two monoclinal flexures defining the fold hinge zone diverge widely at either end of the fold. The major folds described above are linked in an en echelon fashion with numerous unnamed folds of slightly smaller scale but similar geometry.

Slaty cleavage is not developed within Mackenzie Fold Belt, nor have any outcrop-scale folds been observed. The lack of internal strain within beds suggests the folds are generally of parallel type (class 1B of Ramsay, 1967) in which folding is accommodated by slip along bedding planes.

Faults

Faults within Mackenzie Fold Belt trend dominantly north to northeast and northwest. With the exceptions of Sapper and Broken Skull faults described below, stratigraphic separations range upward to about 500 m and fault strike lengths range upward to 20 km. The intersection of fault traces with topography indicates all are steeply-dipping. Offsets can be accommodated by dip-slip displacement, although in most instances strike-slip motion cannot be excluded. In either dominant fault set no consistent sense of offset (e.g. east-side-down or south-side-up) is found.

The Sapper Fault cuts the core of Sapper Anticline and terminates near both ends of this fold. The strike length of this fault is about 30 km and maximum stratigraphic separation is about 1000 m. The persistence of the same stratigraphic units along its trace and the termination of the fault at both ends within the core of Sapper Anticline indicate it is a thrust fault.

The Broken Skull Fault and Divide Lake Fault are the only faults in the map area for which strike-slip movement can be inferred. The Broken Skull Fault trends north-northwest for a total strike length of about 60 km, cutting the eastern side of O'Grady Anticline. The Divide Lake Fault is slightly shorter, parallels the Broken Skull Fault in trend, and occurs midway between it and Black Wolf Syncline. In Sekwi Mountain map area to the north the two structures are linked with several other north-trending faults. Gabrielse et al. (1973) inferred the Broken Skull Fault to continue southeasterly in Glacier Lake map area along the poorly exposed valley of Broken Skull River. They inferred unspecified sinistral displacement to account for apparent offset of the southeastern end of South Nahanni Anticline. However, mapping along the eastern margin of Nahanni map area indicates there is likely continuity of rock units across Broken Skull Valley and that the fault does not extend farther to the southeast. The apparent offset of South Nahanni Anticline mentioned by Gabrielse et al. (1973) may be an artifact of en-echelon folding, rather than faulting. The Broken Skull Fault has a stratigraphic separation of about 1200 m. Dextral strike slip of about 2.5 km can account for the offset of formations on the southeastern flank of O'Grady Anticline. The Divide Lake Fault which merges with the Broken Skull Fault to the southeast has accommodated about 3 km of dextral strike slip. This is inferred from the apparent offset of the Haywire Formation, and truncation of a fold just north of where the two fault strands merge.

Age of deformation

The age of Mesozoic contraction cannot be determined within the map area more precisely than pre-Late Cretaceous and post-mid-Triassic. Folds are clearly truncated by plutons of the mid-Cretaceous Selwyn Plutonic Suite (80-104 Ma). The youngest deformed beds are mid-Triassic (Jones Lake Formation). To the north, in Sekwi Mountain map area (105P), a fault-bounded panel of folded strata is dated by plant impressions and spores as Early or Late Cretaceous (Blusson, 1971, p. 15). Combined with the upper age limit implied by the plutons, this indicates an Early Cretaceous age for folding in this part of Selwyn and Mackenzie mountains. Thrust faults are geometrically related to the folds and are coeval. Shortening within Selwyn Fold Belt in Dawson map area to the northwest is post-mid-Jurassic and pre-mid-Cretaceous. There, folds and thrust faults are cut by mid-Cretaceous plutons, and the youngest deformed beds are of mid-Jurassic age (R.I. Thompson, pers. comm., 1987).

The age of faults other than the thrust faults is not well known. Some are truncated by the mid-Cretaceous plutons, and may have also formed during Early Cretaceous contraction, or immediately after contraction as relaxation features. Others, like that which cuts the Rudi pluton and its aureole, postdate mid-Cretaceous plutonism.

At Mackenzie Mountain front, about 230 km northeast of Nahanni map area (Fort Norman map area, NTS 96C) a small(?) amount of Tertiary shortening is recorded by folded Tertiary beds with dips as high as 20 degrees (Aitken and Cook, 1974, p. 20). Whether this Tertiary shortening and that of Early Cretaceous age in the Nahanni map area are part of a continuum, or represent two separate pulses of contraction, is not known.

Kinematics

Selwyn and Mackenzie fold belts: a thin-skinned detachment terrane

The contrasting structural styles of Selwyn and Mackenzie fold belts reflect different rheological responses to the same contractional event. The Selwyn Fold Belt is underlain by incompetent clastic strata where layering exerted little control on structural geometry, and the rocks deformed internally as a homogeneous mass, with resultant formation of similar or modified similar folds and slaty cleavage. The Mackenzie Fold Belt is underlain by thick sections of competent carbonate strata which buckled through layer parallel slip rather than deforming internally. Cleavage did not develop in the resulting concentric style folds.

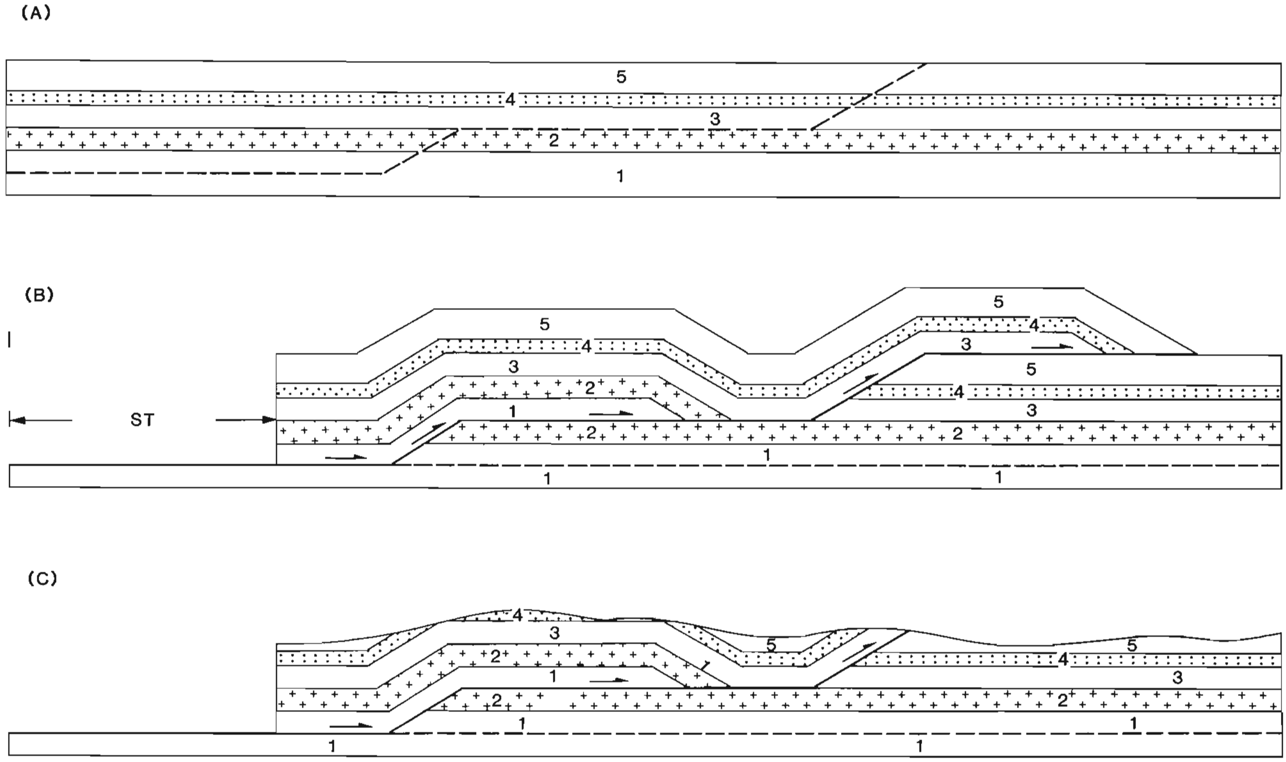


Figure 72. Formation of a ramp anticline. The initial undeformed stage is shown in **(A).** The future trajectory of a thrust fault is shown by dashed line. Stage **(B)** shows the structural geometry after an amount of shortening ST. Note formation of anticlines above thrust ramps. Dashed line shows trajectory of possible future thrust. Effects of erosion on pattern of exposure are diagrammed in **(C).** The formation of a ramp anticline can be kinematically related to a thrust fault exposed at surface. The low numbers of thrust faults at surface in Nahanni map area suggests that this mechanism was not important in forming large scale folds (e.g. South Nahanni Anticline).

The northwest-trending folds and thrust faults formed in response to northeasterly-directed horizontal compression. Their surface geometry is similar to those of other areas of the northern and southern Rockies (Price, 1981; Thompson, 1981) and the Appalachians (Hatcher, 1981), and like them can be interpreted in terms of a "thin-skinned" detachment model (Norris, 1972). Deformation is confined above a subhorizontal basal decollement or detachment. Horizontal displacement along the detachment in the direction of compression occurs as shortening takes place above it. Underlying strata or basement remain undeformed. The detachment and deformation front propagate when it is mechanically easier to extend the detachment and deform as yet unaffected strata, than to further contract existing structures. In a thrust fault-fold terrane there may be several detachments following planes of weakness within the sedimentary succession, all rooting or joining at depth with the lowest or basal detachment. By analogy with the southern Canadian Rocky Mountains (Price, 1981), structures in Nahanni map area can be linked with those across the entire

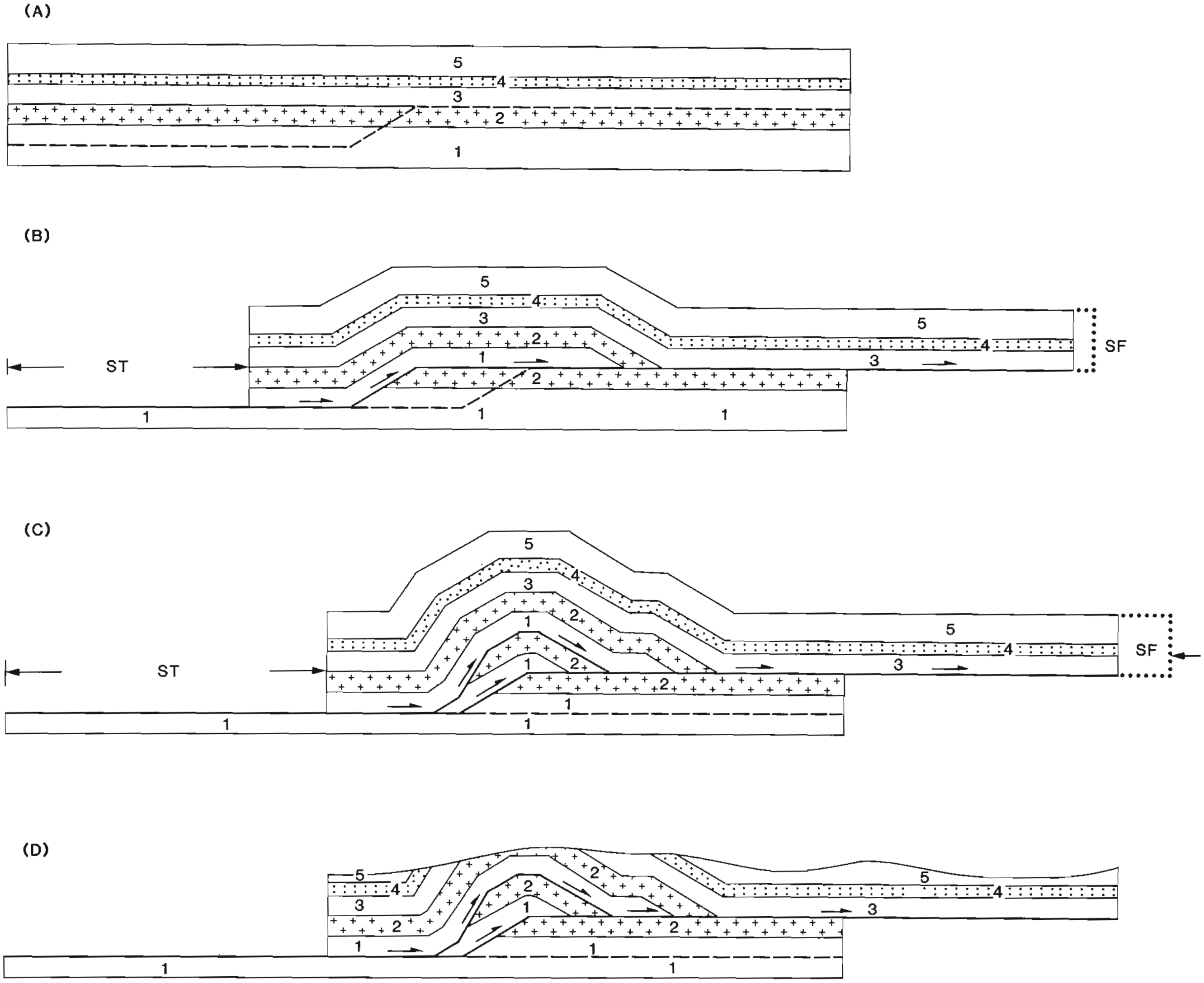


Figure 73. Formation of anticline by stacking of blind thrusts (thrusts that do not surface). The initial undeformed stage is shown in **(A).** Trajectory of a future thrust is shown as a dashed line. Structural geometry after amount of thrust shortening ST is shown in **(B)**. Note formation of anticline above thrust ramp. Amount of shortening related to folding is indicated by SF. A dashed line indicates the trajectory of the next developed thrust fault. Stage **(C)** shows the structural geometry after shortening across the new thrust. The displacement across the new thrust is equal to ST at stage (C) minus ST at stage (B). The dashed line indicates the possible trajectory of a future thrust. Unit 2 and the upper half of unit 1 are shortened much more than units 3, 4, and 5. The total amount of thrust shortening (ST) not evidenced at surface (i.e. blind) required to form the anticline is many times greater than the shortening evidenced in the anticline itself (SF). Stage **(D)** shows the effects of erosion on the pattern of exposure. This mechanism is unlikely to have formed the large folds in Nahanni map area; there is no evidence elsewhere in the fold belt for the large amount of horizontal shortening required (see text).

deformed belt (i.e. across Mackenzie and Franklin mountains) via such a basal decollement. Tertiary shortening at Mackenzie Mountain front may have been expressed in Nahanni map area by an equivalent amount of passive transport of the sedimentary cover and its intruded mid-Cretaceous plutons northeastward above the basal decollement.

Fold style and depth to detachment

The fundamental structural problems in the map area concern the detachment above which the folds and thrust faults of Selwyn and Mackenzie fold belts developed. At what depth is the detachment? Was this detachment the basal decollement for regional deformation? Alternatively, does this detachment separate the structures as seen at surface from other contractional structures at depth? Based on surface control alone, answers to these questions are speculative.

Concentric folds such as those of Mackenzie Fold Belt can be generated by several mechanisms (see Jones, 1987): 1) as ramp anticlines (Fig. 72); 2) by stacking of blind thrusts beneath an upper detachment (Fig. 73); and 3) by shortening across a flat detachment (Fig. 74; Norris, 1972). Ramp anticlines develop through translation across a step in a detachment. Structural relief is equal to stratigraphic relief of the ramp. The production of a fold through the stacking of blind thrusts requires great amounts of horizontal shortening at deeper levels relative to the amounts indicated by the fold itself. For folds developed above a flat detachment anticlines grow in structural relief as deformation progresses; synclines represent areas of little change in relief.

The dominant mechanism of formation of the concentric folds of Mackenzie Fold Belt was probably through shortening above a flat detachment. The other two fold mechanisms probably did not play a dominant role because: 1) there is no evidence elsewhere in the fold belt for the great amounts of horizontal shortening required by the stacking of blind thrusts; and 2) if folding was related to thrust ramping then more thrust faults should be evident at surface. Norris (1972) attributed regional en-echelon fold patterns in Mackenzie Mountains to shortening of a thin sedimentary veneer above a passive basement.

For folds formed by shortening across a flat detachment, an area balance method has been commonly used to calculate depth to the detachment surface (as outlined in Jones, 1987). Figure 75 shows an example calculation for South Nahanni Anticline which yields a depth to decollement of about 16 km beneath the Sekwi-Vampire Formation contact. The assumptions are that bedding line length has not been altered by penetrative strain, volume (area in cross section) is conserved, and that stratigraphic thickness beneath synclinal keels is conserved. However, the accuracy of this figure depends entirely on whether a fold of this type can remain a closed system during its development, a geometrical impossibility according to Jones (1987) and Wiltschko and Chapple (1977). The latter noted that unreasonably deep levels of detachment were required for low amplitude Appalachian Plateau folds. They explained the known shallower detachment for these structures by thinning of weak incompetent strata of the adjacent synclines and compensatory flow of rock into the anticlinal cores (as in Fig. 74). By analogy, failure of weak rock at depth probably was critical to the development of South Nahanni Anticline, and

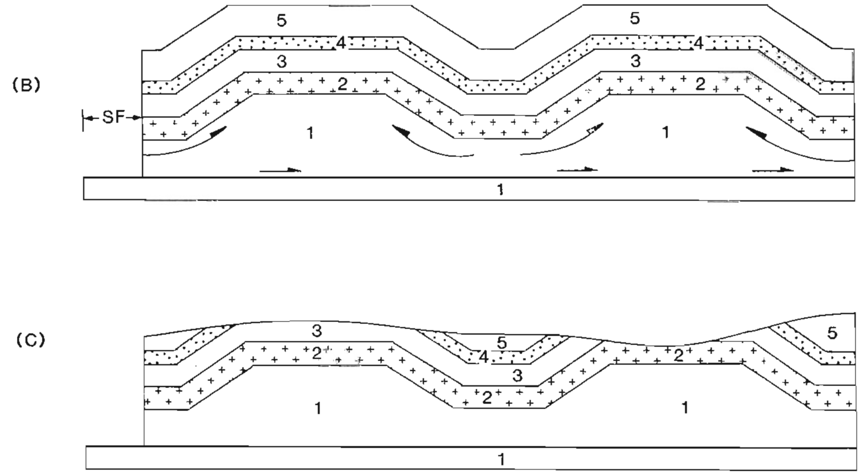


Figure 74. Formation of anticline by simple compression above a flat detachment. Stage (A) shows the initial configuration of bedding. Dashed line indicates future detachment. Stage (B) shows structural geometry after fold shortening by an amount SF. Shortening has been accommodated by the flow of weak rock from synclinal keels into anticlinal cores. Stage (C) shows the effects of erosion on the pattern of exposure. This may have been the mode of formation of large folds in Nahanni map area.

other large folds in Mackenzie Mountains that developed above a flat detachment. The calculated figure for South Nahanni Anticline is therefore erroneous, and at best a maximum estimate. A minimum estimate is provided by the fact that the detachment level cannot be shallower than the oldest strata exposed at surface. For the Mackenzie Fold Belt in Nahanni map area the upper limit so indicated is about 3 km below sealevel.

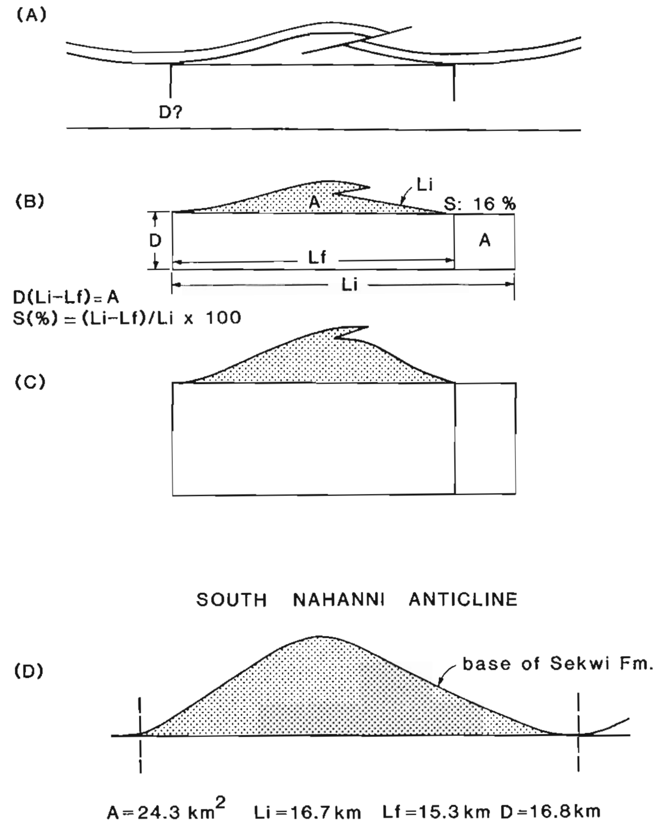


Figure 75. Calculation of depth to decollement. A succession of strata folded above a detachment is shown in (a). Synclinal keels slid passively above the detachment, while the anticlines grew in structural relief as a result of the shortening. If (1) material has not been lost or gained from beneath the synclines, (2) there is no loss of material perpendicular to the cross-section, and (3) bedding line length has not been altered, then depth to detachment can be found as in (b). D = depth to detachment; A = cross-sectional area (shaded); Li = initial line length; Lf = final line length; S = shortening in %. The basis of the calculation is that the area above the datum within the anticlinal closure is equal to the area "displaced" during shortening. In (c) is shown an area of structural closure twice as great as in (b) for about the same amount of shortening which dictates a depth to detachment twice as great. In (d) is shown a profile of the South Nahanni Anticline along section EF along with the calculation of its depth to detachment. The implications of the unreasonably large result of 17 km beneath the base of the Sekwi Formation are discussed in the text.

The "similar type" folds of Selwyn Fold Belt probably also formed by shortening above a flat detachment. The role of thrust ramps and blind thrusts in folding is probably minimal for the same reasons as outlined above. An upper limit for detachment, as indicated by extrapolating known stratigraphic thicknesses beneath synclinal axes, is about 3.6 km below sealevel. There is no method by which to calculate a lower limit, as "similar type" folds can geometrically persist to any depth. However, the major folds within Selwyn Fold Belt are of a scale similar to those within the Mackenzie Fold Belt, perhaps indicating a common detachment level. If detachment levels in either belt were grossly dissimilar there would probably be a corresponding disparity in fold amplitude and wavelength. The identity of the weak horizon that may have acted as a decollement is uncertain. A possibility may be gypsum of the Proterozoic Little Dal Group which occurs in Mackenzie Mountains to the east and which there acts as a detachment for the large Plateau Fault (Aitken and Cook, 1974). However, the continuation of this unit into the subsurface of Nahanni map area is conjectural.

The basal decollement for regional deformation in Mackenzie Mountains east of Nahanni map area may be as much as 20 km below sealevel (Gordey, 1981c). Such a deep detachment is required to allow exposure at surface of as much as 15 km of Proterozoic and Paleozoic stratigraphy. As indicated above, the structures in Nahanni map area root at an uncertain but possibly shallower level.

Faults

In Selwyn and Mackenzie fold belts in Nahanni map area, thrust faults are rare. The March, Appler, Honeymoon, and Sapper faults are all thrusts that are spatially related to folds. They developed synchronously with folding, probably because of the "room problem" that develops in an anticlinal core as a fold is tightened (e.g. Dahlstrom, 1970). The general rarity of thrust faults reflects the relatively low amount of shortening within both fold belts.

The Broken Skull and Divide Lake faults accommodate about 2.5 km and 3 km respectively of dextral strike slip. Their trend and sense of displacement are consistent with shear related to northeast directed compression. These faults probably developed during the later stages of contraction as tear faults rooting in the regional detachment.

The age of movement and kinematic significance of the myriad of other faults in the map area is uncertain; they bear no obvious relationship to folds or known thrust faults. The northwest-trending fault set could represent either minor thrust faults and/or postshortening extension faults. Some faults of the northeast-trending set could be small tear faults and related to northeastward compression. Others, such as that which offsets the Rudi pluton, may postdate regional contraction, and be a response to a much different and younger regional stress regime.

Table 4. Mineral Deposits in Nahanni map area, according to deposit type. Locations shown in Appendix 2.

Property		Mineralogy	Host
		STRATIFORM DEPOSITS	
H.	CINQ	Zn-rich shale	Duo Lake or Portrait Lake Fm.
AD.	unnamed	U, P, Pb, Zn, Ba	Duo Lake Fm.
AE.	PAB	Zn-V-rich shale	Duo Lake Fm.
X.	GRAND	sphalerite-galena	Duo Lake ? Fm.
5.	HOWARDS PASS (XY)	sphalerite-galena	Duo Lake Fm.
6.	SHIELD`	Pb-Zn-rich shale (sphalerite-galena)	Duo Lake Fm.
8.	ANNIV	sphalerite-galena	Duo Lake Fm.
9.	WINKIE	Pb-Zn-rich shale	Duo Lake Fm.
13.	ABBEY	Pb-Zn-rich mudstone	Duo Lake Fm.
a1.	OP	sphalerite-galena	Duo Lake Fm.
P.	VULCAN	sphalerite-pyrite	Sapper Fm.
AB.	HAN	chalcopyrite-sphalerite	Sapper Fm.
W.	GHMS	barite	Portrait Lake Fm.
Y.	CMC	barite	Portrait Lake Fm.
		Pb-Zn-rich shale	Duo Lake Fm.
7.	ORO	barite	Portrait Lake Fm.
11.	DIANNE	barite, minor Zn	Portrait Lake Fm.
14.	TANG	barite	Portrait Lake Fm.
a2.	TROIS	barite, Zn-rich breccia	Portrait Lake Fm.
a3.	unnamed	barite	Portrait Lake Fm.
a4.	unnamed	barite	Portrait Lake Fm.
a5.	unnamed	barite	Portrait Lake Fm.
		SKARN DEPOSITS	
D.	unnamed	scheelite-pyrrhotite-diopside	Sekwi Fm.
S.	BLUE	scheelite-pyrite-pyrrhotite (+ calc-silicates)	Rockslide Fm.
G.	FERN	galena-sphalerite	Rabbitkettle Fm.
I.	CAC	scheelite-diopside-garnet; scheelite-epidote-garnet-diopside; scheelite-calc-silicate	Rabbitkettle Fm.
Q.	LENED	scheelite-pyroxene-garnet ± vesuvianite ± pyrrhotite; scheelite-amphibole ± pyrrhotite; scheelite-biotite ± pyrrhotite ± chalcopyrite	Rabbitkettle Fm.
R.	RUDI	scheelite + ?	Rabbitkettle Fm.
1.	NAR	scheelite-chalcopyrite-sphalerite-galena-pyroxene-garnet-pyrrhotite	Rabbitkettle Fm.
2.	CLEA	scheelite-diopside-garnet-vesuvianite-tremolite-calcite; minor local biotite-muscovite-quartz skarn	Duo Lake ? Fm.
M.	CAN	galena-pyrite-sphalerite-chalcopyrite-arsenopyrite-?stilbite	Funeral Fm.
3.	BIRR	chalcopyrite-pyrrhotite skarn	Mount Christie? Fm.
		VEIN DEPOSITS	
A.	HAT	quartz-malachite-azurite-tetrahedrite	Rabbitkettle Fm.
B.	unnamed	arsenopyrite-galena	Vampire Fm.
C.	JAY	quartz-pyrite-galena-sphalerite-tetrahedrite	Vampire Fm.
F.	unnamed	spodumene-lepidolite pegmatite	Yusezyu Fm.
H.	CINQ	malachite-azurite; quartz-calcite-tetrahedrite	Duo Lake or Portrait Lake Fm.
J.	NANCY	galena-sphalerite-pyrite	Haywire Fm.
K.	CAM	quartz-carbonate-galena-chalcopyrite	Mount Christie Fm.
N.	RA	stibnite-boulangerite-jamesonite-galena-arsenopyrite	Sapper Fm.
Q.	VULCAN	fluorite-galena	Sapper, Haywire ? Fm.
T.	BIG RED	sphalerite-galena	Grizzly Bear, Haywire Fm.
U.	unnamed	quartz-galena-sphalerite-pyrite-arsenopyrite	Cretaceous granodiorite
V.	unnamed	tourmaline-galena-pyrite	O'Grady Batholith
Y.	GRAND	quartz-sphalerite-galena	Duo Lake Fm.
Z.	JOLI GREEN	Zn	Haywire?, Sapper?, or Broken Skull? Fm.
AA.	SKULL	Pb-Zn-Ag	Broken Skull or Sapper Fm.
4.	NOM	quartz-arsenopyrite-pyrite-chalcopyrite	Portrait Lake Fm.
10.	NESS	calcite-malachite-azurite-tetrahedrite	Prevost? Fm
		REPLACEMENT DEPOSITS	
L.	PR	pyrite-pyrrhotite-chalcopyrite	Prevost Fm.
O.	SAND, GUN	sphalerite-smithsonite	Broken Skull? Fm.
AC.	BONNIE	Zn	Haywire Fm.
		UNMINERALIZED TARGETS	
	Property	**Anomaly**	**Underlying Formation**
12.	RITZ	geochem. (Pb-Zn)	Prevost? Fm.
15.	OHNO	geophys.	Duo Lake? Fm.
16.	ROOK	geochem. (Zn-Ba)	Duo Lake Fm.
17.	FAST	unclassified work target	Earn Gp.
E.	HUG	geochem. (Zn)	Duo Lake Fm.

Vergence

Except for Sapper Anticline, which verges locally northeast, congruent with the northeast-directed Sapper Fault which cuts the fold core, folds in Mackenzie Fold Belt are upright. In Selwyn Fold Belt, near South Nahanni River, the Honeymoon Fault is a southwest-directed thrust. From this area to the southwest there is a gradual change from upright folds and vertical cleavage to major folds that show a slight southwest vergence and have axial plane slaty cleavage dipping steeply northeast. The southwest vergence may have developed in two ways: 1) the folds and cleavage were initiated with this sense of asymmetry, or 2) the folds and cleavage were initially symmetrical or even had northeast vergence, but were subsequently rotated and overturned. Relations along the March Fault, a thrust fault which likely developed during folding, suggest that southwesterly overturning did occur locally. For example, near March Creek and to the southeast the fault dips moderately southwest and cleavage dips to the southwest, in places shallowly. The degree of rotation or backfolding increases to the northwestern end of the fault. There, slaty cleavage dips northeast and the fault is vertical to overturned and northeast dipping. Balkwill (1972) described a similar rotation and backfolding of folds, cleavage, and thrust faults on the southwestern side of the Porcupine Creek Anticlinorium in the southern Canadian Rockies.

Amount of shortening

Total shortening across Nahanni map area (along cross section AD), probably amounts to about 39 km over a present width of about 130 km. The component across Mackenzie Fold Belt (omitting crosscutting central South Nahanni pluton) can be determined by measuring bedding line length of competent strata (top of Rockslide Formation along section CD). It amounts to 4 km over a distance of 47 km (8 percent).

In Selwyn Fold Belt the amount of shortening is difficult to ascertain. The presence of slaty cleavage indicates deformation was penetrative. Bedding line length has been distorted and therefore cannot be used to measure shortening. Two other approaches used to estimate shortening give quite different results: 1) casual inspection of the simple large-scale fold pattern in map and cross section views suggests shortening on the order of that in Mackenzie Fold Belt, perhaps 10 to 15 percent; and 2) a minimum of 30 to 50 percent shortening is suggested as necessary for the development of slaty cleavage (Ramsay, 1967; Wood, 1974). Local tight small-scale folds seem better explained by the greater figure. An explanation for the discrepancy may be that the strata underwent a component of layer parallel bulk shortening and internal deformation before or during the formation of the large-scale folds. The folds reflect only the "buckle" component of the strain. Using the higher estimate of 30 percent shortening as a probable maximum for Selwyn Fold Belt (along section AC) yields about 35 km of contraction over a present distance of 82 km.

MINERAL DEPOSITS

Regional setting

The Selwyn Basin area is a world-class province with respect to deposits of lead-zinc-silver, barite, and tungsten. Tungsten deposits such as CanTung (Blusson, 1968), MacTung (Dick and Hodgson, 1982), and Lened (Glover and Burson, 1986) are skarns developed within limestone of various ages next to granitic plutons of the mid-Cretaceous Selwyn Plutonic Suite. Lead-zinc-silver and barite mineralization is stratiform and occurs at several horizons within fine clastic rocks of Paleozoic age. Major camps include the Anvil district (Pb-Zn-Ag, Cambrian(?) (Tempelman-Kluit, 1972; Jennings and Jilson, 1986)), Howards Pass area (Pb-Zn, Early Silurian (Morganti, 1979; Goodfellow and Jonasson, 1986)), and Macmillan Pass district (Pb-Zn-Ag-Ba, Late Devonian; Ba, Mississippian (Abbott, 1982, 1983; Bailes et al., 1986; McClay and Bidwell, 1986)). The Akie district in northern British Columbia hosts stratiform mineralization (Pb-Zn-Ag-Ba, Late Devonian (Jefferson et al., 1983; MacIntyre, 1983)) in stratigraphy much like that of the Macmillan Pass district.

Occurrences and large bodies of subeconomic grade of several of the above types of mineralization occur in Nahanni map area (Appendix 2, Fig. 2.1; Table 4). In addition there are numerous small vein and replacement occurrences. The following presents a summary of characteristics of the main deposit types within the map area. Details and locations of individual showings are listed separately in Appendix 2.

Deposits of Nahanni map area

Exploration history

The earliest important discovery in the region was that of the barite-lead-zinc Tom deposit near Macmillan Pass in 1951, northwest of Nahanni map area (Carne, 1979; Debicki, 1982). Because of its remote location the discovery did not incite other exploration interest in the area (see Debicki, 1982). By the late 1960s however, interest in Macmillan Pass and adjacent areas had increased, and several showings in the northwestern part of Nahanni map area were discovered. In 1953, E.F. Roots of the Geological Survey of Canada made a geological reconnaissance of the upper Flat River region. Athough unpublished, this expedition was significant in spurring early exploration in that area (see White, 1963). Following the discovery of the Canada Tungsten deposit in 1958 in a limestone skarn, exploration accelerated and additional tungsten showings in the southeastern part of Nahanni map area were discovered. In 1972, a staking rush followed the announced discovery of the shale-hosted stratiform lead-zinc deposits at Howards Pass, in rocks not previously thought to be mineralized. As a result of the rush, many new showings were discovered within the following few years. However, none of these later findings turned out to be major. In the early 1970s there was also interest in carbonate-hosted lead-zinc deposits in Mackenzie Mountains. Many of the showings in the carbonate-dominated terrane in the northeastern half of the map area were originally staked at that time. In 1978, new showings were discovered at the Vulcan barite-lead-zinc property south of the South Nahanni River on ground originally staked in 1973 (Mako, 1981). Concurrent with field work for this report, exploratory drilling programs were carried out by various companies on four properties including the Howards Pass (lead-zinc), Lened and Clea (tungsten), and Vulcan (lead-zinc-barite).

Stratiform deposits

In Nahanni map area there are three main exploration targets for stratiform mineralization: 1) lead-zinc mineralization in the Ordovician-Silurian Duo Lake Formation, 2) lead-zinc mineralization within the Silurian to Early Devonian Sapper Formation, and 3) barite within the Early to Late Devonian Portrait Lake Formation.

In the Howards Pass deposits very fine grained stratiform sphalerite- galena-pyrite occurs within latest early to middle Llandovery (Early Silurian) (Norford and Orchard, 1985) black mudstone and carbonaceous chert of the Duo Lake Formation (Road River Group). The mineralization appears to be of the same age and of identical mineralogy in three different bodies (Anniv, XY, OP) that are separated along a strike length of 28 km. Similar mineralization, but at lower grade occurs at the same stratigraphic level at several other localities (Table 4). All of these occurrences are characterized by a lack of massive pyrite, relatively low Ag and Cu, lack of associated bedded barite, and lack of volcanic rocks. Mineralized feeder vents or stockworks have not yet been identified for any of these occurrences. High-grade mineralized shale in outcrop and float looks so much like nonmineralized shale it is easily overlooked. The Howards Pass deposits formed at relatively low temperatures (less than 220°C) from metalliferous chloride-bicarbonate brines discharged at the seafloor. Sulphur was probably derived from the water column (Goodfellow and Jonasson, 1986). In 1982, drill-indicated reserves on the XY and Anniv zones were released as 125 million short tons averaging 5.4 percent zinc plus 2.1 percent lead (see Appendix 2).

The Vulcan property, within the Sapper Formation, is of probable Late Silurian to Early Devonian age. Mineralization consists of discontinuous stratiform lenses of sphalerite-bearing massive sulphide, shale-hosted laminated and brecciated pyrite-sphalerite-galena, and galena-bearing massive barite-fluorite (Mako and Shanks, 1984). The massive barite may represent sinter mounds precipitated around brine vents on the seafloor, whereas the laminated and massive sulphides are interpreted to have formed from brines that flowed away from the vents to collect within topographic depressions (Mako and Shanks, 1984).

Stratiform mineralization within the Portrait Lake Formation is characterized by the barite occurrences at the CMC, ORO, and GHMS properties. Grey weathering thin-bedded barite ranging up to 50 m thick (ORO) occurs within black siliceous shale. The age of many of these types of occurrence is not well known, but available conodont ages, including some from outside the map area suggest two main times of barite deposition (see Portrait Lake Formation). One episode was in the Givetian (late Middle Devonian) and the other in mid-Frasnian (mid-early Late Devonian) time (Dawson and Orchard, 1982). The mid-Frasnian horizon appears to be regional in extent, although at many localities it is inconspicuous, occurring as a baritic shale containing small barite nodules (see Portrait Lake Formation). Development of the regional barite horizon and the barite-lead-zinc deposits were synchronous with extension faulting during Earn Group sedimentation (see Tectonics). Near Macmillan Pass, northwest of the map area, the Tom and Jason deposits consist of zinc-lead-silver-barite of probable Frasnian age hosted within shale and turbidites of the Earn Group (Bailes et al., 1986; McClay and Bidwell, 1986). Geological reserves at the Tom deposit comprise 15 million tonnes averaging 7 percent zinc, 4.61 percent lead, and 49.1 grams/tonne of silver. At the Jason deposit, geological reserves total 14 million tonnes grading 7.09 percent lead, 6.57 percent zinc, and 79.9 grams/tonne of silver (Bailes et al., 1986; McClay and Bidwell, 1986). The Portrait Lake Formation in Nahanni map area is a target for similar types of deposits.

Barite nodules occur within the Carboniferous to Permian Mount Christie Formation (see formation description), but no associated sulphides were noted.

Skarn deposits

Tungsten skarn deposits (e.g. Lened, Clea) are developed within limestone host rocks (Table 4) adjacent to mid-Cretaceous granitic plutons. The age of the host rock is unimportant. Dick (1979) has presented an outline of skarn deposit types of this setting in southern Yukon, from which much of the following is summarized. Skarn deposits can be grouped into four main categories: W-Cu, W-Mo, Zn-Pb, and W-Cu-Sn. W-Cu skarns form the largest group, and are the type found in the Nahanni area. Skarns of this type are localized in limestone beds which may be interbedded with biotite and calc-silicate hornfels. The extent of skarn development coincides with the limit of hornfelsic alteration of the interbedded or overlying pelitic sediments. However, the degree of skarn development and grade of mineralization are not necessarily related to the distance from the intrusive contact. Tungsten mineralization is associated with plutons lacking hornblende (see section on Granitic Rocks). Marginal phases of these plutons, or nearby satellitic intrusions are anomalous in tungsten (8 ppm) and contain combinations of andalusite, garnet, tourmaline, and/or muscovite as primary accessory minerals (Anderson, 1983). Intense alteration of the granitic rock to greisen occurs locally. In the skarn deposits the ore mineral is typically blue-white fluorescing scheelite; pyrrhotite, pyrite, and chalcopyrite are common associated sulphides. Molybdenite has not been observed in skarn of the W-Cu type although minor amounts, accompanied by scheelite, can occur in fractures in the associated intrusion (Dick, 1979). In general, there is a positive correlation between increasing pyrrhotite content and increasing tungsten grade, although even in pyrrhotite-rich skarn, scheelite is extremely erratically distributed and may be absent altogether. Common calc-silicate minerals include pyroxene, garnet, vesuvianite, epidote, and amphibole (Table 4). In individual deposits there may be several crosscutting mineralizing events. Each event may have distinctive prograde and retrograde mineral assemblages. Concentrations of scheelite may be identified with a particular mineral paragenesis or mineralizing event (e.g. Lened, Glover and Burson, 1986). The largest deposits in the region occur just outside of Nahanni map area. The MacTung deposit, near Macmillan Pass has published reserves of 30 million tons of 0.9 percent WO_3 (Dick and Hodgson, 1982). The Canada Tungsten mine, immediately south of the southeastern corner of the map area, is now closed. It was once the world's largest producer of scheelite concentrate; reserves total 4.2 million tons grading more than 1.55 percent WO_3 (Dick and Hodgson, 1982).

Vein deposits

Small vein deposits are numerous, scattered, and are not preferentially concentrated in any rock unit. Sphalerite, galena, and pyrite are the most common sulphides, but tetrahedrite, arsenopyrite (locally Au-bearing), jamiesonite, stibnite, boulangerite, malachite, and azurite are reported at different localities (see Table 4). Spodumene and lepidolite (Li) bearing pegmatite is also found at one locality. The age of most vein occurrences is not obvious. Many have no close spatial relationship to granitic rocks. However, most likely formed in response to a combination of Cretaceous deformation, heating, and intrusion.

Replacement deposits

Three poorly understood occurrences are grouped under replacement deposits (Table 4). The PR consists of disseminated pyrite-pyrrhotite-chalcopyrite in Prevost Formation shale near mid-Cretaceous granite. Mineralization at the SAND deposit is reported to consist of sphalerite-galena within the noses of small folds in Broken Skull Formation(?) limestone. At the BONNIE property, Zn mineralization occurs within the Haywire Formation.

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APPENDIX 1

Index of map areas in northern Cordillera

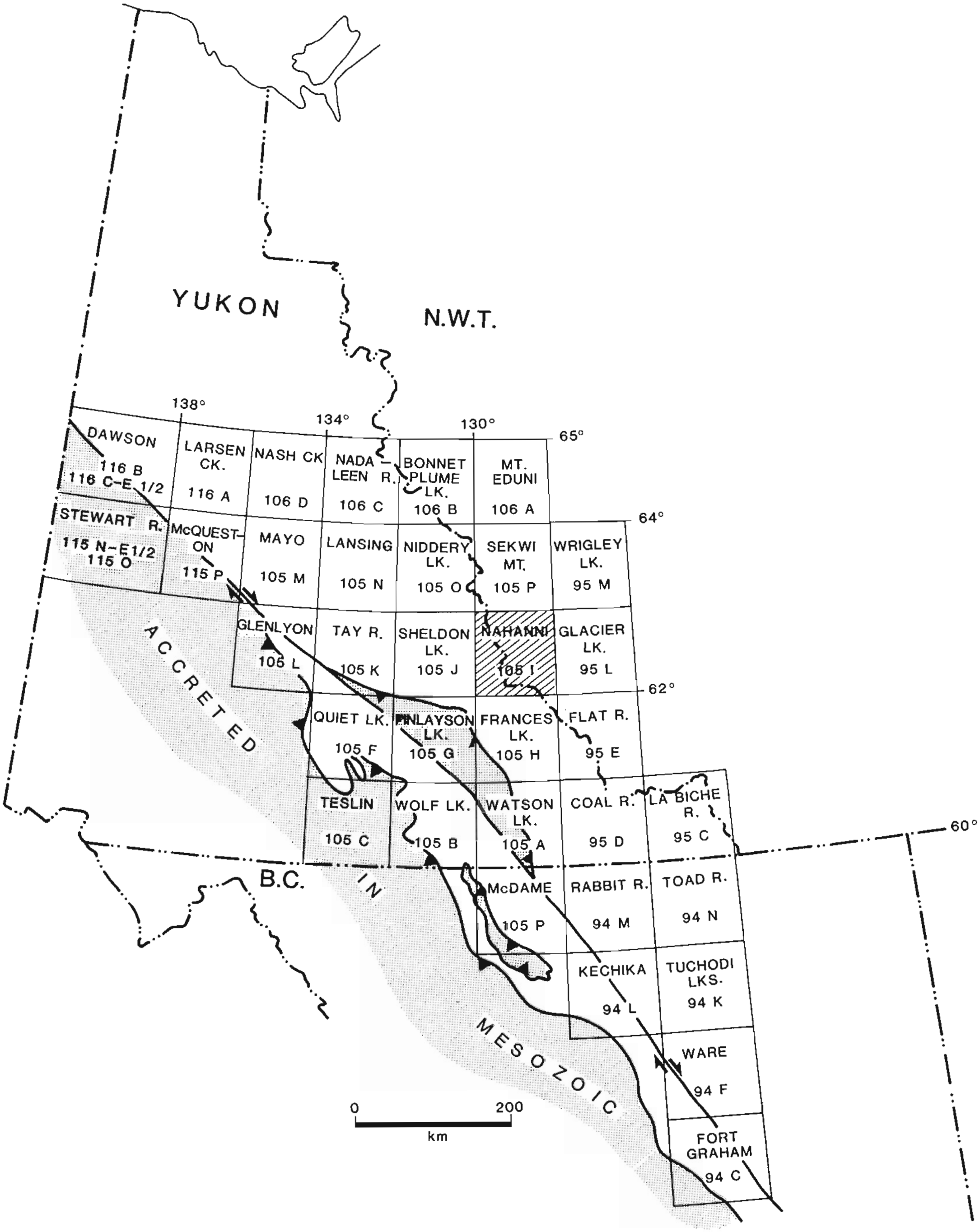


Figure 1.1. Index map of 1:250 000 scale National Topographic System (NTS) map area in the Northern Cordillera that are commonly referred to in the text. Nahanni map area is highlighted with a ruled pattern. Shading indicates accreted terranes. Locus of Tintina (Yukon) and Northern Rocky Mountain Trench (northern B.C.) strike-slip faults also shown for reference.

APPENDIX 2

Mineral deposits

The following property descriptions are largely summarized from the sources quoted, but are upgraded and changed to conform to the present work. Other showings undoubtedly exist for which written information is not readily available. For easy reference the numbering of properties for the Yukon Territory, numbers 1 to 17, corresponds to that of the Department of Indian Affairs and Northern Development, Whitehorse, in their annual report (1983) on Yukon exploration and geology. Property numbers a1 to a5 in the Yukon refer to additional properties not recorded in that reference. Properties in the Northwest Territories are labelled by letters A to AE. Table 2.1 lists the mineral properties and Figure 2.1 gives their locations.

Table 2.1. List of mineral occurences in Nahanni map area. Locations shown in Figure 2.1. Numbers of deposits in Yukon Territory corresponds to those used by the Department of Indian Affairs and Northern Development (1983). Letters refer to deposits in the Northwest Territories.

YUKON TERRITORY			NORTHWEST TERRITORIES		
Name	**Type**	**Host**	**Name**	**Type**	**Host**
1. NAR	skarn W, Cu, Pb, Zn, Ag	Rabbitkettle Fm.	A. HAT	vein Cu, Pb, Zn	Rabbitkettle Fm.
2. CLEA	skarn W, Cu, Zn	Duo Lake? Fm.	B. unnamed	vein Pb	Vampire Fm.
3. BIRR	skarn Cu, Fe	Mount Christie? Fm.	C. JAY	vein Pb, Zn, Au, Ag	Vampire Fm.
4. NOM	vein Au	Portrait Lake Fm.	D. unnamed	skarn W	Sekwi Fm.
5. HOWARDS PASS	stratiform Pb, Zn	Duo Lake Fm.	E. HUG	geochem. (Zn) anomaly	Duo Lake Fm.
6. SHIELD	stratiform Pb, Zn	Duo Lake Fm.	F. unnamed	pegmatite Li	Yusezyu Fm.
7. ORO	stratiform Ba	Portrait Lake Fm.	G. FERN	skarn Pb, Zn	Rabbitkettle Fm.
8. ANNIV	stratiform Pb, Zn	Duo Lake Fm.	H. CINQ	stratiform Zn, Pb, Cu	Duo Lake or Portrait Lake fm.
9. WINKIE	stratiform? Pb, Zn	Duo Lake Fm.	I. CAC	skarn W	Rabbitkettle Fm.
10. NESS	vein Cu	Prevost? Fm.	J. NANCY	vein Pb, Zn	Haywire Fm.
11. DIANNE	stratiform? Ba, Zn	Portrait Lake Fm.	K. CAM	vein Pb, Ag	Mount Christie Fm.
12. RITZ	geochem. (Pb-Zn) anomaly	Prevost? Fm.	L. PR	replacement Cu	Prevost Fm.
13. ABBEY	stratiform Pb, Zn	Duo Lake Fm.	M. CAN	skarn Cu, Pb, Zn	Funeral Fm.
14. TANG	stratiform Ba	Portrait Lake Fm.	N. RA	vein Sb, Cu, Pb	Sapper Fm.
15. OHNO	geophys. anomaly	Duo Lake? Fm.	O. SAND, GUN	replacement Zn	Broken Skull? Fm.
16. ROOK	geochem. (Zn-Ba) anomaly	Duo Lake Fm.	P. VULCAN	stratiform Pb, Zn	Sapper Fm.
17. FAST	unclassified work target	Earn Gp.	Q. LENED	skarn W	Rabbitkettle Fm.
a1. OP	stratiform Pb, Zn	Duo Lake Fm.	R. RUDI	skarn W	Rabbitkettle Fm.
a2. TROIS	stratiform Ba; Zn-rich breccia	Portrait Lake Fm.	S. BLUE	skarn W	Rockslide Fm.
a3. unnamed	stratiform Ba	Portrait Lake Fm.	T. BIG RED	vein Pb, Zn	Grizzly Bear, Haywire fm.
a4. unnamed	stratiform Ba	Portrait Lake Fm.	U. unnamed	vein Pb, Zn	Cretaceous granodiorite
a5. unnamed	stratiform Ba	Portrait Lake Fm.	V. unnamed	vein Pb	O'Grady Batholith
			W. GHMS	stratiform Ba	Portrait Lake Fm.
			X. GRAND	stratiform Pb, Zn	Duo Lake ? Fm.
			Y. CMC	stratiform Ba stratiform Pb, Zn	Portrait Lake Fm. Duo Lake Fm.
			Z. JOLI GREEN	vein Zn	Haywire?, Sapper?, or Broken Skull? fm.
			AA. SKULL	vein Pb, Zn, Ag	Broken Skull or Sapper fm.
			AB. HAN	stratiform Zn, Cu	Sapper Fm.
			AC. BONNIE	replacement? Zn	Haywire Fm.
			AD. unnamed	stratiform U, P, Pb, Zn, Ba	Duo Lake or Portrait Lake fm.
			AE. PAB	stratiform Pb, Zn, V, Cu, Ag	Duo Lake Fm.

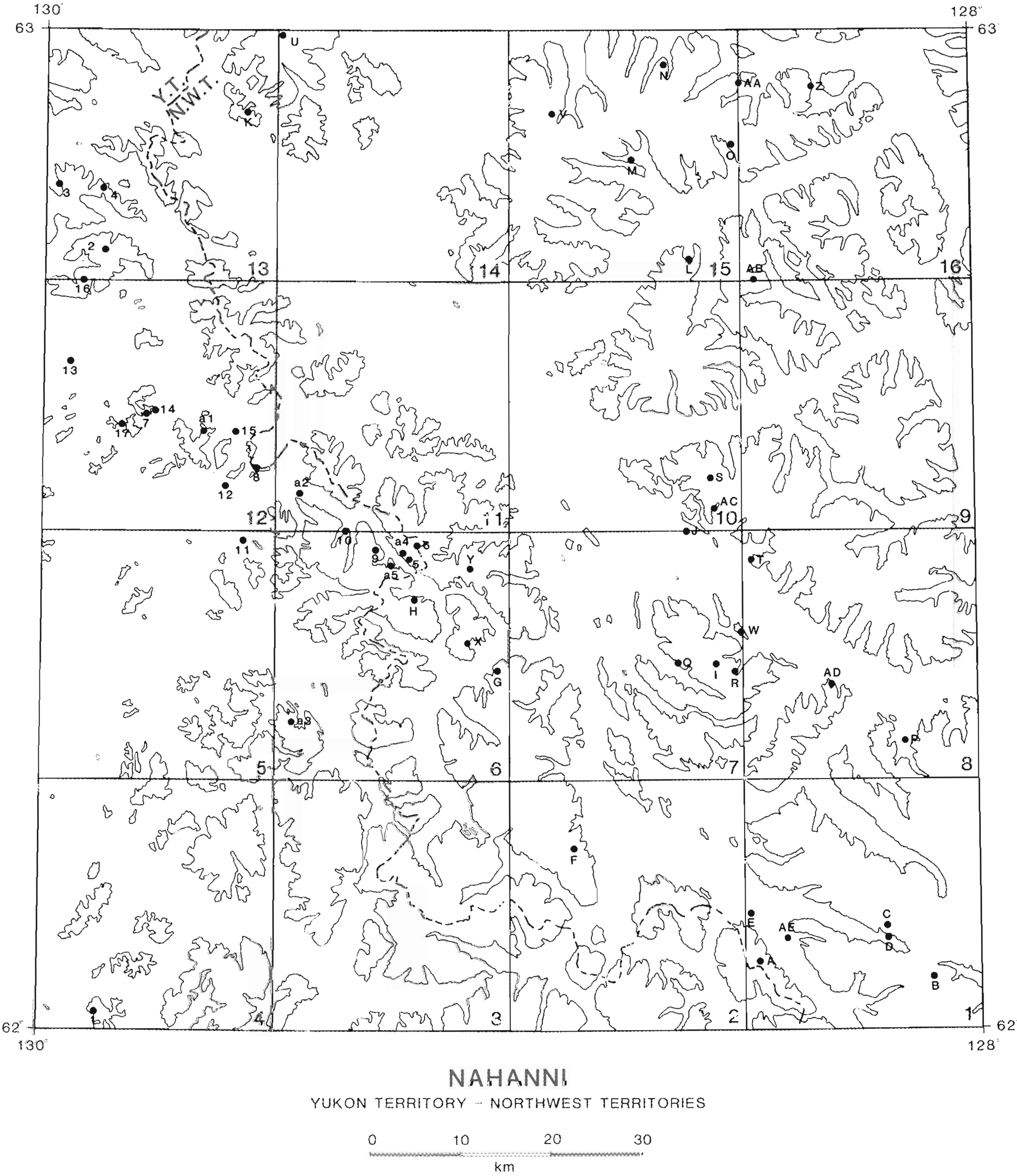


Figure 2.1. Location of mineral showings in Nahanni map area. Numbers indicate showings in Yukon and are consistant with the numbering scheme used by Department of Indian Affairs and Northern Development (1983). Letters indicate showings in the Northwest Territories. Shown for reference are 5000 foot (1524m) topographic contours and 1:50 000 NTS map areas (labelled 1 to 16).

Property description - Northwest Territories

A. HAT
Cu, Pb, Zn
105I/1: 62°4′N;128°28′W

HISTORY:
The property was first staked in February 1973 by Acheron Mines Ltd. and Cream Silver Mines Ltd.

DESCRIPTION:
Prospecting, geological mapping, and geochemical sampling located a few scattered occurrences of malachite, azurite, and minor tetrahedrite in narrow discontinuous quartz veins within Cambro-Ordovician limestone of the Rabbitkettle Formation. Soil or rock samples were taken at 200 foot (61 m) intervals along the east-trending claim lines 1500 feet (457 m) apart. Soil samples contained from 5-187 ppm Pb, 5-2500 ppm Zn, and 3-170 ppm Cu. The sample interval was too wide to pinpoint anomalies from the few anomalous values obtained. Rock samples assayed as much as 0.46% Zn and 0.97% Pb.

SOURCE:
Padgham et al. (1976, p. 124)

B. unnamed
Pb
105I/1: 62°3′N;128°6′W

HISTORY:
Canada Tungsten Mining Corporation examined the occurrence in 1961. The occurrence is reported to have been staked previously.

DESCRIPTION:
Arsenopyrite-galena mineralization occurs in phyllites of the Vampire Formation. The mineralization is reported to be very scant and apparently not of economic grade.

SOURCE:
National Mineral Inventory - #170348 (rev. 3/77):
  1. Department of Indian Affairs and Northern Development; assessment reports: Canada Tungsten Mining Corporation Ltd., map no. 105I-1

C. JAY (RIO, LEO)
Pb, Zn, Au, Ag
105I/1: 62°6′N;128°13′W

HISTORY:
The area was first staked as the D claims in 1953 by G. Dalziel and was examined under option by Yukon Ranges Exploration Limited later that year. It was restaked by Dalziel as the DAL claims in 1959, again as the Zin claims in 1960 by Cassiar Asbestos Corp., by Dalziel in 1966 as the DAL claims, and by Amax in 1969 as the MOON claims, and as the JAY and RIO claims in March 1973 by Alex Black who also staked the contiguous LEO claims in July 1973. The property was aquired by TCL Exploration Group.

DESCRIPTION:
Northwest-trending quartz veins up to 1.5 m wide and 120 m long, crosscut Lower Cambrian slate of the Vampire Formation. The veins contain irregular bands of pyrite, galena, sphalerite, arsenopyrite, and tetrahedrite of variable width, the thickest reaching 0.3 m. Chip samples from the mineralized veins found by Dalziel in 1953 returned an average of 0.05 oz/ton Au, 0.1 oz/ton Ag, 0.45% Pb, and 0.15% Zn over 0.6 m.

SOURCE:
Padgham et al. (1976, p. 125)

D. unnamed
W
105I/1: 62°5.5′N;128°12′W

HISTORY:
Canada Tungsten Mining Corporation carried out prospecting and geological mapping in the area in 1961, at which time the occurrence was discovered. No work was reported and no claims staked.

DESCRIPTION:
Pyrrhotite-bearing diopside skarn is developed in Lower Cambrian dolostone of the Sekwi Formation adjacent to Cretaceous quartz monzonite. A zone as much as 10 feet (3 m) wide and 200 feet (61 m) long within the skarn contains scheelite-pyrrhotite mineralization grading about 0.1% WO_3.

SOURCES:
National Mineral Inventory - #170358 (rev. 3/77)
  1. Department of Indian Affairs and Northern Development; assessment reports, Canada Tungsten Mining Corporation Ltd., 1961, map no. 105I-1
Padgham et al. (1976, p. 125; under description of JAY, RIO, and LEO groups)

E. HUG
Zn
105I/1,I/2: 62°7′N;128°30′W

HISTORY:
The HUG claims were staked in 1973 for Canex-Placer Ltd., as a result of reconnaissance stream geochemistry in 1972. A soil geochemistry survey was done in 1973.

DESCRIPTION:
No mineralization was reported, although two zinc anomalies up to 1200 m long and 600 m wide had values of 5600 ppm Zn, 162 ppm Pb, and 19.7 ppm Cd.

SOURCES:
National Mineral Inventory - #170067
  1. Department of Indian and Northern Affairs; assessment report: Canex-Placer Ltd., 1974, 105I/1,2, doc. no. 080312
Padgham et al. (1976, p. 126-127)

F. unnamed
Li
105I/2: 62°11′N;128°52′W

HISTORY:
The occurrence was located during the course of prospecting and geological mapping in 1961 by Canada Tungsten Mining Corporation.

DESCRIPTION:
Northwest-trending pegmatite dykes crosscutting the Yusezyu Formation and containing spodumene and lepidolite occur over an area about 5 km in length. The vertical dykes vary in width from 0.6 to 12 m and are exposed in the headwalls of cirques as vertical intersections 100 to 120 m in length. Spodumene is the main lithium mineral and occurs commonly at right angles to the dyke

walls. Lepidolite occurs intimately mixed with the spodumene, in a restricted area of one cirque. Assays of grab samples from the dykes gave 1.5% and 2.5% LiO_2. It is estimated from the spodumene content that a large percentage of the pegmatites would grade 1% LiO_2 or better. Both cesium and beryllium are present in trace amounts.

SOURCE:
National Mineral Inventory - #170325 (rev. 3/77)
1. Department of Indian Affairs and Northern Development; assessment reports: Canada Tungsten Mining Corporation, map no. 105I-1.

G. FERN (ALPHA, BRAVO, ECHO)

Pb, Zn
105I/7: 62°21.5′N;129°1.6′W

HISTORY:
The property was originally staked in 1973, and owned 20% by Perry River Nickel Mines Ltd. and 80% by Golden Ram Resources Ltd., who in June 1974 optioned it to Imperial Oil Limited. After summer investigations involving mapping, prospecting, and magnetic and geochemical surveys, Imperial Oil dropped the option in the fall. An agreement was signed with Tricentrol Canada Ltd. who during the period 1975-76 carried out mapping, grid soil sampling, and drilling.

DESCRIPTION:
The main showings are exposed on a southerly-facing, gently rolling slope, between 5300 and 5700 feet (1615-1737 m) in elevation. Galena and dark brown sphalerite occur in massive crystalline lenses and veinlets cutting tremolite-skarn hornfels developed within Cambro-Ordovician Rabbitkettle(?) limestone. Assays from the main showing range up to 27% Pb, but in general (in the hornfels?) were less than 1% combined Pb and Zn. No intrusive rocks are exposed. The mineralization has been traced in a north-south direction for about 500 m. Mineralized float was also found about 900 m to the north of the main (Fern) zone.

SOURCES:
National Mineral Inventory - #512284 (rev. 4/81)
1. Mineral Policy Sector; corporation files, Tricentrol Canada Ltd.
2. Gutrath, G.C.; Report on the Golden Ram Summit Lake property, Nahanni Mining Division, Northwest Territories; report dated October 2, 1973, with Statement of Material Facts, B.C. Securities Commission, July 17, 1974 (copy in Mineral Policy Sector, corporation files, Perry River Nickel Mines Ltd.)
3. Department of Indian Affairs and Northern Development; assessment files: Imperial Oil Ltd.; Perry River Nickel Mines Ltd., 105I/7, Alpha, Bravo, Char, Delta, and Echo groups, 1974-75, doc. no. 080356, 080400

H. CINQ

Zn, Pb, Cu
105I/6: 62°26′N;129°14′W

HISTORY:
The property was originally staked in 1972.

DESCRIPTION:
Five copper occurrences including malachite-azurite on shale cleavage planes and tetrahedrite in quartz-calcite lenses in shale were discovered. Shale samples from three localities assayed 7% Zn. Stream sediment analyses gave maximum values of 2700 ppm Zn and soil samples gave maximum values of 14 000 ppm Zn. A gravity survey was undertaken and a few anomalies discovered, but none were considered to reflect mineralization. Extensive overburden and complicated structure makes it difficult to determine whether the zinc-rich shales should be assigned to the Duo Lake Formation (Road River Group) or to the Portrait Lake Formation (Earn Group).

SOURCES:
National Mineral Inventory - #512440 (rev. 1/75)
1. Mineral Development Sector; corporation files: Vestor Explorations Ltd.
Padgham et al. (1976, p. 139)

I. CAC (RHODES)

W
105I/7: 62°22′N;128°33′W

HISTORY:
The property was staked in 1973 for Amax Exploration Inc. to cover mineralization discovered by prospecting and geochemical exploration that summer. Work by Amax in 1978-79 included mapping, geochemical sampling, magnetometer and electromagnetic surveys, and drilling. Union Carbide acquired the property and carried out additional drilling in 1980.

DESCRIPTION:
Mineralization occurs in skarn developed in the contact aureole of mid-Cretaceous quartz monzonite where it intrudes Cambro-Ordovician Rabbitkettle limestone. Three main types of skarn have been recognized: (1) banded green diopside-garnet skarn; (2) banded dark green epidote-garnet-diopside skarn; and (3) coarse grained light green calc-silicate skarn. Scheelite occurs in all three types, but seems more concentrated in the epidote-bearing variety. Two mineralized zones have been delineated. North Zone mineralization comprises scheelite, 3% disseminated pyrrhotite, and traces of pyrite and chalcopyrite, with highest grade mineralization assaying 0.46% WO_3 over 11 m. The Central Zone consists of isolated skarn within dolomitic limestone that assays up to 0.02% WO_3 over 10 m.

SOURCES:
National Mineral Inventory - #170277 (rev. 8/81)
1. Schneider, D.A., and Leary, G.M.; geological report on the CAC 1-15 claims (Rhodes Tungsten Property), Amax Exploration, Inc., assessment report, 1974, Department of Indian Affairs and Northern Development, doc. no. 080354
Gibbins et al. (1977, p.192)

J. NANCY

Pb, Zn
105I/10,I/7: 62°30′N;128°37′W

HISTORY:
Claims in the area were staked in July 1973, to cover a geochemical anomaly delineated earlier in the year. In 1974, prospecting, geochemical soil and rock sampling, and trenching was carried out.

DESCRIPTION:
Mineralization consists of blebs and veinlets of galena, sphalerite, and pyrite along fractures and bedding planes within brecciated dolomite of the Haywire Formation. Showings generally have a strike length of less than 60 m. Scattered geochemical anomalies reflect the spotty nature of the mineralization. All lead-zinc showings were of generally low grade (1-2% combined Pb-Zn).

SOURCES:
National Mineral Inventory - #170261 (rev. 6/75)
1. Kim, B.Y.; Geological and geochemical report NANCY claims; Department of Indian Affairs and Northern Development, assessment files, 1974
Gibbins et al. (1977, p. 193)

K. CAM
Pb, Ag
105I/13: 62°55′N;129°34′W

HISTORY:
Galena float was discovered in 1971 by Hudson Bay Exploration and Development Company Ltd. prospectors, who subsequently staked the showing. Further work included soil sampling and trenching.

DESCRIPTION:
Argentiferous galena and minor chalcopyrite occur as lenses and blebs within a northwest-trending quartz carbonate vein cutting the Mount Christie Formation. The vein is up to 2 m in width and exposed by trenching over a strike length of 15 m. Talus and permafrost conditions precluded further trenching. Soil sampling outlined a lead anomaly 15-60 m wide and at least 240 m long.

SOURCES:
National Mineral Inventory - #170350 (rev. 4/76)
Padgham et al. (1975, p. 182-183)

L. PR
Cu
105I/15: 62°46′N;128°37′W

HISTORY:
The area was staked by Pete Risby in 1971 to cover copper mineralization found by prospecting. The area was taken under permit in 1972 by Arrow Inter-America Corporation. Five diamond-drill holes totalling 786 feet (240 m) were completed in July 1972.

DESCRIPTION:
Disseminated pyrite and pyrrhotite and minor chalcopyrite, concentrated along thin fractures, occur in hornfelsed sandstone and shale close to mid-Cretaceous quartz monzonite. The best intersection graded 0.69% Cu over 3 m. The copper zone, averaging 1.5 m thick, is reported to contain 25 000 tons grading 0.5% Cu.

SOURCES:
National Mineral Inventory - #170013 (rev. 8/81)
1. Department of Indian Affairs and Northern Development; assessment reports: Arrow Inter-America Corporation, 1972, doc. no. 019791, 060084
Padgham et al. (1975, p. 183-184)

M. CAN
Cu, Pb, Zn
105I/15: 62°52′N;128°44′W

HISTORY:
The property was staked in 1973 and aquired by SEREM Ltd. who conducted prospecting and a geochemical soil survey.

DESCRIPTION:
Prospecting outlined two mineralized skarn zones containing galena, sphalerite, chalcopyrite, arsenopyrite, pyrite, and possibly stibnite 200 m apart in Funeral Formation limestone near the margin of the O'Grady Batholith.

SOURCES:
National Mineral Inventory - #170233 (rev. 6/77)
Padgham et al. (1976, p. 156)

N. RA
Sb, Cu, Pb
105I/15: 62°52′N;128°30′W

HISTORY:
In 1971, P. Risby staked the RA claims to cover an antimony showing, and later in the year Arrow Inter-America Corporation examined the property and obtained prospecting permit 288 covering the surrounding area. In 1972 reconnaissance mapping and detailed prospecting were carried out. Arrow Inter-America Corporation restaked the RA claim as the STIB claim in October 1972, and in March 1973 returned the property to Risby.

DESCRIPTION:
The stibnite showing occurs in a steeply-dipping fracture zone within limestone of the Sapper Formation. This zone varies from 3.5 to 6 m in width and has a vertical extension of 21 m or more. Boulangerite, jamesonite, galena, and arsenopyrite are associated with the stibnite.

SOURCES:
National Mineral Inventory - #170442 (rev. 6/77)
Padgham et al. (1975, p. 184)

O. SAND, GUN
Zn
105I/15: 62°53′N;128°31′W

HISTORY:
The 64 claim SAND group and the 85 claim GUN group were staked in September 1973 to cover zinc mineralization found during a regional geochemical exploration program by Dynasty Explorations Ltd. Prospecting, geological mapping, trenching, geochemistry, and eight diamond-drill holes were completed in 1974.

DESCRIPTION:
Mineralization on the GUN group consists of sphalerite and smithsonite in wavy-banded limestone (Broken Skull Formation?). Massive sphalerite occurs in the nose of small folds within limestone (Broken Skull Formation?) adjacent to quartz monzonite (O'Grady Batholith?). Targets on the SAND group to the east, underlain by lower Sekwi Formation dolostone, quartzite, and shale, and Cambro-Ordovician Rabbitkettle limestone, were strong geochemical anomalies.

SOURCE:
National Mineral Inventory - #170280 (rev. 6/75)
1. McLennan, S.L.; Report of field work 1974, Sand, Gun claim group; Department of Indian Affairs and Northern Development assessment files

P. VULCAN
Pb, Zn
105I/8: 62°18′N;128°10′W

HISTORY:
Regional geochemical exploration by Dynasty Exploration led to staking of the BARBI claims, which included some minor galena-fluorite-sphalerite showings. In 1978, Welcome North Mines discovered a number of new showings and restaked the property as the VULCAN, which was optioned to Rio Canex in 1979. Rio Canex carried out extensive prospecting, geological mapping, geochemical and geophysical surveys, and drilling in 1979 (1334 m in 10 holes) and 1980 (2067 m in 7 holes).

DESCRIPTION:
More than 50 galena, sphalerite, pyrite, fluorite, and barite showings occur in the area, and appear to be of two types: (1) syngenetic fine grained sphalerite and pyrite showing such textures as graded bedding and cross-laminations, several massive sulphide lenses up to 10 m thick that are intercalated with chert and shale, and massive barite-fluorite, possibly vent deposits

related to the more obvious stratiform sulphides (Mako, 1981); and (2) epigenetic fluorite-galena veins formed possibly during folding and/or mid-Cretaceous intrusion of the nearby Appler pluton.

SOURCES:
Brophy et al. (1983, p. 251-253)
Mako (1981)

Q. LENED
W
105I/7: 62°20′N; 128°35′W

HISTORY:
The property was discovered in 1960 by Canex Aerial Exploration Ltd. The claims were allowed to lapse after mapping, trenching, prospecting, and diamond drilling in 1961. H. Brodell restaked the area in 1967, and under option, Atlas Exploration Ltd. tested the property with trenching and geological, geophysical, and geochemical surveys. Canex-Placer trenched and mapped the property in 1973-74. In 1977 Union Carbide acquired the property, and in the following six years up to and including 1962 accomplished an intensive program of geological mapping, geophysics, geochemical soil sampling, and 23 000 m of diamond drilling in 168 holes.

DESCRIPTION:
Tungsten mineralization is associated with scheelite-bearing skarn within contact metamorphosed and metasomatized Cambro-Ordovician Rabbitkettle limestone near intrusive apophyses of the southern margin of Lened Pluton. Two ore-grade zones have been delineated. In both pyroxene-garnet ± vesuvianite ± pyrrhotite is the most pervasive mineral asemblage and carries a grade of mineralization varying from 0.4 to 1.0% WO_3. Amphibole ± pyrrhotite and biotite ± pyrrhotite ± chalcopyrite skarns locally overprint the pyroxene-rich skarns and contain erratic but generally higher grade scheelite mineralization in excess of 10% WO_3. The two mineralized zones, dipping from 60-70° to the southwest, are localized within an imbricate fault zone in the footwall of a major pre-intrusive thrust fault, and range from 2.0 to 14.5 m in thickness.

SOURCES:
Brophy et al. (1983, p. 258)
Glover and Burson (1986)
Dawson and Dick (1978)
Dick (1980, p. 45)

R. RUDI
W
105I/8: 62°22′N; 128°31′W

DESCRIPTION:
Tungsten-bearing skarn is developed at the contact of the Rudi pluton and the Rabbitkettle Formation.

S. BLUE
W
105I/10: 62°33′N; 128°34′W

HISTORY:
The property was staked in 1975.

DESCRIPTION:
Thin skarn bands in hornfelsed Middle Cambrian limestone of the Rockslide Formation adjacent to mid-Cretaceous quartz monzonite contain scheelite, pyrite, and pyrrhotite. Their grade has been visually estimated at no more than 0.50% WO_3. Anomalous tungsten values in soil samples were present only over the intrusion and adjacent skarns.

SOURCE:
Brophy et al. (1983, p. 258)

T. BIG RED
Pb, Zn
105I/8: 62°25′N; 128°21′W

HISTORY:
The claims were staked in August 1979.

DESCRIPTION:
Occurrences of red sphalerite with lesser galena were found over a strike length of 9.5 km in breccias and veins in Middle Devonian Grizzly Bear Formation limestone and Haywire Formation dolostone.

SOURCE:
Brophy et al. (1983, p. 254)

U. unnamed
Pb, Zn
105I/14: 62°59.5′N; 129°29.5′W

HISTORY:
Discovered by Geological Survey of Canada in 1970 and never staked.

DESCRIPTION:
A quartz vein cutting mid-Cretaceous granodiorite contains galena, sphalerite, arsenopyrite, and pyrite.

SOURCE:
Garrett (1971, p. 73)

V. unnamed
Pb
105I/15: 62°54.9′N; 128°54.8′W

HISTORY:
Discovered by Geological Survey of Canada in 1970 and never staked.

DESCRIPTION:
A tourmaline vein crosscutting mid-Cretaceous granite of the O'Grady Batholith contains galena and pyrite.

SOURCE:
Garret (1971, p. 73)

W. GHMS
Ba
105I/7, I/8: 62°24′N; 128°30′W

HISTORY:
The claims were staked in 1976 by Canex-Placer Ltd. to cover anomalous amounts of zinc and lead associated with a barite horizon. Work in 1977 included stratigraphic section measurement and a geochemical survey.

DESCRIPTION:
One main "bed" of thin-bedded grey barite 8 to 12 m thick plus barite lamellae in underlying and overlying siliceous siltstone outcrops over a strike length of 2.5 km. The barite/siltstone interval in the Portrait Lake Formation is overlain successively by black siliceous shale and brown weathering, locally coarse grained clastic rocks of the Prevost Formation. Thin limestone beds at 15 m beneath, 6 m beneath, and immediately beneath the barite have yielded conodonts of mid-Frasnian age.

SOURCES:
Dawson and Orchard (1982)
Lord et al. (1981, p. 124)

X. GRAND (NOR)

Pb, Zn
105I/6: 62°23′N;129°5′W

HISTORY:
The NOR claims, initially staked in February 1973, were restaked in July 1973 to correct staking irregularities (Archeron Mines Ltd. and Grandora Explorations Ltd.). Prospecting, geological mapping, and soil and rock geochemical sampling were carried out in 1973. In 1976, the property was optioned to Serem Ltd. who carried out further mapping and prospecting.

DESCRIPTION:
Disseminated sphalerite and galena was found in grey chert and shale of the Duo Lake Formation(?), and in a 150 m long quartz vein within this chert unit. Soil samples analyzed by atomic absorption methods indicated 3-2700 ppm Zn, 6-780 ppm Pb, and 2-230 ppm Cu. Rock samples assayed up to 2.63% Pb and 2.92% Zn.

SOURCE:
Padgham et al. (1976, p. 132)

Y. CMC

Pb, Zn, Ba
105I/6: 62°28′N;129°5′W

HISTORY:
The CMC claims were staked for Cominco in December 1972 adjacent to the Howards Pass property. In 1973, the property was mapped and a geochemical soil survey conducted. Amomalies were tested in 1975 by 61.3 m of trenching. In 1979, 15.1 km of line were cut and an extensive geochemical sampling program outlined several anomalies.

DESCRIPTION:
Stratiform mineralization occurs at two different stratigraphic levels on the property. In the Duo Lake Formation a 1.5 m section of trench dug over one of the zinc anomalies in 1973 assayed 0.28% Pb and 0.02% Zn. Grab samples 15 m upsection from the trench assayed 2.95% Pb and 1.5% Zn. Geological mapping delineated an 8 m thick barite unit within the Portrait Lake Formation.

SOURCES:
Brophy et al. (1983, p. 250)
Padgham et al. (1976, p. 146)

Z. JOLI GREEN

Zn
105I/16: 62°57′N;128°20′W

DESCRIPTION:
Stratabound sphalerite occurs in carbonates. Its reported coordinates place it in either the uppermost Broken Skull, Haywire, or lowermost Sapper formations.

SOURCE:
Geological Survey of Canada Canmindex File #10000000 (05/01/84)

AA. SKULL

Pb, Zn, Ag
105I/16: 62°57′N;128°30′W

DESCRIPTION:
A vein cutting limestone contains lead, zinc, and silver. Its reported location places it within either the Broken Skull or Sapper formation.

SOURCE:
Geological Survey of Canada Canmindex File #10000100 (05/01/84)

AB. HAN

Zn, Cu
105I/9: 62°45.3′N;128°28.4′W

DESCRIPTION:
Stratabound zinc and copper occur within the Sapper Formation.

SOURCES:
Geological Survey of Canada Canmindex File #10000200 (05/01/84)
Scott (1974)

AC. BONNIE

Zn
105I/10: 62°31′N;128°34′W

DESCRIPTION:
Zinc occurs within dolostone of the Haywire Formation.

SOURCE:
Geological Survey of Canada Canmindex File #10000300 (05/01/84)

AD. unnamed

U, Pb, Zn, P, Ba
105I/8: 62°17′N;128°9′W

HISTORY:
High radioactivity in black shale was noted by the Geological Survey of Canada in 1978.

DESCRIPTION:
Carbonaceous graptolitic shale (Duo Lake or Portrait Lake formation) with fine grained pyrite laminae and encrustations of gypsum and hydrozincite registers 70 000 total counts per minute and and assays up to 247 ppm U. Assays are very high in P_2O_5 and in conjunction with high U, Zn, and V indicate that an organic metal concentrating component exists in the shale. High Ba assays and high Sr/Ba ratios may relate to a volcanic source.

SOURCES:
Bell and Jones (1979, p. 398)
Dawson (1979, p. 375-376)

AE. PAB

Pb, Zn, V, Cu, Ag
105I/1: 62°5′N;128°25′W

HISTORY:
Staked by Canex-Placer Ltd. in the late 1960s. Work on the property at this time included trenching and drilling.

DESCRIPTION:
Stratiform mineralization occurs in shale of the Duo Lake Formation.

SOURCE:
Geological Survey of Canada Canmindex File #00076200 (05/01/84)

Property descriptions - Yukon Territory

1. NAR

Zn, Pb, Cu, Ag, (W)
105I/4: 62°1′N;129°53′W

DESCRIPTION:
The Nar is a pyroxene-garnet-pyrrhotite(?) skarn developed near a small plug of mid-Cretaceous granite within Rabbitkettle Formation limestone. Sphalerite and galena and scheelite associated with chalcopyrite are minor constituents.

SOURCE:
Dawson and Dick (1978)

2. CLEA (OMO)

W, Cu, Zn
105I/13: 62°46′N;129°52′W

HISTORY:
Two showings, about a mile (1.6 km) apart were discovered by Hudson Bay Exploration and Development in 1967 (HI-MIN group). Exploration from 1968-71 included mapping, trenching, sampling, and drilling. Scheelite mineralization in float was discovered by Canex-Placer Ltd. in 1976 during a lead-zinc reconnaissance exploration program, prompting staking of the CLEA and OMO groups. Work by Canex-Placer (later Placer Development Ltd.) from 1977-1981 included geological mapping, geophysics, trenching, and an extensive diamond-drill program (1979: 852 m in 14 holes; 1980: 1500 m in 33 holes; 1981: 1616 m in 5 holes).

DESCRIPTION:
Near the centre of the property a Cretaceous quartz monzonite stock has intruded and hornfelsed complexly folded and faulted Duo Lake Formation. Beds and axial planes strike northwest and dip moderately southwest, and folds plunge northwest. Two occurrences of calc-silicate skarn consist of scheelite, diopside, garnet, vesuvianite, tremolite, calcite, and local biotite, muscovite, and quartz. At the most continuous of these, along the southwestern margin of the intrusion, scheelite-rich skarn (about 1.5% WO_3) occurs in a metamorphosed limestone bed close to or directly overlying the stock, and maintains a 10 m thickness over a strike length of about 600 m. A third occurrence about 3 km southeast of the stock consists of sulphide-rich skarn forming small lenses in sucrosic marble, the scheelite occurring as fine disseminations with more than 60% massive sulphide minerals including pyrite, pyrrhotite, chalcopyrite, and minor bornite and sphalerite.

SOURCES:
Cathro (1969)
Dawson and Dick (1978)
Department of Indian Affairs and Northern Development (1981, p. 190)
Department of Indian Affairs and Northern Development (1982, p. 147)
Dick (1980, p. 42)
Godwin et al (1980)
Marchand et al (1978, p. 92-93)
Morin et al (1980, p. 70)
Tempelman-Kluit et al (1980, p. 10)
Tompson (1978)

3. BIRR (BEE)

Cu, Fe
105I/13: 62°52′N;129°58′W

HISTORY:
The BEE group was staked in 1968 to cover a previously known showing.

DESCRIPTION:
The occurrence is a chalcopyrite-pyrrhotite showing in skarn rocks along the contact between mid-Cretaceous granodiorite and possibly Ordovician-Silurian Road River Group.

SOURCE:
Findlay (1969, p. 50)

4. NOM (SEL)

Au
105I/13: 62°51′N;129°53′W

HISTORY:
The claims were first staked in 1969 by Hudson Bay Exploration and Development Co. Ltd. to cover a geochemical anomaly found in 1967. A gold-arsenic showing is noted at this locality by Blusson et al. (1968). Further soil sampling and geological mapping were undertaken in 1970. The area was restaked late in the summer of 1973 (as the SEL group), following the discovery of gold-bearing quartz veins and a reconnaissance total heavy mineral anomaly during prospecting and regional soil and silt sampling. Field work in 1974 consisted of geological mapping and soil sampling, and in 1976 of geological mapping, soil sampling, and trenching (11 trenches).

DESCRIPTION:
Mineralization consists of arsenopyrite, pyrite, and chalcopyrite with traces of gold within several zones (one up to 6 m wide) of narrow quartz veinlets in black shale of the Portrait Lake Formation.

SOURCES:
Blusson et al. (1968)
Craig and Laporte (1972, p. 130)
Morin et al. (1977, p. 213)
Sinclair et al. (1975, p. 165-166)

5. HOWARDS PASS

Pb, Zn
105I/6,I/11,I/12: 5A. (XY) 62°28′N;129°13′W
5B. (Anniv) 62°33′N;129°32′W
5C. (OP) 62°33.5′N;129°35′W

LOCATION:
The property straddles the Yukon Territory-Northwest Territories border about 260 km north of Watson Lake and 161 km east-northeast of Ross River, Yukon. The main mineralized zone, the XY, is situated near the southeastern end of the property, about 16 km northeast of Summit Lake. From here the property, which is up to 20 km wide, trends northwesterly for about 75 km to include the Anniv and OP zones. Most of the mineralization is on the Yukon side of the border. The main showings are at elevations from 1500 to 1800 m.

HISTORY:
Canex-Placer Ltd. first investigated the area in 1968, carrying out a regional geochemical survey, and in 1971 conducting detailed geochemical sampling. Canex-Placer staked 450 claims on its initial lead-zinc discovery made in July 1972 as a result of additional geochemical work and prospecting. A limited amount of hand trenching and bulldozer work was carried out during the year. An airstrip and tote roads were also built at this time. From 1973-78 the company carried out extensive geological mapping, trenching, gravity and geochemical surveys, and diamond drilling. In 1975 Canex-Placer entered into a joint venture with Essex Minerals Co., a subsidiary of U.S. Steel Corp. During 1977, an 80 km road to the property was constructed that joins the Nahanni Range Road near Flat Lake, but the road was not subsequently maintained, and is presently impassable. When Canex-Placer was dismantled in December 1977, the parent company Placer Development took over operation of the property. An adit was driven in 1980 and 1981 on the XY zone for bulk sampling, and to test possible underground mining problems.

DESCRIPTION:
The XY, Anniv, and OP zones all occur in a similar setting. The individual deposits are complex saucer-shaped bodies containing laminated to massive sulphide minerals characterized by simple sulphide mineralogy, predominantly sphalerite, pyrite, and galena. The deposits are also characterized by a lack of massive pyrite, relatively low Ag and Cu, and lack of associated bedded barite. The ore minerals are so fine grained that hand samples containing up to 20% combined Pb and Zn have the appearance of barren shale. The mineralization occurs within black shale (Lower Silurian) of the Duo Lake Formation (in this region about 300 m thick), roughly 60 m above the contact with underlying Rabbitkettle limestone. Secondary lead-zinc minerals such as smithsonite, cerussite, and particularly hydrozincite have been obvserved in surface showings. In 1982, drill indicated reserves on the XY and Anniv zones were released as 125 million short tons averaging 5.4% Zn plus 2.1% Pb. In addition, inferred reserves in excess of 400 million tons were projected on the basis of known geology and limited drilling. An analysis of higher grade mineralization of the XY zone shows drill indicated, diluted ore reserves of about 9 million tons grading 10.6% Zn and 5.5% Pb. The evaluation concludes that underground mining and shipment of concentrate to toll smelters, under assumptions made were not economically viable at that time.

SOURCES:
Department of Indian Affairs and Northern Development (1982, p. 9)
Department of Indian Affairs and Northern Development (1983, p. 11)
Goodfellow and Jonasson (1986)
Morganti (1979, 1981)
Morin et al. (1978, p. 91)
National Mineral Inventory - #511586 (Y.T.) + #170389 (NWT) (rev. 9/80)

6. SHIELD (PAS)

Pb, Zn
105I/6,I/11: 62°29′N; 129°14′W

HISTORY:
The original claims were staked by Dynasty Explorations Ltd. in 1972 and 1973. Reconnaissance geological mapping and geochemical surveys were carried out in 1973. Subsequently, the claims were transferred in 1973 to the Selwyn Project (Dynasty, Atlas, Shield Resources, and Numac Oil and Gas). Exploration work in 1974 included geological mapping, soil sampling, trenching, and the drilling of 4 holes (about 500 m).

DESCRIPTION:
A lead anomaly with lesser zinc and copper, corresponds with a lead- and zinc-rich horizon 10 to 15 cm thick in black shale of the Duo Lake Formation. Assays from this horizon average 3.99% Pb, 14.5% Zn, and 0.12 oz/ton Ag. Samples from the 10 cm above this horizon assayed only 0.15% Pb and 1.24% Zn. The sulphides are very fine grained and occur along a light grey siliceous horizon within the shale.

SOURCES:
National Mineral Inventory - #512993 (rev. 4/83)
Sinclair and Gilbert (1975, p. 92-92)
Sinclair et al. (1975, p. 160-161)

7. ORO

Ba
105I/12: 62°37′N; 129°46′W

HISTORY:
The area was staked by Noranda Exploration Co. Ltd. in 1972-3. Exploration included a stream sediment survey and local soil sampling. A barite discovery was investigated by 308 m of diamond drilling in 6 holes in 1973. In 1975 part of the ORO property was restaked as the Tang by Ogilvie Joint Venture, and work performed during 1976-77 included geological mapping and geochemical stream, soil, and silt sampling.

DESCRIPTION:
A lenticular thinly bedded barite horizon outlined by 1973 drilling to be 1100 m long, 15 to 50 m wide, and up to 50 m thick occurs in siliceous shale and siltstone of the Portrait Lake Formation. Barite beds grade upward to siliceous siltstone that is overlain by pebbly mudstone. The barite body is underlain by a stockwork of quartz-ankerite-pyrite-barite veins within silicified, locally pyritic grey siltstone and argillite. Footwall siltstone is underlain by 100 m of chert and siliceous argillite, that in turn overlies the Steel Formation orange dolomitic mudstone. A dark grey silty limestone bed 0.7 m thick that lies 34 m below interbedded barite and siltstone in Oro drill hole no. 73-6 yielded a small *Polygnathus* conodont fauna of possible Middle Devonian age.

SOURCES:
Dawson and Orchard (1982)
National Mineral Inventory - #513028 (rev. 4/83)

8. ANNIV

Pb, Zn
105I/12: 62°34′N; 129°31′W

For history and description see 5. HOWARDS PASS.

9. WINKIE (ROSS)

Pb, Zn
105I/6: 62°29′N; 129°17′W

HISTORY:
The claims were staked during the 1972-73 rush into the region and acquired by Cream Silver Mines Ltd. The claims were subsequently optioned to Maverick Syndicate. Exploration in 1973 included geological mapping, and soil and rock geochemical surveys. The property was restaked by Placer Development in 1982.

DESCRIPTION:
A number of coincident lead-zinc soil anomalies occur within shale of the Duo Lake Formation. Rock samples in the area of the soil anomalies assayed up to 2.2% combined Pb-Zn.

SOURCES:
Department of Indian Affairs and Northern Development (1983)
National Mineral Inventory - #512994 (rev. 2/75)
Sinclair et al. (1975, p. 161-162)

10. NESS
Cu
105I/6: 62°29′N;129°22′W

HISTORY:
The area was originally staked in the fall of 1972 during the staking rush that followed the announced discovery of the Howards Pass deposit. Field work in 1973 consisted of geological mapping and stream sediment and soil geochemical surveys.

DESCRIPTION:
Minor malachite, azurite, and tetrahedrite are found associated with calcite in a graphitic shear zone. Lead and zinc geochemical anomalies were outlined but no lead or zinc mineralization found.

SOURCE:
Sinclair and Gilbert (1975, p. 96-97)

11. DIANNE (TAP)
Ba, Zn
105I/12: 62°29′N;129°37′W

HISTORY:
The claims were staked by Dynasty in the summer of 1973 to cover a zinc anomaly discovered during a regional reconnaissance program. Further geochemical sampling in 1973 outlined a number of zinc anomalies. Detailed geological mapping and soil sampling were carried out by Dynasty in 1974.

DESCRIPTION:
Blocky thick-bedded, black chert of the Portrait Lake Formation is the most extensive unit in the vicinity and hosts a number of beds up to 10 m thick of black baritic limestone. Mineral showings consist of gossanous baritic limestone with minor hydrozincite coatings in and adjacent to a northeast-trending fault zone. Selected gossanous samples assayed up to 3% Zn.

SOURCE:
Sinclair et al. (1975, p. 163)

12. RITZ
unmineralized target
105I/5,I/12: 62°31′N;129°32′W

HISTORY:
The area was staked in July 1977 for Cominco Ltd. who carried out geological mapping, geochemical soil sampling, and test geophysical surveys. Further geochemical and geophysical surveys were carried out during 1978, and geological surveys in 1979. A 49.9 line-kilometre geochemical survey was carried out over parts of the claims. The soil geochemical anomalies were tested in 1979(?) by 3 NQ diamond-drill holes totalling 700 m.

DESCRIPTION:
Geochemical soil sampling and geophysical surveys outlined electromagnetic conductors coincident with lead-zinc geochemical anomalies. The soil geochemical anomalies were tested by drilling without success.

SOURCE:
Department of Indian Affairs and Northern Development (1981, p. 190)

13. ABBEY
Pb, Zn
105I/12,J/9: 62°40N;129°56′W

HISTORY:
Four diamond-drill holes totalling 624.5 m were drilled by Archer, Cathro and Associates for Itsi Joint Venture (St. Joseph Exploration Ltd., Union Oil Company of Canada Ltd., and Aquitane Company of Canada Ltd.) in the spring of 1980 to test stratigraphy and electromagnetic conductors on three sections along a strike length of 10 km.

DESCRIPTION:
The drill holes intersected chert conglomerate and wacke, graphitic cherty argillite and siliceous mudstone (Portrait Lake Formation), wispy mudstone (Steel Formation), and carbonaceous graphitic calcareous laminated cherty mudstone, graphitic cherty mudstone, and graphitic and pyritic siliceous shale of the Duo Lake Formation. Graphitic and siliceous mudstone more than 100 m thick was intersected within the Duo Lake Formation, a thicker yet similar succession to that which hosts the Howards Pass deposit. Lithogeochemical assays showed the presence of anomalous lead and zinc in some sections of graphitic mudstone. The best assay was 585 ppm Pb, 3350 ppm Zn, and 78 ppm Cu for 1.5 m of graphitic mudstone in hole 80-A4, but no sulphide mineralization was seen.

SOURCE:
Department of Indian Affairs and Northern Development (1981)

14. TANG
Ba
105I/12: 62°37′N;129°45′W

HISTORY:
The claims were first recorded in August 1975. In 1976, reconnaissance geological mapping and geochemical stream sediment programs were conducted.

DESCRIPTION:
Impure medium to dark grey, thinly to thickly laminated, bedded barite ranging in thickness from 30 to 45 m occurs within black siliceous argillite of the Portrait Lake Formation. No visible lead or zinc mineralization was discovered. A linear zone of anomalous barium values was determined to extend to the west along trend of the barite horizon on the ORO property (no. 7).

SOURCE:
Marchand et al. (1978, p. 92)

15. OHNO
unmineralized target
105I/12: 62°36′N;129°35′W

HISTORY:
The claims were staked in 1977 for Itsi Joint Venture (St. Joseph Exploration Ltd., Union Oil Company of Canada Ltd., and Aquitane Company of Canada Ltd.) by Archer, Cathro and Associates and partially covered ground staked in 1972 as the Nor group. In 1977, preliminary geological mapping, prospecting, and geochemical soil and silt programs were conducted, and in 1978 an electromagnetic survey was undertaken that outlined several conductors.

DESCRIPTION:
The property is largely overburden covered. The 1978 electromagnetic survey outlined several conductors interpreted to be within Road River Group shale. Earlier geochemical surveys outlined no anomalies.

SOURCE:
Morin et al. (1980, p. 69)

16. ROOK

unmineralized target
105I/13: 62°45′N;129°55′W

HISTORY:
The area was staked in August 1976 and work during summer 1977 consisted of geological mapping, prospecting, and geochemical soil and stream sediment sampling. In 1978, further geological mapping and soil and stream sediment geochemical surveys were undertaken.

DESCRIPTION:
Several geochemical anomalies were found for zinc and barium. No mineralization was found.

SOURCE:
Morin et al. (1980, p. 70)

17. FAST

unmineralized(?)target
105I/12: 62°36′N;129°50′W

HISTORY:
Claims were staked in 1982 by Hudson Bay Exploration and Development Company.

DESCRIPTION:
Claims are underlain by the Earn Group.

SOURCE:
Department of Indian Affairs and Northern Development (1983, p. 135)

a1. OP

Pb, Zn
105I/12: 62°36′N;129°39′W

For history and description see 5. HOWARDS PASS.

a2. TROIS

Zn
105I/11: 62°32′N;129°27′W

HISTORY:
Claims were staked in the fall of 1972 following the announced discovery of lead-zinc mineralization in the vicinity by Canex-Placer Ltd.

DESCRIPTION:
Two mineral occurrences have been described, both possibly within the Portrait Lake Formation. One is a breccia with quartz and shale fragments which assayed 1.7% Zn, and the other is a black shale with malachite staining and containing barite.

SOURCES:
National Mineral Inventory - #512996 (rev. 2/75)
1. Mineral Development Sector; corporation files: Vestor Exploration Ltd.
Sinclair and Gilbert (1975, p. 106)

a3. unnamed

Ba
105I/6: 62°18.4′N;129°28.3′W

HISTORY:
The occurrence was found by Geological Survey of Canada in 1980.

DESCRIPTION:
Stratiform bedded barite occurs within black siliceous shale and chert of the Portrait Lake Formation.

SOURCE:
Geological Survey of Canada Canmindex File #00076000 (05/01/84)

a4. unnamed

Ba
105I/6: 62°28.6′N;129°14′W

HISTORY:
Occurrence was discovered by Canex-Placer Ltd. in vicinity of their Howards Pass (XY) deposit.

DESCRIPTION:
Yellow-grey weathering laminated barite occurs over a stratigraphic interval of about 12 m. Within the middle (about 2.5 m thick) and at the base (about 1 m thick) of the barite is thin-bedded carbonaceous chert. The baritic intervals consist of intercalated laminated barite to highly baritic mudstone and laminated baritic mudstone containing limestone clasts and concretions. The barite horizon is within the Portrait Lake Formation and is underlain by carbonaceous wacke containing chert clasts in a carbonaceous mudstone matrix. It is overlain by graded coarse siltstone to mudstone.

SOURCE:
Morganti (1979, p. 76)

a5. unnamed

Ba
105I/6: 62°28′N;129°15.5′W

DESCRIPTION:
Laminated barite occurs within the Portrait Lake Formation.

SOURCE:
Geological Survey of Canada Canmindex File #00005200 (05/01/84)

Appendix 3

Measured Sections

This appendix presents columnar diagrams of measured sections with annotations. The format for all sections is the same as on the legend, except for those measured by W.H. Fritz. These have been previously published, and are included for completeness in their original published form. For each of these a separate legend is indicated. A synopsis of stratigraphic thicknesses for the measured sections is presented in Table 3.1. Figure 3.1 shows the section locations.

Table 3.1. Tabulation of formation thickness data from measured sections.

FORMATION	SECTION THICKNESS IN m																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Jones Lake	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	750+	-	-	-	-	-	-	-	-	-	-
Mount Christie	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	402+	-	-	687	-	-	-	-	-	-	-	-	-	-
chert mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	106+	-	-	163	-	-	-	-	-	-	-	-	-	-
shale mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	296	-	-	524	-	-	-	-	-	-	-	-	-	-
Unnamed shale-limestone	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	325	-	-	-	-	-	-	-	-	-	-	-
Unnamed carbonate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	368+	-	-	-	-	-	-	-	-	-	-	-	-
Tsichu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	267	226	219	173	-	-	-	-	-	-	-	-	-	-
Prevost	-	-	-	-	-	-	-	-	-	-	-	-	-	57+	555+	49+	-	171	386	-	-	-	-	-	-	-	-	-	-	-
Portrait Lake	-	-	-	-	-	-	-	-	149	-	-	-	219	321	-	119	-	54+	204+	-	-	-	-	-	-	-	-	-	94+	-
Steel	-	-	-	-	-	-	-	-	96	-	-	-	97	143	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Duo Lake	-	-	-	-	-	-	-	-	225	-	-	312	122+	296	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rabbitkettle (SW)[1]	-	-	-	-	-	-	-	252	-	993+	505	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gull Lake	-	-	-	-	-	-	-	1050	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
grey mudstone mbr	-	-	-	-	-	-	-	386	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1st cong mbr	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Narchilla	-	-	-	-	-	34+	828	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
sandstone mbr	-	-	-	-	-	-	71	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yusezyu	816+	1140+	408+	364+	291+	107+	15+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
limestone mbr	-	-	-	-	-	12	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nahanni	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Funeral	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grizzly Bear	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sapper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	82	-	-	-	-	-	-	-	-	-	-	-	-	250	297
silty limestone mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	207
limestone mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	90
Broken Skull	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	276+	-	769	559
limestone mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21+	-	179	220
dolostone mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	255+	-	487	339
sandy carb mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	103	-
Haywire	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	101.5+	-	-	84+	102+	81+	-	-	861	379
banded dst mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	396	-
resistant dst mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	465	-
white dst mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
volcanic mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
sandy carb mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	101.5+	-	-	-	102	81	-	-	-	-
Rabbitkettle (NE)[2]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	490+	-	-	-	-	360+	438	-	-
Avalanche	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	324.5	64	285+	204	-	-	-	-
Rockslide	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	452.5	432	100.5	461	-	153	-	-	105+	-
Sekwi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	674	403	504.5	-	-	54+	-	-	-	-
sandy carb mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	363.5	204	232.5	-	-	54+	-	-	-	-
carb mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	310.5	199	272	-	-	-	-	-	-	-
Vampire	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	231+	560+	318+	-	-	-	-	-	-	-
Headless	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Landry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Natla	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arnica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sombre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
striped dst mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
black dst mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
white dst mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carnsell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Delorme	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

FORMATION	SECTION THICKNESS IN m																													
	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Jones Lake	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mount Christie	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
chert mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
shale mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unnamed shale-limestone	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unnamed carbonate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tsichu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Prevost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Portrait Lake	-	-	-	-	39	-	-	-	-	-	161	-	132	-	880	-	282	-	273	184	-	-	279	563	-	-	-	-	-	-
Steel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Duo Lake	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rabbitkettle (SW)[1]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gull Lake	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
grey mudstone mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1st cong mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Narchilla	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
sandstone mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yusezyu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
limestone mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nahanni	-	-	-	-	90	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31	-
Funeral	-	-	-	-	747	167	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grizzly Bear	-	-	-	-	-	-	40	-	-	-	-	-	-	-	-	200.5	-	-	-	28	172	-	-	-	-	-	-	-	-	60
Sapper	-	184	-	400	714	243	578-	-	-	-	159	-	-	295+	17+	-	505+	330+	291	102	362	81+	590	333	-	-	-	-	-	255
silty limestone mbr	-	90	-	-	-	149	551-	-	-	-	132	-	-	-	17+	-	-	330+	267	-	255	-	585	253	-	-	-	-	-	253
limestone mbr	-	94	-	-	-	94	27	-	-	-	27	-	-	295	-	-	-	-	24	-	107	-	5	80	-	-	-	-	-	100
Broken Skull	-	47+	-	143+	-	221+	-	583+	-	-	-	489	-	36+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
limestone mbr	-	47+	-	118	-	221+	-	583	-	-	-	151	-	36+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dolostone mbr	-	-	-	25+	-	-	-	-	-	-	-	338	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
sandy carb mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Haywire	276+	261	884+	538	258+	141	156+	62+	336+	639+	12+	45	-	239	-	-	-	-	-	-	-	-	-	-	17+	-	-	-	-	-
banded dst mbr	-	-	-	200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
resistant dst mbr	-	-	-	338	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
white dst mbr	-	-	299	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
volcanic mbr	-	-	-	-	-	-	-	-	336+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
sandy carb mbr	-	-	-	-	-	-	-	-	-	86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rabbitkettle (NE)[2]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avalanche	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rockslide	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sekwi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
sandy carb mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
carb mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vampire	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Headless	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Landry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	222+	389+	-	-	-	-
Natla	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	327	464	-	-	-	-
Arnica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	42	-	40	-	-
Sombre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	635	-	-	575	-	-
striped dst mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	273	-	-
black dst mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	108	-	-
white dst mbr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	194	-	-
Carnsell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	324	-	-	-
Delorme	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	687	-	-	-

[1] southwest of South Nahanni River

[2] northeast of South Nahanni River

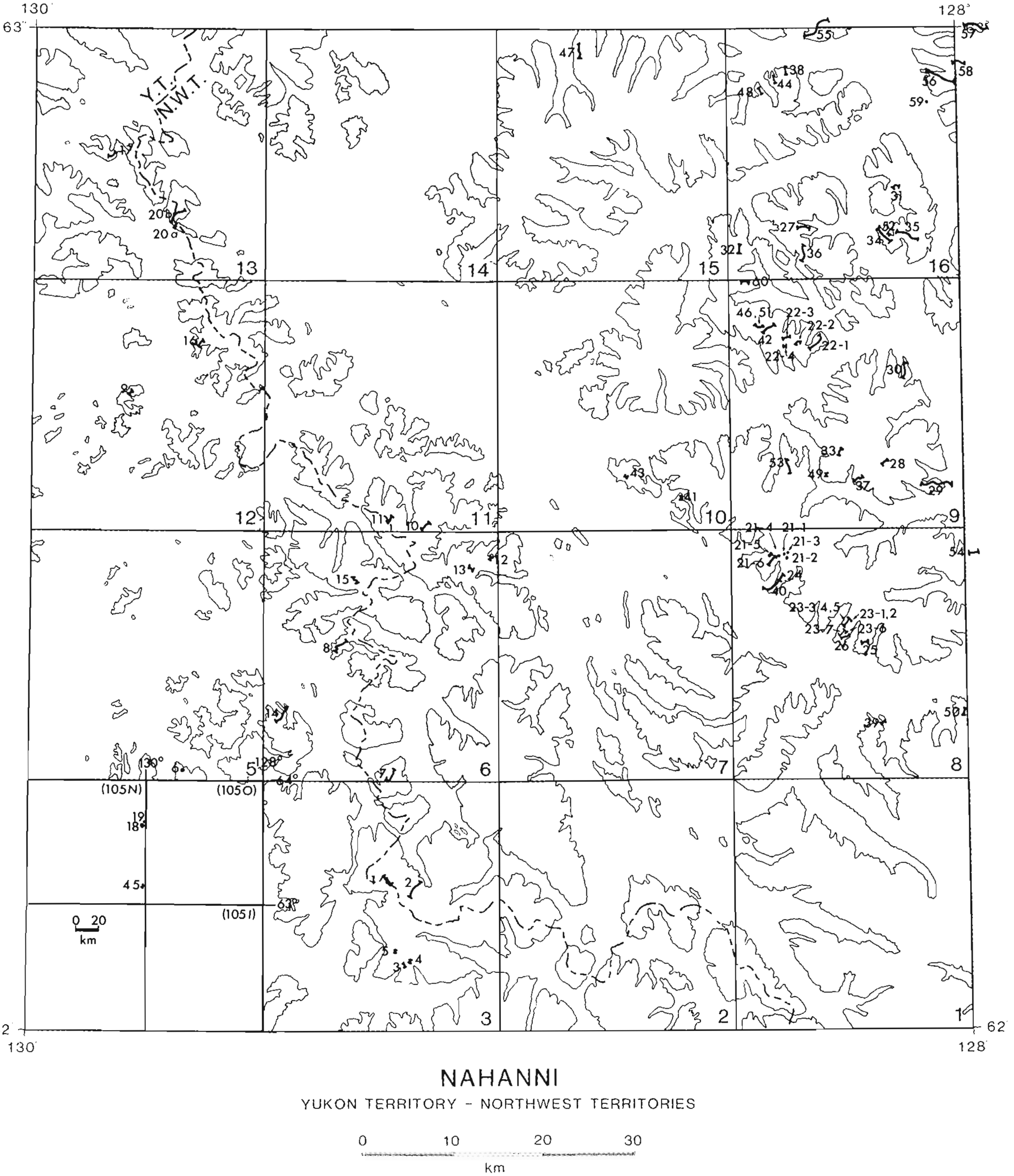


Figure 3.1. Location of measured sections. Shown for reference are 5000 foot (1524m) topographic contours and 1:50 000 NTS map areas (labelled 1 to 16). Inset shows location of sections in Niddery Lake map area (105N).

LAT/LONG
BASE
TOP

PHOTO NO

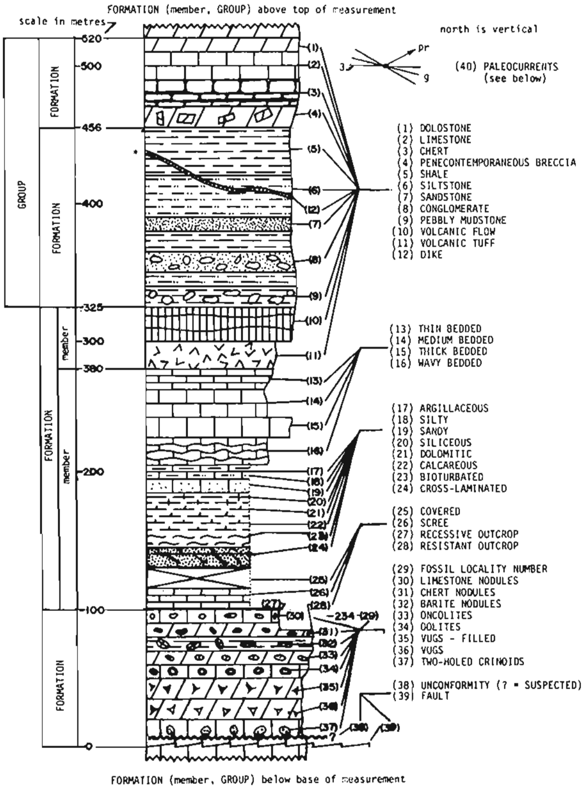
x,y
PHOTO COORD
BASE
TOP

AREA
NTS

MEASURED BY

DESCRIBED BY

SECTION NO.



(1) DOLOSTONE
(2) LIMESTONE
(3) CHERT
(4) PENECONTEMPORANEOUS BRECCIA
(5) SHALE
(6) SILTSTONE
(7) SANDSTONE
(8) CONGLOMERATE
(9) PEBBLY MUDSTONE
(10) VOLCANIC FLOW
(11) VOLCANIC TUFF
(12) DIKE

(13) THIN BEDDED
(14) MEDIUM BEDDED
(15) THICK BEDDED
(16) WAVY BEDDED

(17) ARGILLACEOUS
(18) SILTY
(19) SANDY
(20) SILICEOUS
(21) DOLOMITIC
(22) CALCAREOUS
(23) BIOTURBATED
(24) CROSS-LAMINATED

(25) COVERED
(26) SCREE
(27) RECESSIVE OUTCROP
(28) RESISTANT OUTCROP

(29) FOSSIL LOCALITY NUMBER
(30) LIMESTONE NODULES
(31) CHERT NODULES
(32) BARITE NODULES
(33) ONCOLITES
(34) OOLITES
(35) VUGS - FILLED
(36) VUGS
(37) TWO-HOLED CRINOIDS

(38) UNCONFORMITY (? = SUSPECTED)
(39) FAULT

* dyke crosses section at this level

(40) PALEOCURRENTS

paleocurrent orientation	—
paleocurrent direction	→
from:	
ripple marks	r
ripple cross-lamination	xr
cross-bedding	xb
parting lineation	pl
groove casts	g
prod casts	pr
(all single measurements unless stated otherwise)	

GUIDE TO DESCRIPTION OF MEASURED SECTIONS

1) grain size for clastic rocks follows Wentworth size scale (e.g. Pettijohn et al (1973))

2) approximate grain size for carbonate rocks:

cryptocrystalline or very fine crystalline	<.06 mm
fine crystalline	.06 - .25 mm
medium crystalline	.25 - 1.0 mm
coarse crystalline	>1.0 mm

3) approximate bed thickness:

laminated	<1 cm
thin bedded	1 - 10 cm
medium bedded	10 - 30 cm
thick bed	>30 cm

bed thickness for scree-covered intervals inferred from lithology and typical bed thickness where exposed elsewhere

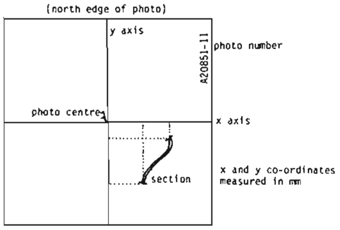
4) FOSSIL LOCALITIES are indexed to sections by metres above base of measurement and by fossil locality number

5) SUSPECTED UNCONFORMITY is inferred from sharp lithologic change and regional thickness variations of underlying strata

6) sections described previously by Fritz (#21,22,23) are included in their original form.

7) all thicknesses measured by Jacob Staff

EXPLANATION OF AIR PHOTO CO-ORDINATES

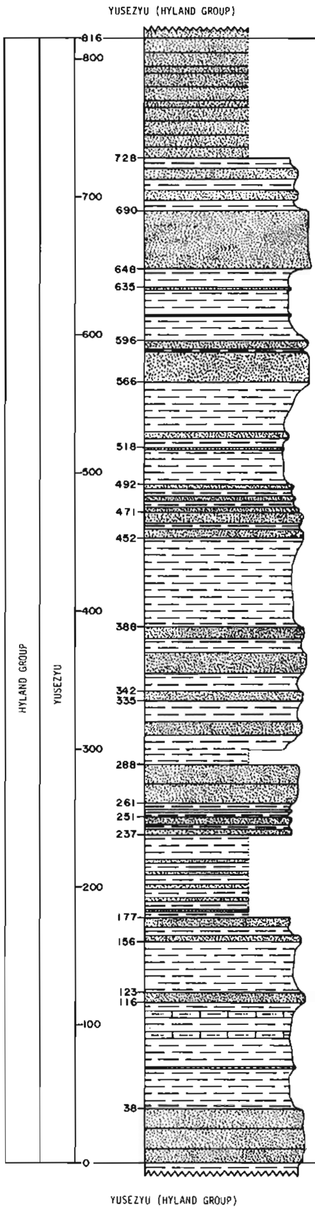


vertical air photographs available through
Department of Energy, Mines & Resources, Canada,
National Air Photo Library,
615 Booth Street,
Ottawa, Ontario,
K1A 0E9

LEGEND FOR STRATIGRAPHIC COLUMNS

SECTION I

62°/8.8';129°/13.6' A20851-11 (-18,15) 105 I-3 meas: K.B. Heather desc: S.P. Gordey
62°/9.2';129°/14.6' (-34,30)



fine- to medium grained, variably calcareous, quartz sandstone; blocky talus only; sandstone outcrop along strike is thin- to medium bedded; section continues in same lithology above end of measurement at ridge crest

interbedded, medium grained, massive sandstone (50%; in beds 0.3 m thick) and blue-grey laminated slate (50%)

medium grained to granule, massive, quartz sandstone

rusty orange weathering, pale green slate; massive, except for thin bedding-parallel parting

brown weathering, blue-green to blue-grey slate; at about middle of interval is 0.6 m thick bed of brown weathering, calcareous, coarse grained, gritty quartz sandstone; unit capped by 2 m of similar sandstone

medium grained to granule, massive, quartz sandstone; at top of interval three slate interbeds (less than 0.5 m thick) separate individual 1.5 m thick sandstone beds

dark brown weathering, blue-grey slate; massive, other than a thin bedding-parallel parting; from 525-530 m is medium grained, quartz sandstone in massive 0.7 m thick beds, some of which have parallel laminated tops

rusty brown weathering, blue-grey slate; top of unit capped by 1.5 m thick bed of massive medium- to coarse grained, quartz sandstone

interbedded, thin bedded, calcareous, parallel laminated, siltstone to fine grained quartz sandstone, and black slate

interbedded, medium grained, quartz sandstone (60%; beds to 0.7 m thick) and blue-grey slate (40%)

rust-brown weathering, blue-grey slate

interbedded in subequal proportion, orange weathering, grey, medium to coarse grained, calcareous, quartz sandstone and rust-brown weathering, blue-grey to black, slate; beds less than 0.4 m thick

medium grained, variably calcareous, thin- to medium bedded, quartz sandstone

from 288-297 m is blue-grey weathering, grey slate; from 297-300 m is rusty weathering pale green slate; from 300-335 m is slate as from 288-297 m, but with 15% beds (0.2 m thick) of orange brown weathering, fine to coarse grained, calcareous, parallel laminated, quartz sandstone

brown weathering, grey, medium grained, variably calcareous, thick bedded, quartz sandstone; rare graded bedding and small shale clasts; both massive and parallel laminated beds common; a few percent thin interbeds of laminated dark grey slate

rusty weathering, blue-grey slate; 10% medium to thick beds of orange weathering, grey, medium grained, parallel laminated, quartz sandstone

interbedded, coarse grained, quartz sandstone (60%; beds 1.0 m thick) and slate (40%; beds 0.7 m thick); base of unit at base of lowest sandstone bed

brown weathering, grey, calcareous, very fine grained sandstone and grey weathering grey slate; scree of each type in subequal proportion; top 15 m of unit is orange weathering, pale green slate

interbedded, fine grained, parallel laminated, calcareous siltstone to fine grained sandstone (60%; beds 0.4 m thick) and slate (40%; beds 0.2 m thick); rare blue-grey shale clasts to 3 cm diameter in some sandstone beds

brilliant orange weathering, pale green slate

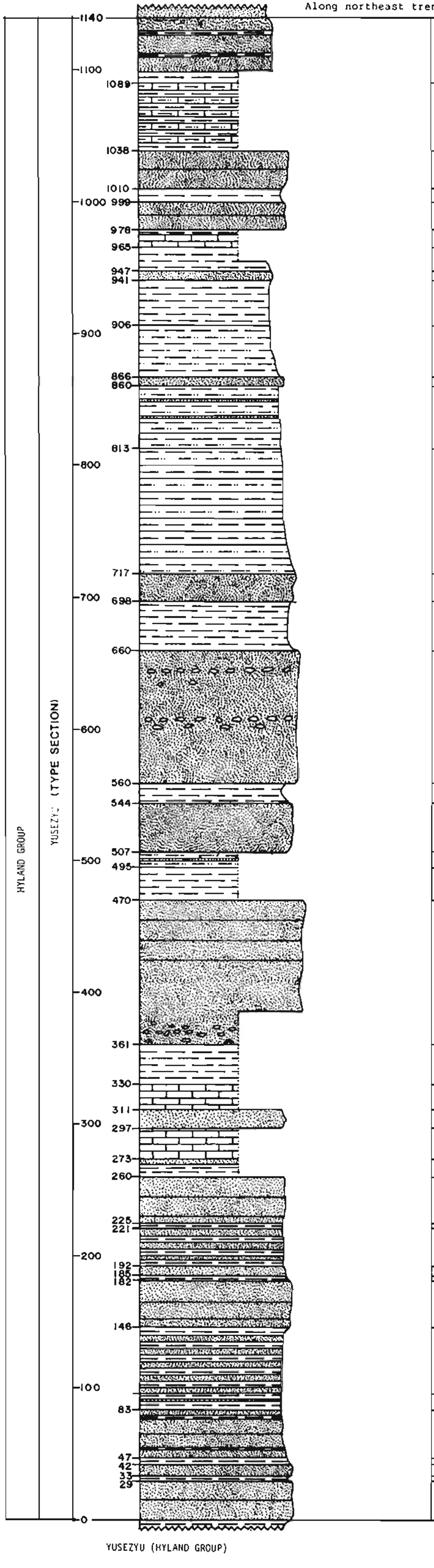
orange to grey weathering, grey, medium grained, variably calcareous, thick bedded, quartz sandstone; bedding defined by 0.7 m thick parting

orange weathering, blue-grey slate; from 71-72 m is brown weathering, parallel laminated calcareous, very fine grained sandstone; upper part of interval contains common thin interbeds of white weathering, fine crystalline, silty limestone

orange to white weathering, grey, coarse grained to granule, thick bedded, quartz sandstone; bedding defined by 1.5 m thick parting; rare graded beds with parallel laminated tops; rare shale clasts to 0.5 m diameter; calcareous cemented horizons and patches weather orange, less calcareous areas grey to white; base of section at contact with underlying recessive, brown weathering, slate with 15% suspended 'clasts' of grey limestone averaging a few millimeters in diameter

YUSEZYU (HYLAND GROUP)   62°/7.9';129°/11.3'   A20851-11   (-12,35)   105 I-3   meas: K.B. Heather   desc: S.P. Gordey
62°/8.9';129°/10.0'   (23,53)
Along northeast trending ridge

SECTION 2



white weathering, grey, medium grained, medium- to thick bedded, quartzose sandstone; locally calcareous and orange weathering; rare interbeds of rusty weathering, blue-grey slate; basal 6 m of unit is rust to pale green weathering, blue-grey slate

orange weathering, blue-black, argillaceous to silty limestone; blue-grey weathering, blue-grey, calcareous? slate

grey-white weathering, grey, fine- to medium grained, massive, quartzose sandstone; upsection similar, yet orange weathering, calcareous sandstone occurs within the non-calcareous variety as distinct beds 0.3 m thick, and as local 'concretionary' pods; calcareous beds locally contain pods of white weathering, non-calcareous sandstone

rust weathering, pale colored slate

medium to coarse grained, quartzose sandstone

grey weathering, grey, finely crystalline limestone, in upper part becoming orange weathering; top 4 m of unit are rusty blue-grey weathering, blue-grey slate

rust and blue-grey weathering, blue-grey slate

orange weathering, grey, medium to coarse grained, calcareous, quartzose sandstone in beds 0.3 m thick interbedded with slate

blue-grey weathering, blue-grey papery slate; measurement from base of overlying unit is resumed on other side of a fault of small displacement, across which offset units can be recognized

rusty blue-grey weathering, laminated in white and black, slate

grey to orange weathering, grey, medium grained, massive, quartzose sandstone

blue-grey weathering, blue-grey slate; faintly laminated; 5% beds (0.6 m thick) of orange weathering, grey medium- to coarse grained, quartzose sandstone; toward top of unit slate develops red coloration on cleavage surfaces

light green weathering, pale green slate; rarely laminated in shades of pale green; much of unit may be slaty-cleaved siltstone; bedding defined by a 0.2 m thick parting; minor thin beds of very fine grained sandstone

grey-white weathering, grey, very coarse grained, locally gritty to pebbly, quartzose sandstone; shale clasts common; local coarse tail grading; base of some beds defined by 0.1-0.2 m thick pebbly horizons

rusty blue-grey weathering, blue-grey slate

grey-white weathering, grey, very coarse grained, massive quartzose sandstone with about 15% quartz pebble conglomerate; shale clasts abundant; along a strike distance of 100 m thickness of underlying slate is reduced to one-half, likely through erosion

rusty blue-grey weathering, blue-grey slate; in good outcrop bedding is defined by 0.2 m thick parting

grey weathering, grey, very coarse grained, locally gritty, massive sandstone; rare scattered shale clasts; at least 7 m of erosional relief may be present at basal contact with underlying unit

orange weathering, laminated in orange and black, siltstone to fine grained sandstone

brown-green weathering, pale green slate; faintly laminated in brown and green

grey-white weathering, grey, coarse- to very coarse grained, locally gritty, massive quartzose sandstone; bedding defined in upper part of unit by a 2-3 m thick parting; base of interval contains about 10% quartz pebble conglomerate with a few per cent pebbles of altered feldspar; exposure of lower part of unit is as large talus blocks and scree

overall orange weathering slate, laminated on fresh and weathered surfaces in blue-grey and orange; silvery blue-grey weathering, blue-grey slate

grey weathering, black, fine crystalline limestone; at about 323 m is minor medium grained sandstone

grey-white weathering, grey, very coarse grained, locally gritty, massive, quartzose sandstone; bedding defined by a 1.5-2.0 m thick parting

grey weathering, black, fine crystalline limestone

rust weathering, pale green slate; in upper part of unit minor, fine grained, quartzose sandstone is interbedded with slate in beds 0.2-0.3 m thick

white weathering (orange weathering at base), grey, medium- to very coarse grained, locally gritty, massive, quartzose sandstone; bedding defined by 1.5 m thick parting

rust brown weathering slate

grey-white weathering, grey, medium- to very coarse grained, locally gritty, massive, quartzose sandstone and slate interbedded in equal proportion in units up to and less than 3 m thick; bases and tops of units have sharp contacts

white weathering, grey, medium- to very coarse grained, locally gritty, quartzose sandstone; bed thickness 1.0 m; normal size grading common

rust weathering, brown to pale green slate; cleavage refraction locally indicates normal size grading (i.e. from silt to clay size?)

white weathering, grey, medium- to very coarse grained, locally gritty, massive, quartzose sandstone; bedding is defined by a vague 3-4 m thick parting; rare isolated lenses of slate; near top of unit some sandstone beds show vague parallel lamination

interbedded slate and medium- to coarse grained, massive, quartzose sandstone in sub-equal proportion; at base slate and sandstone are evenly interbedded in beds 0.2-0.3 m thick; upwards the sandstone beds thicken to 0.5 m and are separated by intervals of slate as much as 3-5 m thick; all beds have sharp bases and tops

rust weathering, pale green slate; 20% scattered beds (0.5 m thick) of fine- to medium grained, quartzose sandstone

white weathering, grey, medium grained, massive, quartzose sandstone; scattered 0.5 m thick beds of slate (same as underlying unit) with sharp bottom and top contacts; top 5 m of unit is interbedded sandstone (beds 0.5-1.0 m thick) and slate (beds 0.2 m thick)

rust and pale green weathering, pale green slate

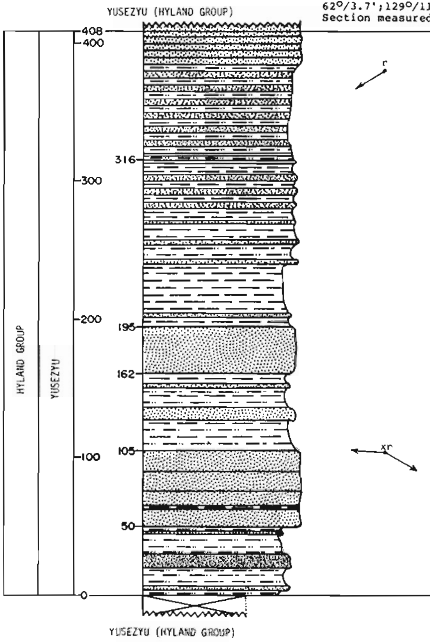
white weathering, grey, medium- to coarse grained, massive quartzose sandstone; bedding defined by 1.0 m thick parting

rust weathering, interbedded (3 cm), grey, fine grained sandstone and black to pale green slate

white weathering, grey, medium- to very coarse grained, locally gritty, massive quartzose sandstone; bedding defined by 0.5-1.0 m thick parting; suspended shale clasts common; base of unit scoured into underlying unit with relief of at least 3 m

SECTION 3

62°/4.0';129°/12.1' A20849-59 (-28,92) 105I-3 meas: R.G. Anderson desc: R.G. Anderson
62°/3.7';129°/11.9' (-26,86)
Section measured from near valley bottom south-southeasterly to ridge crest



greenish grey alternating with buff-grey weathering, grey to black, siltstone to fine grained quartz sandstone; rare white weathering sandstone; top 20-30 m (approx.) of unit is platy, medium grained, thin bedded (1-3 cm) with shaly partings, quartz sandstone; section continues beyond measurement in similar lithology

from base of unit to 240 m (approx.) is rusty grey weathering, dark grey to black, laminated to thin bedded slate; basal 15 m of unit contains white weathering, resistant, grey, quartz sandstone in beds 0.5-1.5 m thick with top 10-30 cm of beds being thinly laminated and bases of beds being massive; from 240-260 m (approx.) is alternating (in 2-4 cm thick beds) white and grey weathering, light and dark grey, quartz sandstone, and siltstone to very fine grained sandstone; from 260-316 m (approx.) is alternating (in equal proportion) (in beds 0.4-1.5 m thick, the sandstone beds increasing in thickness upwards) white weathering, resistant, grey, medium- to coarse grained, quartz sandstone to grit and browny grey weathering, dark grey to black, laminated slate; at top of unit is a 2-3 m thick bed of white weathering, massive sandstone with 5-10 cm long black shale rip-up clasts

white weathering, grey, medium- to coarse grained, quartz sandstone; bedding defined near top of unit by 1.5-4 m thick parting; at base of unit are rare 0.5 m thick shale beds; sandstone near base is laminated and has 1% small (2 cm) shale rip-up clasts

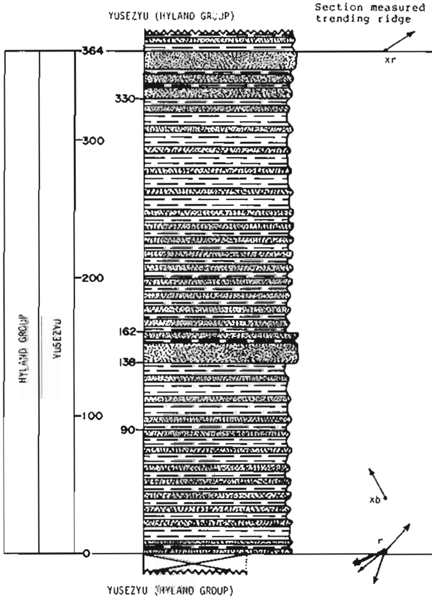
grey weathering, dark grey, laminated slate; bed thickness 1-5 cm, locally to 20 cm probably originally silty shale to siltstone; minor interbeds (20 cm - 9 m thick) of white weathering, medium grey, coarse grained quartz sandstone

white weathering, resistant, grey, coarse- to very coarse grained, massive, quartz sandstone with scattered clear quartz grains to 5 mm diameter; bedding defined by 1.5-6 m thick parting; rare slate beds (less than 1 m thick); sandstone is laminated, locally cross-laminated, in top meter of unit; 1-3%, 1-2 cm diameter, randomly oriented, irregular shaped, shale rip-up clasts at base of unit

dark grey weathering, grey to black, laminated to thin bedded (0.5-2 cm) shaly siltstone to very fine grained quartz sandstone; from about 3-5 m, 20-30 m, and 45-48 m is white weathering, resistant, grey, medium grained, massive, quartz sandstone; top of middle sandstone bed is laminated; base of section at beginning of outcrop

SECTION 4

62°/3.9';129°/11.4' A20849-59 (-9,94) 105 I-3 meas: R.G. Anderson desc: R.G. Anderson
62°/4.2';129°/11.3' (-7,113)
Section measured north-northeasterly across a low southeast-trending ridge crest to the east of main north trending ridge



white weathering, grey, medium- to coarse grained, massive, quartz sandstone (beds 0.05-4 m thick) with lesser interbeds (0.02-3 m thick) of dark colored slate; thinner sandstone beds are internally laminated to thin bedded; rare load casts; lithology continues into isoclinally folded succession above limit of measurement

grey weathering, laminated to thin bedded unit of dark grey to black slate and dark to light grey, very fine- to fine grained, quartz sandstone; in lower to mid-upper half of unit slate and sandstone are in equal proportion; upper half of unit contains 30% grey to white weathering, grey, massive, medium grained, quartz sandstone in beds 0.2-1.5 m thick within dark grey to black slate, the sandstone beds becoming more abundant towards the top of the unit

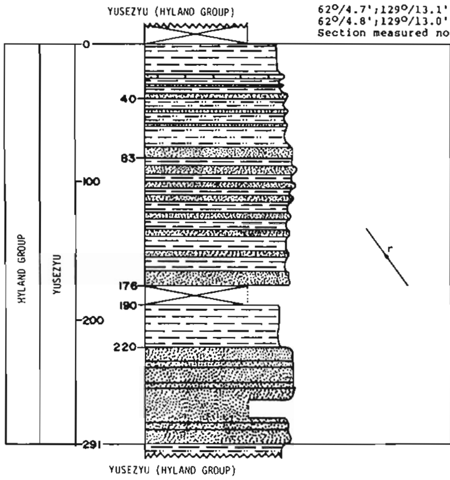
white weathering, grey, medium grained, massive quartz sandstone; near top of unit are rare 5-15 cm thick beds of dark slate

grey weathering, black slate with 30%, 5-20 cm thick beds of white weathering, grey, medium grained, quartz sandstone as seen below

interbedded white weathering, grey, fine- to medium grained, locally gritty, quartz sandstone and dark grey weathering, dark grey to black slate; basal 10 m of unit is ripple marked (0.5-2 cm amplitude, 2-4 cm wavelength, assymetrical), medium grained, quartz sandstone and slate alternating in 5-10 cm thick beds; from 10-20 m is slate; above 20 m is alternating massive sandstone and thin bedded to laminated (0.5-2 cm) slate in beds 0.1-1.5 m thick and 0.02-1.5 m thick respectively; ripple cross lamination at 40 m; proportion of sandstone to shale changes from 70:30 at base of unit to 40:60 at top; base of section at beginning of outcrop

SECTION 5

62°/4.7';129°/13.1'   A12247-423   (101,30)   105 I-3   meas: R.G. Anderson   desc: R.G. Anderson
62°/4.8';129°/13.0'   (102,39)
Section measured northerly across overturned limb of southwest-verging fold



rusty grey weathering, grey, thin bedded (2-5 cm), laminated slate; at about 24 m is thin bed of brown weathering, light grey, laminated, fine crystalline, pyritic limestone; white weathering, grey, medium grained, massive, quartz sandstone in beds 5-20 cm thick is more common in lower part of unit (10%); at base of unit is a 2 m thick bed of white weathering, grey, medium grained, massive (top 10 cm laminated), quartz sandstone; beginning of measurement is at beginning of outcrop

grey weathering, dark grey, laminated to thin bedded (0.2-2 cm) siltstone to very fine grained sandstone; upper half of unit has interbedded, white weathering, grey, fine- to medium grained, quartz sandstone in beds 5-20 cm thick with massive central portions and laminated bases and tops (5%); at base of unit is 7 m (approx.) of fine- to medium grained sandstone with rare 1-3 cm thick slate interbeds

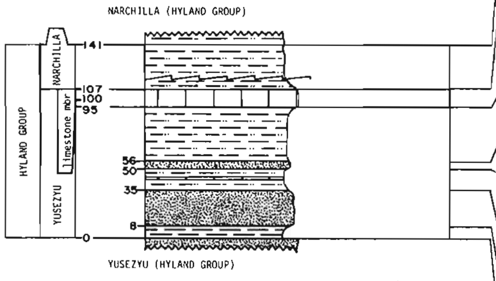
generally thickenning and coarsening upwards succession of interbedded sandstone and slate; top 8 m of unit is light brown weathering, thin bedded siltstone underlain by grey weathering, blue-grey slate; otherwise upper part of unit is white weathering, grey massive, medium- to coarse grained, quartz sandstone in beds 0.4-3 m thick (80%) and interbedded grey slate in beds 5-15 cm thick (20%); near middle of unit sandstone bed thickness and proportion diminish to 1.0-1.5 m and 50% respectively, and slate bed thickness increases to 1.0-1.5 m; towards base of unit sandstone bed thickness is reduced to 2-10 cm and proportion of sandstone is reduced to 35%; symmetrical ripple marks at 155 m; at base of unit is 10 m of white to grey weathering, grey, medium to coarse grained, quartz sandstone (with minor thin slate interbeds) in beds 1-1.5 m thick with laminated bases containing shale rip-up clasts to 30 cm in maximum dimension

grey weathering, with some rust, dark grey slate

white weathering, grey, massive, medium- to coarse grained, locally gritty, quartz sandstone in beds 0.6-1 m thick; 20% interbeds 0.1-0.4 m thick of massive, grey, fine grained quartz sandstone; underlying lithology is black slate and thinly interbedded (1-2 cm) white weathering, grey, laminated, convolutely bedded siltstone

SECTION 6

62°/15.5';129°/40.2'   A19439-81   (24,-29)   105 I-5   meas: S.P. Gordey   desc: S.P. Gordey
62°/15.5';129°/40.3'   (20,-28)
Measured up headwall of small cirque



(REFERENCE SECTION FOR UPPER CONTACT OF YUSEZYU F.)

maroon weathering, maroon shale to siltstone; pale green shale interbeds 1-3 cm thick are spaced on average every 5-10 cm; at 114 m is fault of small? displacement; same lithology continues above limit of measurement

olive-grey to white weathering, dark grey to black, very fine crystalline limestone; bedding defined by 1.0-1.5 m thick parting; contact with underlying shale is sharp; upper contact is gradational (over 1.5-2.0 m) by even interbedding, in 0.3 m thick beds, of white weathering, light to dark grey, very fine crystalline limestone and pale green weathering, pale green shale; at about 105 m limestone contains 5% floating coarse quartz sand; upper contact placed at top of highest limestone bed

pale to dark green weathering, pale to dark green, shale to siltstone; rare ripple cross lamination in silty intervals; laminated in lower one-third, massive in upper two-thirds of unit; near top of unit are a few 0.1 m thick interbeds of orange weathering, black and grey laminated, siltstone and fine grained sandstone

grey weathering, grey, medium- to coarse grained and gritty, massive, quartz sandstone; bedding defined by 1.0 m thick parting; basal and top contacts sharp

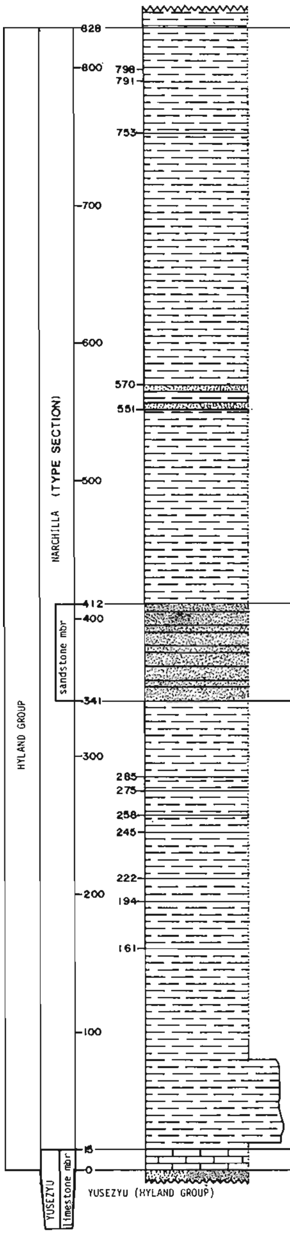
grey-green to black weathering, grey-green to black siltstone; drab tan weathering, blue-grey, very fine crystalline, laminated limestone in 0.2 m thick beds is evenly distributed (about every meter) over middle third of unit; rare thin beds of fine grained quartz sandstone occur near top of unit

grey-green weathering, grey, fine- to coarse grained and gritty, massive quartz sandstone; bedding by parting 1-2 m thick; pockets of gritty quartz sandstone occur within fine- to medium grained sandstone; rare shale clasts; basal and top contacts sharp

grey-green weathering, grey-green, laminated shale; rare grey weathering beds to 0.1 m thick of ripple cross-laminated, fine grained, quartz sandstone; basal contact sharp against light grey weathering, light grey, massive, very coarse grained, gritty, quartz sandstone

SECTION 7

62°/15.7';129°/13.2' A19439-75 (-8,-41) 105 I-6 meas: K.B. Heather desc: S.P. Gordey
62°/15.0';129°/14.1' (-23,-64) T.J. Prakes
Section is poorly exposed, slaty cleavage is pervasive, and structural repetition likely. Thickness of Narchilla Formation should be considered a maximum.



pale green weathering, pale green slate, grading upward in upper half of unit to tan-buff weathering, tan to buff slate; top of section is in first small saddle going downslope within which is 1.5 m of small float of orange weathering, grey, fine crystalline limestone and rare limestone conglomerate belonging to the conglomerate member of the Gull Lake Formation; overlying in turn is tan-buff weathering, blue-grey slate typical of the Gull Lake Formation

dark blue to purple weathering, dark blue-grey slate

pale apple green weathering, apple green slate; 8 m thick bull quartz vein crosses line of section at contact with underlying unit; thickness of vein not included in measurement

dark blue-grey weathering, dark blue-grey slate

alternating intervals about 2 m thick of dark blue-grey weathering, dark blue-grey slate and orange-grey weathering, pale green, very fine grained sandstone

dark blue-grey weathering, dark blue-grey slate, rarely laminated or banded in green; very minor green weathering, pale green slate

orange-grey weathering, grey, fine grained, quartz sandstone and siltstone

dark blue-grey slate

pale green slate

dark blue-grey slate

pale green slate

dark blue-grey slate; minor pale green slate

pale green slate; minor dark blue-grey slate

dark blue-grey slate; minor pale green slate

pale green slate

alternating dark blue-grey weathering, dark blue-grey slate and pale green weathering, pale green slate; the dark blue grey slate commonly has laminae and bands (to 5 cm) of light blue-grey to pale green slate with sharp to diffuse boundaries; in units where pale green slate predominates it is laminated to thinly banded in dark to light green; outcrop distribution at base of section is approximate; basal contact with underlying limestone member of the Yusezyu Formation is abrupt

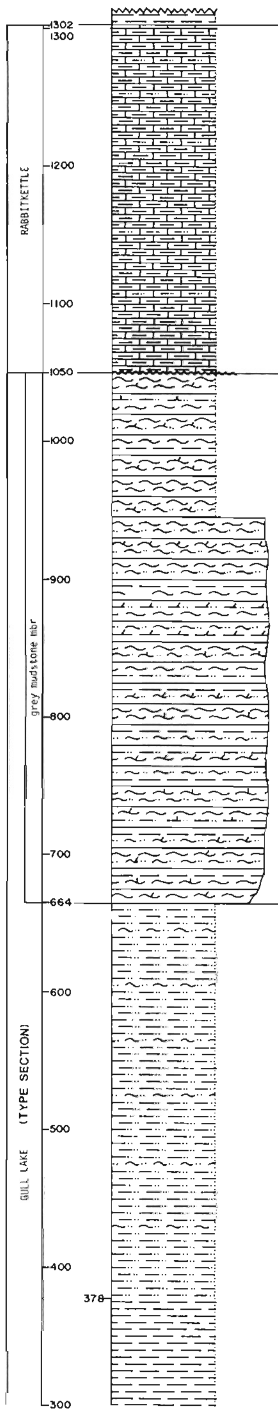
grey-white weathering, grey, fine crystalline limestone; contact with underlying fine- to medium grained sandstone is abrupt

SECTION 8

DUO LAKE (ROAD RIVER GROUP)

62°/23.4';129°/19.2'   A24801-60   (45,79)   105 I-6   meas: K.B. Heather   desc: S.P. Gordey
62°/22.7';129°/20.8'   (29,54)

Section is poorly exposed and slaty cleavage is pervasive. Thicknesses should be considered maximum. Section measured using estimated dip of 65° towards 225°.



overall white weathering, on weathered surface laminated to thin bedded in grey to white, blue-grey argillaceous to silty, very fine crystalline limestone; rare outcrops, otherwise poor scree exposure; lower contact defined at sharp, stratigraphically lowest limit of white weathering limestone scree; contact with overlying black slate of *Duo Lake Formation (Road River Group)* sharply delineated by scree

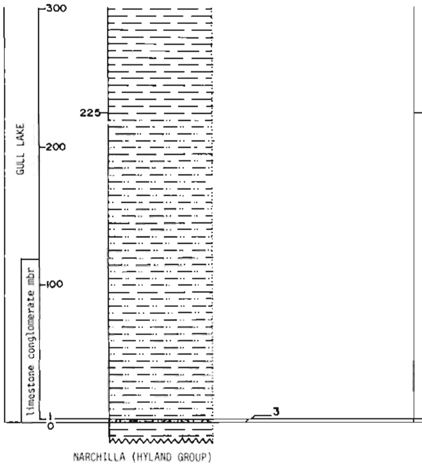
overall grey weathering, resistant, grey to black, thick bedded, bioturbated mudstone and siltstone; variably strongly calcareous to non-calcareous and dolomitic, typically the latter; lamination characterized by centimeter scale alternations of burrowed and non-burrowed intervals; base of unit defined at base of resistant outcrop

orange-brown weathering, well laminated in grey to blue-grey, siltstone; local discontinuous lamination (bioturbation) similar to that in overlying unit

(continued)

SECTION 8

(continued)



rust-brown to buff weathering, well laminated in shades of blue-grey to white, slate; contact with underlying unit is gradational and approximate

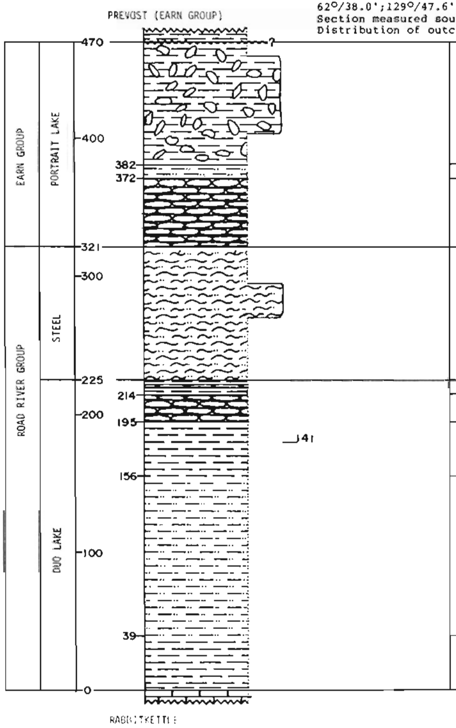
brown to rust brown weathering, poorly laminated in shades of blue-grey, siltstone to very fine grained sandstone; poorly developed slaty cleavage

small exposure of massive, clast supported limestone conglomerate; clasts are moderately sorted, subrounded to subangular, light grey weathering, dark grey, finely crystalline limestone to 3 cm diameter; matrix is orange weathering, highly calcareous, poorly sorted quartz sandstone with rounded quartz grains to granule size; Archaeocyatha occur as rare clasts; this member (thickness here less than 1 m ?) is discontinuous along strike and occurs at the contact between brown weathering Gull Lake Formation and maroon weathering Narchilla Formation (Hyland Group)

3 0-1 Early Cambrian

SECTION 9

62°/38.2';129°/47.1' A24778-138 (33,76) 105 I-12 meas: J.G. Beekmann desc: R.G. Anderson
62°/38.0';129°/47.6' (25,67)
Section measured southwesterly along a low ridge using estimated dip of 40° towards 230°. Exposure is poor. Distribution of outcrop shown is approximate.



black weathering, dark grey to black, massive, poorly sorted, commonly matrix supported, pebbly mudstone; most clasts are dark grey to black (minor lighter colored varieties) chert and shale?, well rounded, to 3 cm diameter, and randomly oriented; rare floating quartz grains within the matrix; top of section at contact with rusty brown to black weathering, black, laminated slate of the Prevost Formation

gun-blue weathering, black siltstone; well cleaved

black, blocky weathering, black chert

orange brown weathering, greenish grey, non-calcareous, silty mudstone; wispy laminated (burrowed), with dark colored 'wisps' within the lighter colored matrix

mixture of black weathering, black chert, and bluish grey weathering, black slate; poorly exposed

black, blocky weathering, black chert

light blue-grey weathering, black slate; poorly preserved graptolites

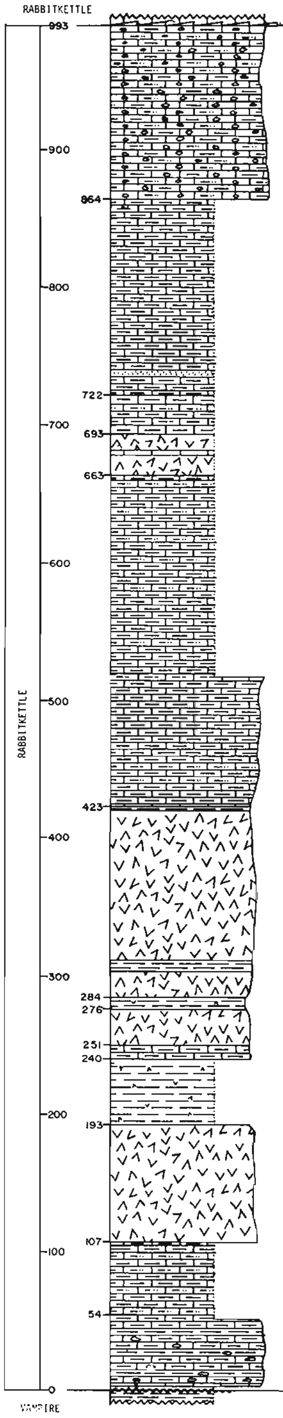
141 180-190 Middle or Late Ordovician, late Llandeilo to Ashgill

tan to tan-grey weathering, light grey, slightly calcareous, laminated siltstone; well developed cleavage; towards top of unit siltstone becomes darker weathering

black, recessive weathering, black, slightly calcareous slate; most of interval above 6 m very poorly exposed and lithology deduced from scree in ground squirrel holes; basal contact placed between scree patches of this unit and the underlying, grey white weathering, dark grey, very fine crystalline, argillaceous, limestone of the Rabbitkettle Formation

SECTION 10

62°/30.4';129°/8.6' A18044-14 (31,-25) 105 I-11 meas: K.B. Heather desc: S.P. Gordey
62°/30.0';129°/9.7' (14,-44)
Perpendicular to northwest trending ridge



grey weathering, grey, fine crystalline, nodular, argillaceous to silty limestone; nodules are dark grey weathering, to 2 cm across and abundant within a light grey weathering, argillaceous to silty limestone matrix; top of section in possible fault contact with orange to buff weathering limestone, siltstone,silty limestone, and dolostone, also of the Rabbitkettle Formation

overall orange weathering, blue-grey, fine crystalline, argillaceous limestone; banded (to 0.1 m) in blue-grey to orange on weathered surfaces; minor fine grained dolomitic quartz arenite, and grey weathering, blue-grey, fine crystalline limestone

brown to green-brown weathering, dark blue-grey, fine crystalline, argillaceous to silty limestone; bedding (2-3 cm) defined on weathered surface by color variation from grey-green to tan brown

grey-green weathering, green tuff; fragment size to 2 cm; minor limestone like that of overlying interval

overall grey to orange weathering, fine crystalline argillaceous to silty blue-grey limestone; bedding to 0.1 m defined by alternating blue-grey and orange weathering color

green to orange weathering, dark green to pink, massive, moderately to poorly sorted tuff; fragment size less than 2 cm; at 400 m scattered fragments to 12 cm across, predominantly black to pale green weathering tuffaceous shale, and laminated tuffaceous siltstone to sandstone; from 307-312 m is orange weathering, blue-grey argillite with bright orange weathering 2 cm thick beds and nodules of dolomitic? mudstone; at top of unit are about 3 m of finely laminated, green, pink, and blue-black argillite transitional to next interval

orange weathering, laminated, blue-grey shale; tuffaceous?

grey-green weathering, mostly massive, dark green to grey tuff; fragment size less than 2 cm; fragments pale green and very fine grained; bedding locally defined by 3-5 cm alternations of coarse and fine tuff

overall orange weathering, blue-grey, fine crystalline, argillaceous limestone; banded (to 10 cm) on weathered surfaces in orange-grey and blue-grey

grey-green weathering, laminated, grey shale; minor mudstone that breaks with brittle aspect; probably tuffaceous

green weathering, massive to thin bedded, green tuff; bedding seen locally as alternations of coarse and fine tuff; maximum fragment size 2 cm; fragments pale green and very fine grained

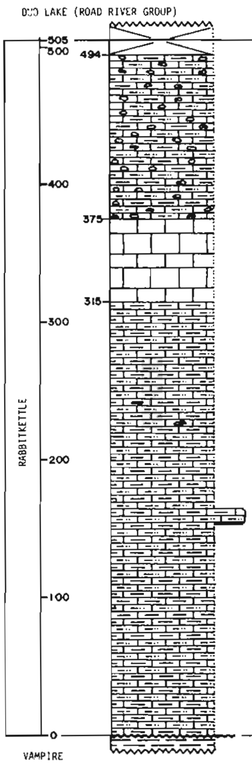
orange to grey weathering, grey to black, fine crystalline, argillaceous to silty limestone; small slump folds in some larger float blocks; minor limestone conglomerate with tabular angular clasts of blue-grey weathering limestone up to 10 cm long in an orange weathering, sandy limestone matrix

orange-grey weathering, grey-green, argillaceous, fine crystalline, nodular limestone and shale; blue-grey weathering, finely crystalline, carbonate nodules, up to 5 cm diameter comprise about 5% of lower part of unit as concentrations along bedding, rarely coalescing as thin beds; base of section at highest position of scree of brown weathering, blue-grey shale of underlying Vampire Formation

SECTION 11

62°/30.8';129°/13.6' A18044-13 (46,-27) 105 I-11 meas: K.B. Heather desc: S.P. Gordey
62°/30.5';129°/14.2' (28,-31)

Section is poorly exposed, and structural cut-out or repetition is possible. Section measured using estimated dip of 35° towards 225°.



contact with overlying Duo Lake Formation not exposed; its position is estimated by extrapolation from along strike

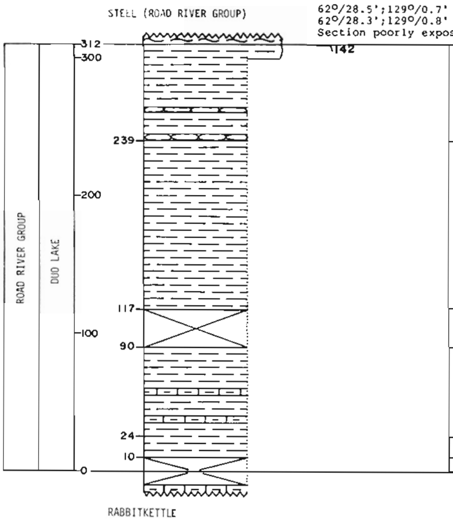
grey weathering, grey, finely crystalline, nodular, argillaceous to silty limestone; large resistant felsenmeer blocks;

blue-grey weathering, blue-grey to black, fine crystalline limestone; probably medium- to thick bedded judging by character of local large felsenmeer blocks; poor exposure

overall orange weathering, blue-grey to black, fine crystalline, argillaceous to silty limestone; laminated in grey to orange on weathered surfaces; outcrop at 158 m is just beneath ridge crest; from 158-315 m is moss covered slope with scattered float, including minor nodular limestone with small grey nodules in orange weathering limestone matrix; base of section at highest position of scree of brown weathering, blue-grey slate of underlying Vampire Formation

SECTION 12

62°/28.5';129°/0.7' A24801-39 (19,92) 105 I-6 meas: K.B. Heather desc: S.P. Gordey
62°/28.3';129°/0.8' (18,83)
Section poorly exposed. Measured along short north-northeast trending ridge.



blue-black weathering, grey shale; from 239-263 m about 10% of scree is blue-black weathering, laminated black chert; distribution of outcrop is approximate; contact with overlying unit is gradational and is placed at lower limit of dark grey weathering, dark grey, bioturbated shale, which passes upward within 2 m to orange weathering, burrow-mottled, grey mudstone and siltstone

blue-black weathering, platy, black, shale; graptolites abundant, but poorly preserved

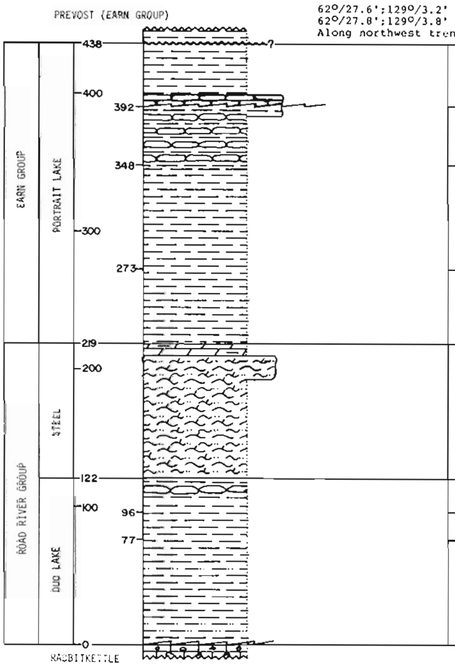
orange-buff weathering, platy, black silty shale; 15% grey to black argillaceous limestone

scattered scree, on a smooth grass covered slope, of dark grey weathering, yellow laminated, black shale; position of contact with silty limestone of Rabbitkettle Formation estimated between bounding scree patches 20 m apart; Rabbitkettle Formation crops out immediately beneath lower limit of section

142 311 Middle Silurian, Wenlock *rigidus* Zone

SECTION 13

62°/27.6';129°/3.2' A24801-39 (-14,64) 105 I-6 meas: K.B. Heather desc: S.P. Gordey
62°/27.8';129°/3.8' (-23,77)
Along northwest trending ridge



black weathering, thin bedded, black chert and siliceous black shale overlain by bluish black weathering shale faintly laminated in grey and white; top of section at contact with brown weathering shale of Prevost Formation; base of interval at fault of small? displacement across which section is likely deleted rather than duplicated; fault truncates limb of small fold

blue-black weathering chert and siliceous shale

blue-grey to blue-white weathering shale, jet black on fresh surface, locally banded in grey and black; rarely weathering orange or with yellow patina

blue-grey weathering, locally faintly laminated in dark blue-grey, jet-black shale; base of the interval poorly defined in patchy scree

wispy laminated, pyritic, dolomitic mudstone and siltstone; wispy laminations are blue-grey; matrix varies from dark blue-grey to pale green, the former predominant; top 10 m of unit is orange weathering, massive, grey-green dolostone, somewhat argillaceous; weathering colors of the unit vary from brown (122-160 m), orange (160-200 m; 210-219 m) and blue-black (200-210 m); base of this interval defined at uppermost limit of scree of underlying unit and by change upwards to brown weathering coarse scree and talus

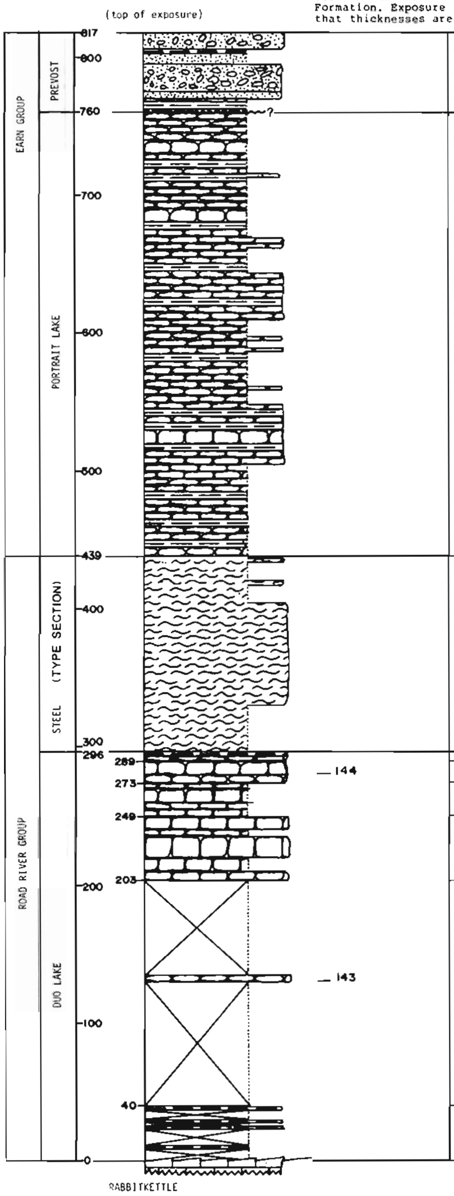
mixture of scree of blue-grey to black weathering chert and faintly laminated blue-white weathering, black shale

blue-white weathering, non-laminated black shale; earthy scree

blue-black weathering splintery argillite, evenly laminated on weathered surfaces in yellow white, grey and black pinstripes; fresh surfaces similar to weathered surfaces; rarely calcareous; section apparently faulted at base against Rabbitkettle Formation; base of section is at change of slope at felsenmeer contact of Rabbitkettle nodular limestone and shale

62°/19.5';129°/27.0'   A24801-60   (-53,-60)   105 I-6   meas: B.S. Norford   desc: B.S. Norford
62°/18.6';129°/28.4'   (-72,-85)
Section measured southwesterly, mostly along ridge crest. Section begins at highest level of the Rabbitkettle Formation. Exposure is poor, small-scale isoclinal folds are common, and small faults are locally discernible so that thicknesses are exaggerated and probably a maximum for the various units.

SECTION 14



conglomerate, very fine to very coarse sand and fine pebbles of chert, rare grains that are not chert, subangular to well rounded, matrix very fine-grained, dark brownish grey weathers yellowish brown, light brown, dull dark olive-grey and dark yellowish orange with abundant lichens, bedding 10 to 80 cm; with about 1 to 2 per cent porosity; chert-pebble conglomerate constitutes 30 to 90 per cent of various levels of unit. Shale, poorly fissile, dark grey, weathers light grey and light bluish grey, recessive. Chert, somewhat argillaceous, dark grey, weathers dull light olive-grey and grey, recessive; thinly bedded and present also as laminae within shale. Covered intervals at 814 to 815, 808 to 810, 795 to 807 and 760 to 770 m; preponderance of conglomerate at 775 to 794 m results in resistant sequence that contains several chevron-folds. Contact with underlying rocks drawn within covered interval at change of colour of float from rusty reddish brown to dull dark grey.

chert, some argillaceous, greyish black and dark grey with dark brownish grey layers, weathers light grey, bluish grey, and dark grey, with abundant lichens, and (in upper beds) yellowish orange, greyish orange and reddish brown; platy, recessive; bedding 1 to 100 cm. Interbedded shaly mudstone and very fissile shale, dark grey and greyish black, weathers greyish black and dull olive-grey with yellowish brown and light brown stains. Unit very poorly exposed, many of outcrops show chevron-folds; covered intervals 716 to 760, 669 to 714, 643 to 662, 597 to 609, 589 to 595, 561 to 588, 548 to 560, 440 to 505 m.

mudstone, siliceous, dark grey, weathers yellowish brown, dull olive-grey and dark yellowish brown with greyish red stains, recessive and rubbly; some more resistant, very siliceous mudstone weathers dark yellowish orange; bedding 10 to 80 cm, no cleavage; most rocks show wispy discontinuous layering that weathers yellowish brown and dull olive-grey. Covered intervals at 422 to 435 1/2, 404 to 417 and 296 to 331 m.

chert, greyish black weathers same, bedding 1 to 10 cm; with interbeds of greyish black siliceous shale that comprises 40 per cent of lower beds and 90 per cent of top beds

chert, dark grey, weathers greyish-black with abundant lichen stains, resistant; beds 5 to 50 cm with very minor shale interbeds. Folds present.

covered interval with chert float

chert, dark grey, weathers greyish-black with abundant lichens and yellowish grey stains; bedding 2 to 70 cm, very rarely laminated. Very rare shale but covered intervals at 244 1/2 to 246 1/2, 236 1/2 to 240 1/2, 230 to 232 and 210 1/2 to 220 1/2 m. Folds present.

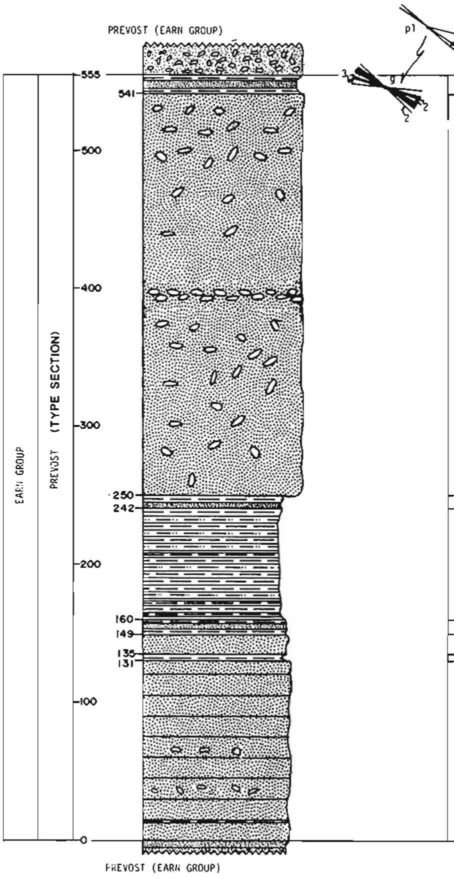
covered interval with local outcrop laterally (at about 130 to 135 m) of chert, greyish black, weathers dark grey with abundant lichens; bedding 10 to 30 cm, some beds laminated; rare interbeds of very siliceous, dark brownish grey mudstone.

covered interval with very minor outcrop; dark grey shale at 40 m, poorly cleaved, weathers olive-grey and dark yellowish orange; slightly dolomitic, dark olive-grey mudstone at 30 m, weathers dull olive-grey with 15 cm bed of greyish black chert, weathers olive-black; slightly limy, dark brownish grey shale at 26 m, weathers olive-grey, cleavage not parallel to bedding, with dark grey chert interbeds; float of cherty mudstone at 9 m; attitude of underlying rocks indicates a faulted? contact. The underlying Rabbitkettle Formation consists of limestone, aphanitic to microcrystalline, dark grey and dark olive-grey, weathers yellowish brown, dark grey and greyish orange, with lichen stains; bedding 15 to 70 cm, most beds with lamination, 0.5-1 cm, that show well on weathered surfaces, with abrupt bases to dark grey laminae that grade up into greyish orange laminae.

144	281	Early Silurian, Middle Llandovery, *Monograptus gregarius* Zone
143	130	Early Silurian, Early Llandovery *Monograptus acinaces* Zone or *M. cyphus* Zone, probably the latter

SECTION 15

62°/26.8';129°/18.1' A24801-14 (-45,36) 105 I-6 meas: K.B. Heather desc: S.P. Gordey
62°/27.2';129°/18.5' (-51-49)
Lower part of section measured up south facing slope to east trending ridge crest, then along ridge to the west. Upper part of section measured along adjoining north trending ridge. Section well exposed.



grey to blue-grey weathering, thinly interbedded shale and fine- to medium grained sandstone; groove and prod casts common on base of sandstone beds; parting lineation and ripple cross lamination also common; this unit is sharply overlain by at least 27 m of grey weathering, chert pebble conglomerate with clasts locally to 0.1 m diameter

grey weathering, grey, massive, coarse grained, chert quartz sandstone and chert pebble conglomerate; from a distance appears thick bedded (a thick parting), but at close view is entirely massive and lacking bedding; from about 393-402 m is horizon of clast supported, poorly sorted, cobble conglomerate with well rounded clasts to 0.3 m diameter of black to grey chert, fine grained quartz sandstone, and coarse grained quartz sandstone; distribution of other conglomerate shown is diagrammatic; top 4 m of unit is thin bedded, platy, medium grained sandstone

thinly interbedded blue-black weathering black shale, and fine grained, parallel laminated chert quartz sandstone; contact with overlying unit is abrupt, displaying relief of at least 1 m

brown weathering, laminated in black to light grey, thin bedded shale and siltstone; scattered minor thin beds of very fine grained sandstone and siltstone, particularly at base of unit; rare medium beds (0.2 m) of parallel laminated fine- to medium grained chert quartz sandstone

equal proportions in units 1-3 m thick of brown weathering, black shale and grey weathering, grey, medium- to coarse grained, chert quartz sandstone; sandstone shows normal size grading and contains small shale clasts

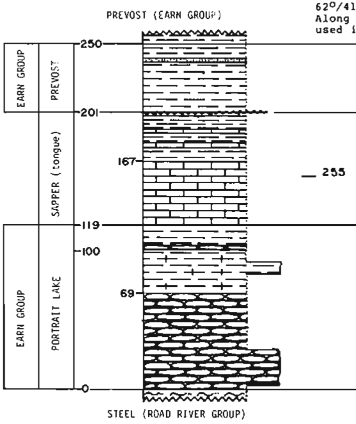
grey weathering, grey, medium- to coarse grained, poorly bedded, thick bedded (0.8 m), chert quartz sandstone; local normal graded bedding; minor shale as thin beds (1-2 cm)

brown weathering, black, recessive shale

grey weathering, grey, medium- to coarse grained, thick bedded (0.8 m), massive, chert quartz sandstone; minor granule to pebble conglomerate; rare graded bedding and suspended shale clasts to 1-2 cm diameter; from 27-29 m is thin bedded siltstone and shale; from 87-131 m bed thickness is slightly less and grain size slightly smaller than lower part of unit, and interval also contains rare thin shale interbeds; base of section at contact with brown weathering thin bedded sandstone that is slightly less resistant weathering

SECTION 16

62°/41.2';129°/38.5' A24778-37 (24,21) 105 I-12 meas: J.G. Beekmann desc: R.G. Anderson
62°/41.3';129°/38.1' (29,38)
Along northeast trending ridge. Tight minor folds seen in places, so thicknesses are probably a maximum. Dip used in measurement was 70° towards 40°.



dark brownish grey weathering, black, laminated slate; from about 237-240 m is dark grey weathering, dark grey, medium grained, chert quartz sandstone; lithology of unit continues above limit of measurement

poorly exposed mixed interval of light grey weathering, black, very fine crystalline limestone and black weathering, black slate; contact with very similar slate of overlying Prevost Formation placed at top limestone horizon

tan to buff grey weathering, black, very fine crystalline limestone; upper and lower contacts are sharp in scree

255 155 Middle Ordovician-Early Devonian

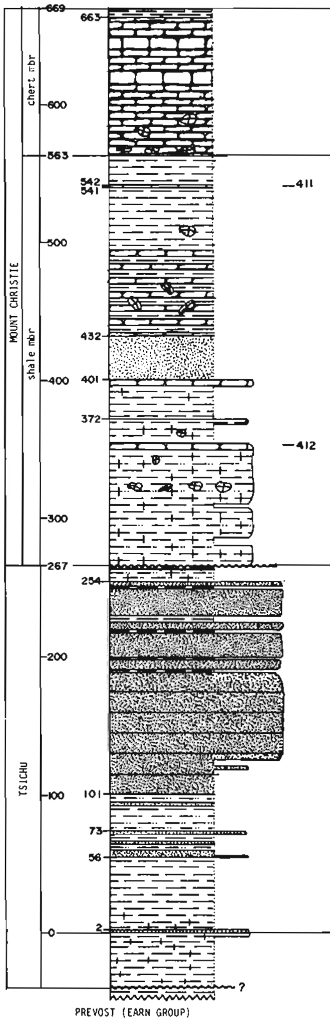
bluish grey weathering, black, siliceous slate; minor black chert

black to bluish grey weathering, black, thin bedded (beds 1-2 cm thick), black chert and minor siliceous shale; contact with underlying orange weathering, bioturbated silty mudstone of the Steel Formation is sharp

SECTION 17

(top of exposure)

62°/52.6';129°/49.7' A24778-102 (-10,26) 105 I-13 meas: S.P. Gordey desc: S.P. Gordey
62°/52.4';129°/50.6' (-23,20)
Measured along northeast trending ridge



grey-green weathering, grey-green argillite; top of measurement marks top of exposure

orange weathering, grey chert; at 596 m is small amount of float of ochre weathering, grey, coarse crystalline limestone; in lowermost part of unit are abundant, round concretions or nodules to 0.3 m diameter of dark grey, fine crystalline barite with coarse crystalline, star-shaped cores, locally with central void space and small barite crystals projecting into the cavity; thickness of unit approximate;

dark grey-green weathering, siliceous argillite

dark red-brown weathering, light grey, medium crystalline limestone

dark green-brown weathering, green argillite; few per cent round, fine crystalline, barite nodules to 10 cm diameter, locally with central, star-shaped core of coarse crystalline barite, locally with void space; argillite is locally highly siliceous, but good chert is found only below 446 m where it comprises about 50%?

white weathering, white, chalky, fine grained, clean, quartz sandstone

green with rust weathering, green argillite; outcrop (poor) is thin bedded, well bedded; from 396-400 m is resistant, rusty weathering, thin bedded (0.1 m), grey chert and very siliceous argillite; at top of unit is 0.25 m of red weathering, platy, siliceous siltstone

rust weathering, black, thin bedded, very well bedded, very siliceous shale and silty shale; at 320 m is lowermost occurrence of round, up to fist-sized, rust-orange weathering, dark grey, fine crystalline, barite nodules which occur to the top of the section in amounts to a few per cent; from 350-354 m is grey weathering, black, wispy laminated, medium- to thick bedded (0.3 m) chert; basal contact not exposed

blue-black weathering, black, platy siliceous siltstone; minor black chert towards top of interval

grey weathering, resistant, grey, fine- to medium grained, quartz sandstone; internally massive except for 1.5 m thick parting ; contacts with shale intervals listed below are sharp, and tops and bases of sandstone beds are smooth and planar; from 121-126 m is mixed rubble of quartz sandstone and black, very muddy, siltstone and sandstone with vague small carbonaceous impressions; black weathering, black, recessive shale scree, locally with minor, fine grained, muddy, quartz sandstone at 189-190 m, 191-191.5 m, 198-199 m, 208-208.5 m, 217-220 m, 225-230 m, 250-252 m

brown weathering, grey to brown, siltstone, silty shale, and muddy, fine grained, quartz sandstone; 101 m marks uppermost limit of this recessive scree beneath talus of overlying unit

mixed interval of grey weathering, black, muddy, fine- to medium grained quartz (and some chert) sandstone (56-63 m, 71-73 m, 65-66 m) and brown weathering shale and silty shale (remainder of unit)

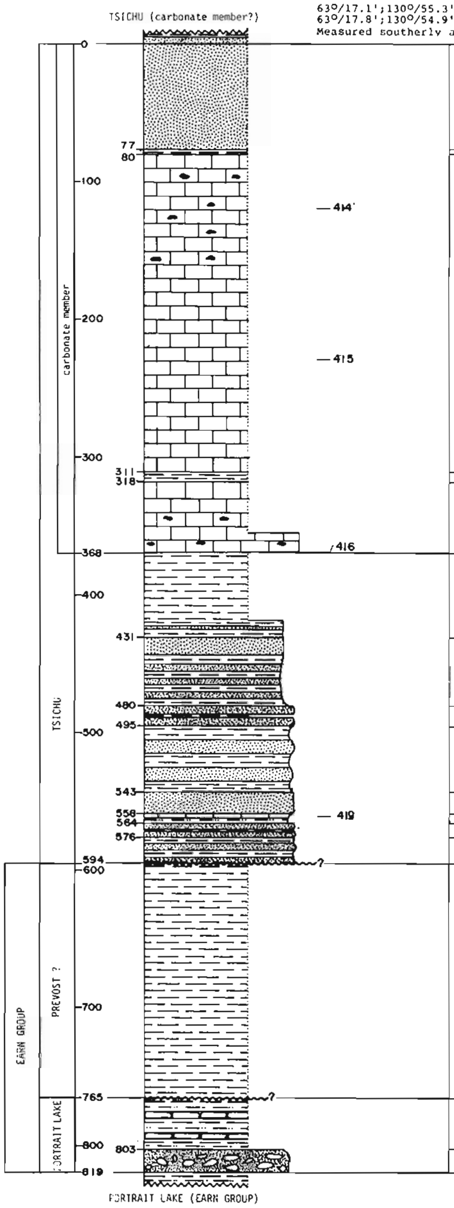
black weathering, black shale with abundant float of orange weathering grey-green argillite; from 2-4 m and 47-53 m is blue-grey weathering, black, siliceous shale

grey-white weathering, dark grey, medium grained, quartz sandstone; bedding defined by 0.4 m thick parting; sharply overlies 2 m thick outcrop of gun-blue to black weathering, black, siliceous shale and shale; from 2-39 m below base of section are quartz sandstone talus blocks (derived from overlying bed) and scree of similar siliceous shale in turn underlain by recessive fine scree of brown weathering, grey shale

411	541.5	Late Pennsylvanian, Virgilian-Early Permian, Wolfcampian
412	354	probably Late Mississippian

SECTION 18

63°/17.1';130°/55.3' - - 1050-7 meas: S.P. Gordey desc: S.P. Gordey
63°/17.8';130°/54.9'
Measured southerly along ridge. Section is overturned with overturned beds dipping southerly about 50°.



grey weathering, grey, very fine- to fine grained, clean quartz sandstone; base of section is arbitrary and placed at base of first continuous downsection scree of quartz sandtone; stratigraphically above the base of section are scree patches of quartz sandstone and brown splintery shale

dark grey to black weathering, black, splintery shale

grey-white to orange weathering, grey, fine grained bioclastic limestone; fossil hash is largely unrecognizable, but locally contains crinoids; nodules and irregular thin beds of grey to black chert are common to 162 m; a few scattered outcrops; contact with stratigraphically overlying unit is sharp in scree

brown to blue-grey weathering, pale green to blue-grey shale; contact with over- and underlying carbonate is abrupt

same as 80-311 m; shale as in stratigraphically overlying unit from 336-337 m and 344-345 m; at 346 m and 362 m nodules and beds (to 0.1 m thick) of black chert are common; outcrop at top 10-15 m of unit is medium bedded; contact with stratigraphically underlying shale is sharp and basal limestone contains 5-10% irregular shaped shale clasts to 3 cm in diameter

dark brown weathering, dark grey to black shale; bottom few meters (stratigraphically) of unit have thin- to medium interbeds of sandstone

orange-grey weathering, grey, very fine- to fine grained quartz sandstone; below 443 m shale becomes abundant and unit is thinly interbedded, clean quartz sandstone and dark shale; sandstone beds are locally graded, having sharp bases (stratigraphic) and indistinct tops)

two ribs of subequal thickness of massive, fine grained, grey to rust stained, clean, quartz sandstone separated by 2 m of dark shale; contacts with shale are sharp

interbedded in equal proportion in thick beds are dark grey to black weathering, black shale to siltstone and orange weathering, grey, fine grained, clean, quartz sandstone

massive resistant, fine- to medium grained, clean, locally calcareous, quartz sandstone

orange weathering, grey, calcareous siltstone to silty limestone; ripple cross-lamination abundant; local slump folds

orange-grey weathering, grey, fine grained, clean, quartz sandstone in massive beds to 3 m thick; thin interbeds (scree) of dark shale; sandstone locally contains rip-up clasts and the bases of some beds have load casts; bottom (stratigraphically) 6 m of unit are orange weathering, laminated, calcareous, very fine grained sandstone and dark, blue-grey shale

thickly interbedded, yellow weathering, grey, laminated, calcareous, clean, quartz sandstone and dark shale; sandstone laminations locally outline slump folds; locally sandstone contains shale clasts; shale interbeds are locally highly bioturbated; base of unit (stratigraphically) marks lowest limit of quartz sandstone

dark brown to dark blue-grey weathering, dark blue-grey shale

angular scree of grey to blue-grey weathering, black siliceous siltstone, shale and lesser black chert

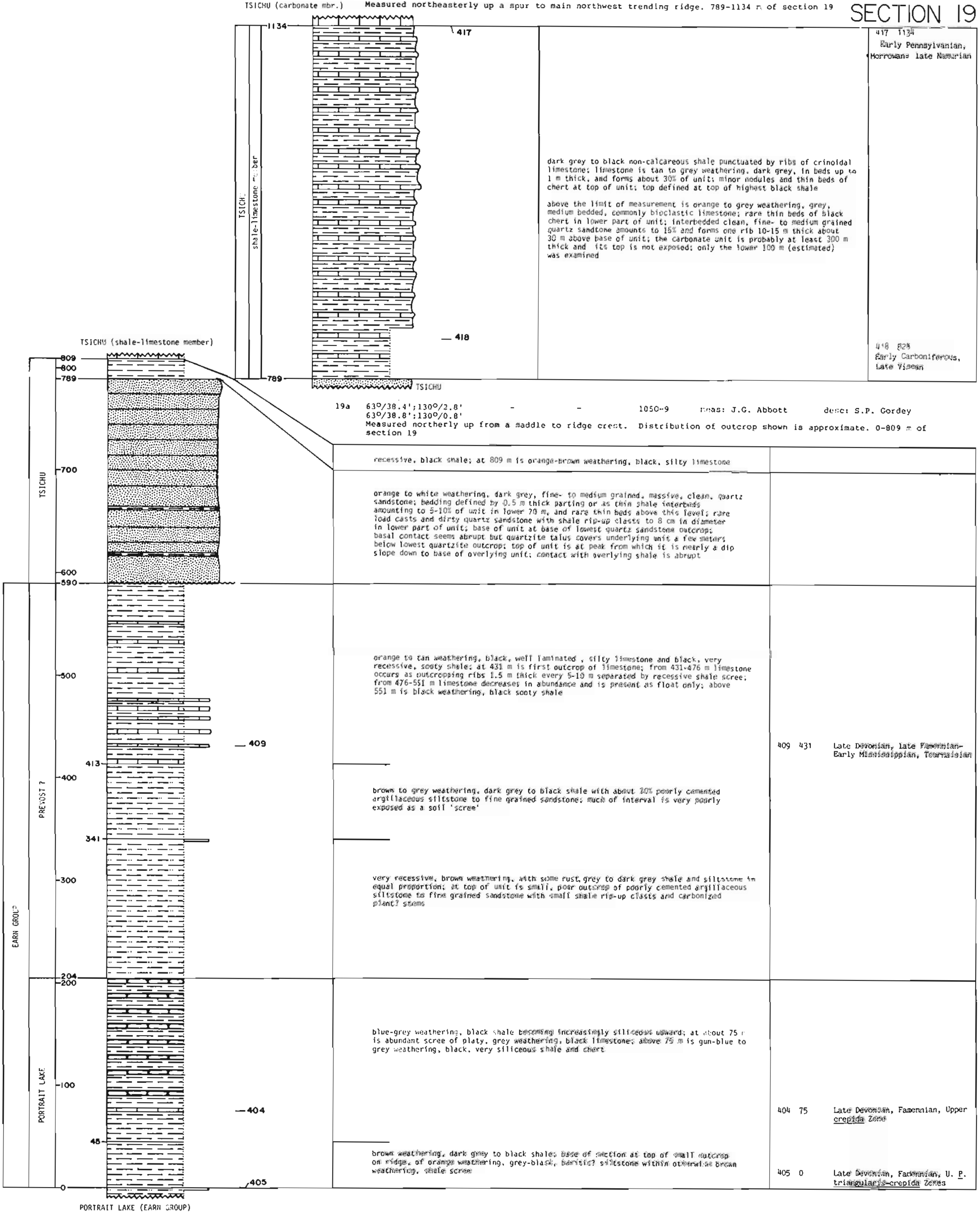
resistant rib of blue-grey to grey weathering, clean, massive, chert granule to chert pebble conglomerate; chert granules and pebbles are black to light grey, angular to subrounded and moderately sorted; below base of unit (stratigraphically) is poorly exposed, brown weathering, silty shale

414	119	Late Mississippian, Chester= probably Early Namurian
415	229	Late Mississippian, Chester= probably Early Namurian
416	368	Early Carboniferous, probably late Visean
419	561	Early Carboniferous, Late Visean

SECTION 19

19b 63°/39.2';130°/0.5' - - 1050-9 meas: J.G. Abbott desc: S.P. Gordey
63°/39.2';130°/0.0'

TSICHU (carbonate mbr.) Measured northeasterly up a spur to main northwest trending ridge. 789-1134 m of section 19



dark grey to black non-calcareous shale punctuated by ribs of crinoidal limestone; limestone is tan to grey weathering, dark grey, in beds up to 1 m thick, and forms about 30% of unit; minor nodules and thin beds of chert at top of unit; top defined at top of highest black shale above the limit of measurement is orange to grey weathering, grey, medium bedded, commonly bioclastic limestone; rare thin beds of black chert in lower part of unit; interbedded clean, fine- to medium grained quartz sandtone amounts to 15% and forms one rib 10-15 m thick about 30 m above base of unit; the carbonate unit is probably at least 300 m thick and its top is not exposed; only the lower 100 m (estimated) was examined	417 1134 Early Pennsylvanian, Morrowan= late Namurian 418 828 Early Carboniferous, Late Visean

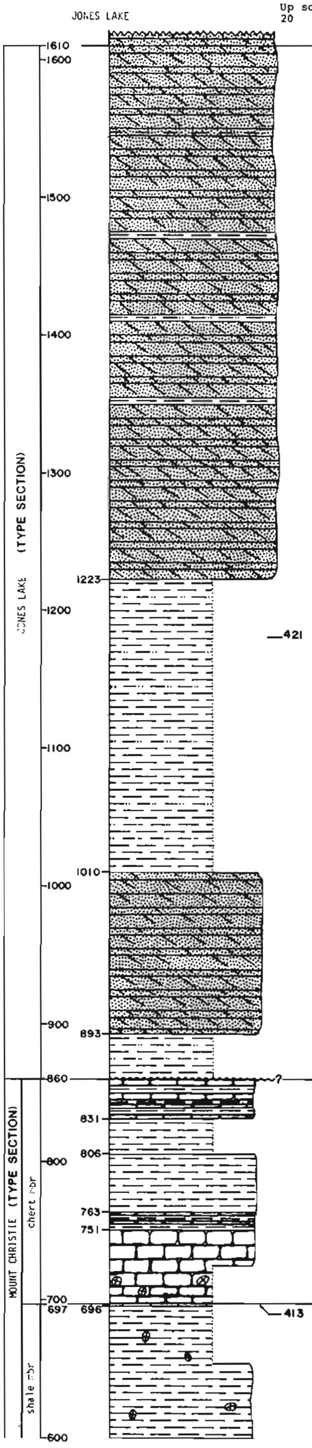
19a 63°/38.4';130°/2.8' - - 1050-9 meas: J.G. Abbott desc: S.P. Gordey
63°/38.8';130°/0.8'
Measured northerly up from a saddle to ridge crest. Distribution of outcrop shown is approximate. 0-809 m of section 19

recessive, black shale; at 809 m is orange-brown weathering, black, silty limestone	
orange to white weathering, dark grey, fine- to medium grained, massive, clean, quartz sandstone; bedding defined by 0.5 m thick parting or as thin shale interbeds amounting to 5-10% of unit in lower 70 m, and rare thin beds above this level; rare load casts and dirty quartz sandstone with shale rip-up clasts to 8 cm in diameter in lower part of unit; base of unit at base of lowest quartz sandstone outcrop; basal contact seems abrupt but quartzite talus covers underlying unit a few meters below lowest quartzite outcrop; top of unit is at peak from which it is nearly a dip slope down to base of overlying unit; contact with overlying shale is abrupt	
orange to tan weathering, black, well laminated , silty limestone and black, very recessive, sooty shale; at 431 m is first outcrop of limestone; from 431-476 m limestone occurs as outcropping ribs 1.5 m thick every 5-10 m seperated by recessive shale scree; from 476-551 m limestone decreases in abundance and is present as float only; above 551 m is black weathering, black sooty shale	409 431 Late Devonian, late Famennian-Early Mississippian, Tournaisian
brown to grey weathering, dark grey to black shale with about 30% poorly cemented argillaceous siltstone to fine grained sandstone; much of interval is very poorly exposed as a soil 'scree'	
very recessive, brown weathering, with some rust, grey to dark grey shale and siltstone in equal proportion; at top of unit is small, poor outcrop of poorly cemented argillaceous siltstone to fine grained sandstone with small shale rip-up clasts and carbonized plant? stems	
blue-grey weathering, black shale becoming increasingly siliceous upward; at about 75 m is abundant scree of platy, grey weathering, black limestone; above 75 m is gun-blue to grey weathering, black, very siliceous shale and chert	404 75 Late Devonian, Famennian, Upper *crepida* Zone
brown weathering, dark grey to black shale; base of section at top of small outcrop on ridge, of orange weathering, grey-black, baritic? siltstone within otherwise brown weathering, shale scree	405 0 Late Devonian, Famennian, U. *P. triangularis-crepida* Zones

20b 62°/48.3';129°/42.4' A24778-72 (-16,31) 105 I-13 meas: J.G. Beekmann desc: S.P. Gordey
62°/49.0';129°/40.6' (5,45)
Up and along east-northeast trending ridge about 0.75 km northwest of section 20a. Section 20 above 173 m.

20a 62°/48.2';129°/42.0' A24778-72 (-11,21) 105 I-13 meas: J.G. Beekmann desc: S.P. Gordey
62°/48.3';129°/41.8' (-8,23)
Up southwest side of low southeast-trending ridge about 0.75 km southeast of section 20b. Basal 173 m of section 20

SECTION 20



grey to tan weathering, grey to black, ripple cross-laminated, very fine grained, clacareous sandstone; above 1323 m is about 15% interbedded shale to siltstone; minor fold at 1323 m; similar lithology continues above limit of measurement but strata are folded and measurement becomes unreliable

dark brown to dark tan weathering, dark brown, siltstone (15%) and shale (85%); at 1181-1182 m is bed of calcarenite

brown weathering, dark grey, thin- to medium bedded (less than 0.1-0.2 m) ripple cross-laminated siltstone and very fine grained sandstone; ripple marks locally; minor brown weathering, dark shale; calcareous

dark grey weathering, dark grey to black siltstone and shale; minor grey, calcareous siltstone to silty limestone; lower limit of 'in place' scree of the latter is 875 m; top of unit at first, albeit poor, outcrop upwards; base of the Jones Lake Formation is picked at the top of the highest chert bed of the Mount Christie Formation; upper Mount Christie shale, and the lowest shale here assigned to the Jones Lake are very similar

alternating in units several meters thick are medium bedded, nodular bedded chert, and soft brown weathering, brown to black shale

dark blue-grey weathering, dark grey to black, shale

dark green-brown weathering, pale green to dark blue-green, splintery shale

mostly like overlying unit but with rare beds of chert like that of underlying unit

orange grey weathering, pale green, blue-grey and grey, chert with minor shale partings; medium bedded (0.2 m) and even bedded to lenticular bedded (a 0.2 m thick bed may have a length as short as 1.0 m); scattered nodules to 0.2 m diameter of grey, medium crystalline barite

dark red-ochre weathering, grey, medium crystalline, limestone

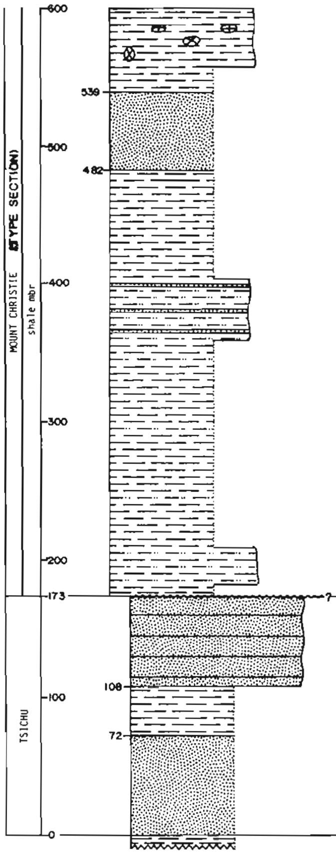
dark brown to tan to pale green weathering, blue-grey to grey-green shale; scree below 553 m, good outcrop above this becoming scattered outcrop above about 653 m; from about 548-593 m is scattered (5-10%) round grey-white weathering, dark grey very fine crystalline nodules of barite to 0.3 m in diameter; above this level the nodules diminish rapidly upward in size and proportion to form about 1% at the top of the unit

421	1181	Early Triassic, Smithian
413	696	Early Permian, probably late Wolfcampian

(continued)

SECTION 20

(continued)



white-orange weathering, white, fine- to medium grained, quartz sandstone; some scree shows ripple marks; by small size estimate interval to be thin bedded

dark brown-tan to blue-grey weathering, dark blue-grey to black, thin bedded, silty shale to shaly siltstone; from 358-403 m (approx.) is brown to dark brown weathering, dark grey, medium bedded, very fine grained quartz sandstone or siltstone, and splintery black to blue-grey shale; at 403 m begins abundant scree cover from overlying unit; upper part of unit above about 410 m is pale green argillite scree like that from 539-696 m; contact with overlying sandstone located approximately and picked at highest limit of shale scree

grey-white weathering, grey to dark grey, very fine- to medium grained, massive, clean, quartz sandstone; bedding locally defined by 2 m thick parting; no other sedimentary structures visible; outcrop and much blocky felsenmeer

scree of blue-black weathering, black, shale washed over by much quartz sandstone scree from overlying unit

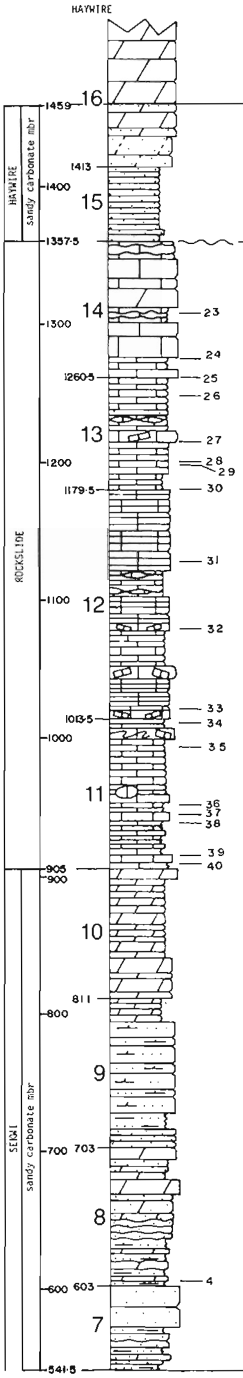
grey-white weathering, grey to black, very fine- to medium grained, quartz sandstone; locally with minor proportion of chert grains; base of unit at scree contact with underlying, brown weathering, recessive, black shale

PREVOST (EARN GROUP) ?

(REFERENCE SECTION FOR UPPER CONTACT OF PREVOST F.)

SECTION 21

Location given on section - - 105I-8 meas: K.B. Heather desc: W.H. Fritz
S.P. Gordey
Section is from Fritz (1979) with modification of formation names



Haywire Formation (upper Cambrian to Silurian), 101.5+ m

The basal unit (unit 15, 55.5 m) is composed of medium light brownish grey and light grey weathering sandstone in thin, platy beds. On a fresh surface the sandstone is light brown and light grey, and very fine grained. Some bright orange weathering interbeds of sandy dolomite are also present. Only the lower part of the next unit (unit 16, 45+ m) was inspected. The basal beds (base to 22.5 m) contains cream to light orange weathering dolomite in medium and thick beds. Fresh surfaces are light brownish grey, and abundant very fine quartz grains (some up to coarse in size) are visible. Higher beds (22.5 to 46 m) contain cream weathering dolomite that is light grey on a fresh surface and finely crystalline. Dolomite above the 46 m level is light and medium light grey weathering and fresh, thick bedded, and finely crystalline.

Rockslide Formation, (Middle Cambrian), 452.5 m

The basal unit (unit 11, 108.5 m) of this formation is composed of medium and medium dark grey weathering limestone that is dark grey and finely crystalline on fresh surfaces. The lower half weathers to chips with some thin and medium beds of platy, planar laminated limestone, whereas in the upper half of the unit the platy limestone predominates. A limestone pod (3 m diameter) is present 67 m above the base of the unit, and a scoured surface at least 2 m deep is located 76.5 m above the base. Fossils from this unit belong to the Middle Cambrian Albertella and/or Glossopleura Zone (GSC loc. 95671-95673), Bathyuriscus-Elrathina Zone (GSC loc. 95674, 96575), and Bolaspidella Zone (GSC loc. 95676, 95677). Unit 12 (166 m) is composed of limestone weathering to plates with a medium brownish grey surface. Although the plates are thin and planar laminated, the parting is thick to thin, and fresh surfaces are dark grey and finely crystalline. Several thick beds containing penecontemporaneous breccia are present in the lower half of the unit and bright orange weathering limestone interbeds are located in the top 7.5 m of the unit. Limestone in thin plates that weather medium brown to orange on parting surfaces predominate in unit 13 (81 m). Fresh surfaces are dark grey and finely crystalline. Two beds containing penecontemporaneous breccia were noted, and 2.5 m of very fine grained sandstone is present. The uppermost unit (unit 14, 97 m) of the Rockslide Formation is mainly composed of medium light to medium grey limestone in medium and thick beds. Fresh surfaces are medium grey and fine to coarse grained. Cream weathering dolomite containing abundant fine quartz sand is present 50.5 to 64.5 m above the base. Fossil localities in this unit (GSC loc. 95686-95688) and in the two units below (units 12, 13; GSC loc. 95678-95685) belong to the late Middle Cambrian Bolaspidella Zone.

23	1307	Bolaspidella Zone, Middle Cambrian
24	1275	Bolaspidella Zone, Middle Cambrian
25	1261	Bolaspidella Zone, Middle Cambrian
26	1247	Bolaspidella Zone, Middle Cambrian
27	1214.5	Bolaspidella Zone, Middle Cambrian
28	1199	Bolaspidella Zone, Middle Cambrian
29	1197	Bolaspidella Zone, Middle Cambrian
30	1180	Bolaspidella Zone, Middle Cambrian
31	1127	Bolaspidella Zone, Middle Cambrian
32	1079	Bolaspidella Zone, Middle Cambrian
33	1021	Bolaspidella Zone, Middle Cambrian
34	1010.5	Bolaspidella Zone, Middle Cambrian
35	993	Bolaspidella Zone, Middle Cambrian
36	951	Bathyuriscus-Elrathina Zone, Middle Cambrian
37	944	Bathyuriscus-Elrathina Zone, Middle Cambrian
38	938	Albertella and/or Glossopleura Zone
39	914	Albertella and/or Glossopleura Zone
40	908	Albertella and/or Glossopleura Zone

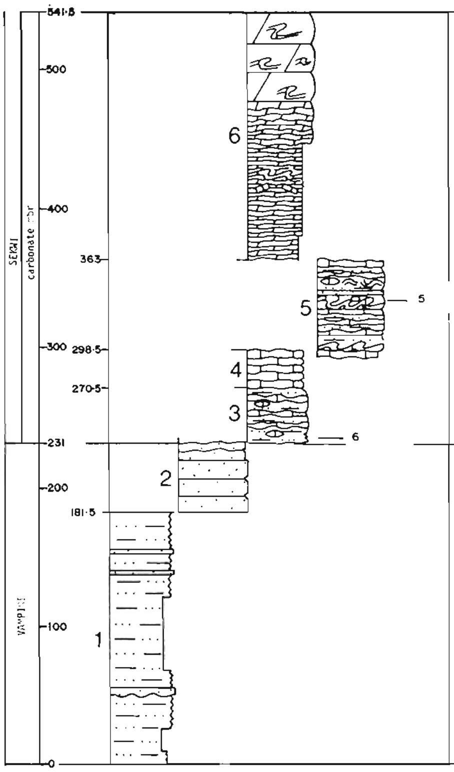
Sekwi Formation (Lower Cambrian), 674 m

A concentration of quartz sand near the middle of the Sekwi Formation provides a reliable criterion for the recognition of unit 7. The lower part (base to 31.5 m) contains light orange weathering, thin to thick sandstone beds that are intercalated with beds of medium brown weathering, siltstone. The sandstone is medium grey on fresh surface and is mainly very fine grained. The upper part of the unit (31.5 to 61.5 m) is composed of quartzite in thick, resistant beds that are light grey on weathered and fresh surfaces, and contains the trace fossil Skolithos. Unit 8 (100 m) contains a mixture of thin to thick bedded quartzite and orange weathering dolomite, and in the lower part, brownish grey weathering siltstone. Burrows and mud cracks are present, and fossils belonging to the Bonnia-Olenellus Zone were located (GSC loc. 95670) 3 m above the base of the unit.

Purple grey is the dominant weathering colour of strata in unit 9 (108 m). Brownish grey and purple-grey siltstone (base to 13 m) and brownish grey weathering siltstone (13 to 25 m) with mud cracks are in the lower part of the unit. Dolomitic(?) siltstone in thick to thin, blocky beds occupy most (25 to 93.5 m) of the unit. This siltstone is medium dark purple grey on fresh and weathered surfaces. Recessive weathering, thin bedded dolomite at the top of unit 9 (93.5 to 108 m) weathers to bands of orange, medium dark grey, and purple. The uppermost unit (unit 10, 94 m) in the Sekwi Formation is composed of bright orange weathering dolomite in thin to thick beds that provide a sharp contrast to the overlying grey weathering strata of the Rockslide Formation.

4	606	Bonnia-Olenellus Zone, Early Cambrian

(continued)



(continued)

Sekwi Formation (Lower Cambrian), 674 m

The basal unit in the Sekwi Formation (unit 3, 39.5 m) contains medium brown to light orange weathering siltstone (1/2) that is limy and is light brown to medium grey on fresh surface, and orange to medium grey weathering limestone (1/2) in thin wavy beds and nodules. Fresh limestone surfaces are medium dark grey and finely crystalline. Fossils located (GSC loc. 95668) 6.5 m above the base of the unit are questionably assigned to the Lower Cambrian Fallotaspis Zone. The next unit (unit 4, 28 m) consists of limestone in thin (average 3.75 cm), broadly wavy beds that weather medium grey and have light yellow to pink parting surfaces. Fresh surfaces are medium dark grey and finely crystalline. Sparse layers containing "floating", medium grained quartz sand are present. Unit 5 (64.5 m) resembles unit 3 in that it contains similar limestone and siltstone in approximately the same ratio. However, penecontemporaneous folds and breccia are abundant at various horizons in unit 5. Rare, "exotic" blocks are also present in this unit, such as a large (2 m wide) limestone boulder that is medium grey on fresh and weathered surfaces and contains coarse "floating" clasts of quartz sand. Holmiella sp. and Nevadella faceta located (GSC loc. 95669) 38 m above the base of unit 5 belong to the Zone.

Light grey to cream weathering dolomite in thin (0.6 to 1.2 cm) beds and lenses predominate in unit 6. In the lower 114 m the bedding is distinct, and locally small penecontemporaneous folds and pods of breccia are present. In the upper 64.5 m large scale slumping has fused the thin beds to give the dolomite a thick bedded to massive appearance. Most of the dolomite is medium grey on fresh surface and finely crystalline, but the uppermost 10.5 m is light grey on fresh surface, finely to coarsely crystalline, and contains fine to coarse "floating" quartz grains.

5	336.5	Nevadella Zone, Early Cambrian
6	232.5	Fallotaspis Zone?, Early Cambrian

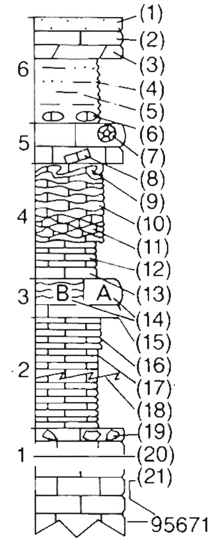
Vampire Formation (Lower Cambrian), 231+ m

The oldest stratigraphic unit (unit 1) in the section starts above valley alluvium and consists of siltstone (base to 120 m) and silty sandstone (120 m to 181.5 m) that weather medium greenish grey and rust, and are medium greenish grey on fresh surfaces. Rare thin to thick interbeds of quartzite are present, and are either the colour of the adjacent strata or are light brown on weathered and fresh surfaces. Both the quartzite and the sand in the silty sandstone are very fine grained. The second unit (unit 2) contains very fine grained quartzite in thick, light orange-brown to rust weathering beds (base to 37.5 m) and in thick to thin, greenish yellow to rust weathering beds (37.5 to 49.5 m). Fresh quartzite surfaces on the former beds are light brown, whereas those on the latter are greenish grey. The transition between unit 2 and unit 3 of the overlying Sekwi Formation takes place in an interval that is 1 or 2 m thick. Thus the boundary between the Vampire Formation and the Sekwi Formation, was placed at the horizon where limy siltstone (above) predominates over very fine grained quartzite (below).

top ↑

seg	lat		long
6	62°27'30"	(top)	128°25'30"
	62°28'30"	(base)	128°24'30"
5	62°28'15"		128°25'00"
4	62°28'30"		128°24'15"
1-3	62°28'15"		128°23'00"

LEGEND



(1) Quartzite, (2) Limestone,
(3) Dolomite

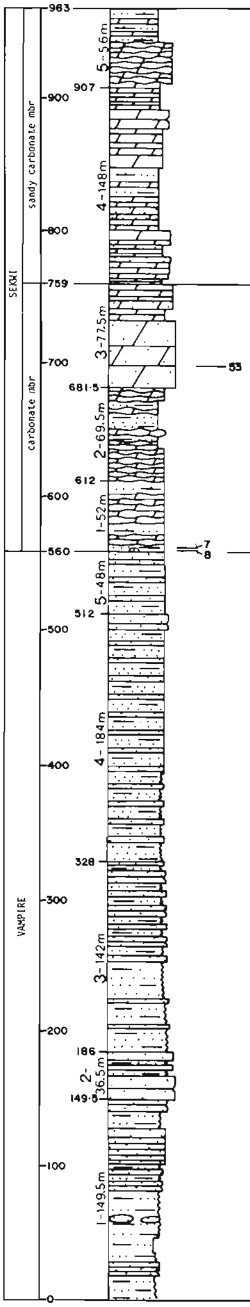
(4) Siltstone, (5) Shale,
(6) Limestone nodule

(7) Archaeocyathid,
(8) Penecontemporaneous breccia
(9) Penecontemporaneous fold
(10) Thin wavy bedded, (11) Thin nodular bedded, (12) Thin platy bedded

(13) Medium bedded, (14A) Thick bedded,
(14B) Thin bedded but thick parting

(15) Resistant outcrop, (16) Recessive outcrop, (17) Covered, lithology inferred from float, (18) Fault, (19) Diamictite,
(20) Lithologic unit described in text
(21) Fossil locality

SECTION 22



(continued)

Sekwi Formation (403)

Dolomite that is orange on weathered and fresh surfaces predominates in unit 4 (148 m). The dolomite is in thin, platy beds except for thin to thick beds 29 to 40 m above the base and medium and thin beds 85.5 to 130 m above the base. Interval 16 to 20.5 m contains thick beds of medium grained quartzite that is white on weathered and fresh surfaces and contains Skolithos sp. Fine to coarse quartz grains that are "floating" and are in planar and crossbedded laminae are abundant 20.5 to 63 m above the base. Interval 63 to 85.5 m contains dolomite as mentioned and siltstone (66 per cent) that weathers purple, maroon and light brown.

Unit 5 (56 m) is composed of dolomite and a subordinate amount of siltstone. The lower 30 m is composed of light brownish grey weathering dolomite in thin wavy beds with thin to thick partings. Fresh surfaces are medium light grey and finely crystalline. The upper 26 m of unit 5 contains orange weathering siltstone and dolomite in thin plates. The top of this unit and the top of the Sekwi Formation is placed at an abrupt change from orange weathering siltstone and dolomite to medium grey weathering limestone.

The basal unit (unit 1, 52 m) in this formation comprises 40 per cent orange to orange brown weathering siltstone and 60 per cent thin, wavy bedded dolomite. Half of the dolomite is cream weathering with fresh surfaces that are light grey, and the other half is medium grey on both weathered and unweathered surfaces.

Unit 2 (69.5 m) contains dolomite (60 per cent) in thin, broadly wavy beds that are light grey on fresh surfaces, except in the top 13.5 m where the dolomite is pink to cream weathering. Between the dolomite exposures are covered intervals (40 per cent) that probably are underlain by siltstone similar to that in unit 1.

Unit 3 (77.5) is composed of dolomite in thick beds (0 to 50 m) and in thin to thick beds (50 to 77.5 m) that are cream coloured on both weathered and fresh surfaces. The dolomite is finely crystalline and contains fine to coarse quartz grains that are "floating" in a dolomite matrix and are also concentrated in planar and crossbedded laminae.

53	696	Albertella Zone, Middle Cambrian
7	562.5	Early Cambrian, Nevadella Zone
8	561	Early Cambrian, Fallotaspis Zone

Vampire Formation (560+ m)

Above the covered base of the section unit 1 (149.5+m) is composed of rust to medium brownish grey siltstone (30 per cent) and very fine grained quartzite (70 per cent) in thin (5 mm), planar laminated plates. Fresh surfaces of the siltstone and of half of the quartzite are light greenish grey and those of the remaining quartzite are light brownish grey. Lenses of quartzite 0.7 m thick and 2 m long are present 60 m above the base of the section and trace fossils 5 mm wide are present near the same horizon.

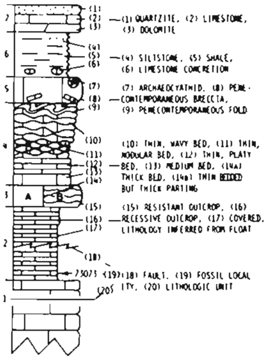
Unit 2 (36.5 m) contains white weathering and unweathered quartzite in thin to thick beds that are fine to coarse grained. Intervals 17.5 to 22.5 m and 26.5 to 30 m above the base contain highly burrowed, very fine grained quartzite and siltstone that are similar to that in unit 1.

Interbedded siltstone and very fine grained sandstone in approximately equal proportions comprise unit 3 (142 m). In the lower part (0-67 m) the siltstone and sandstone weather medium dark grey, medium dark brownish grey, and rust and they are in plates that are dark grey on fresh surfaces. In the upper part (67 m to 142 m) half of the strata is like that below and half is rust to light brownish grey, very fine grained quartzite in medium and thin beds that are medium to dark grey on unweathered surfaces. The trace fossil Didymaulichnus sp. is present 29 m above the base, burrows and mud cracks are present at 63.5 m, and cross ripples and burrows are present in float at 120 m.

Unit 4 (184 m) is composed of silty very fine grained sandstone and sandy siltstone in thin plates that weather medium grey, medium reddish brown and are medium dark grey on fresh surfaces. In the interval 65 to 173 m above the base rust weathering sandstone (25 per cent) is interbedded with the strata just described. Resistant, thick bedded quartzite in the top 11 m of the unit weathers light grey and is light brown on unweathered surfaces. Trace fossils and cross ripples are present in local float 14 m above the base of the unit.

The highest unit (unit 5, 48 m) contains siltstone and sandstone as in the 65 to 173 m interval of unit 4, but also contains khaki shale in various intervals throughout the unit. Large (2 cm wide), abundant burrows are present 0.5 m above the base.

LEGEND



↑ top

seg	lat		long
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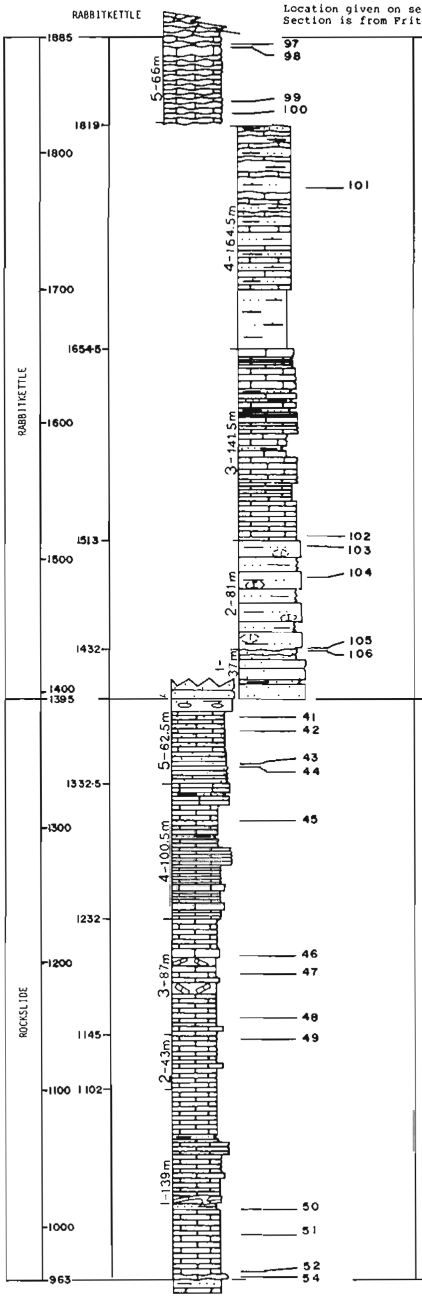
	62°41'30"	(base)	128°22'15"
2	62°41'00"	(top)	128°21'30"
	62°41'00"	(base)	128°20'45"
1	62°40'30"	(top)	128°19'45"
	62°41'15"	(base)	128°19'00"

Location given on section - - 105I-9 meas: W.H. Fritz desc: W.H. Fritz
Section is from Fritz (1981) with modification of formation names only

SECTION 22



Rabbitkettle Formation, 490+ M

Orange to brownish grey weathering quartzite in medium and thick beds predominates in the basal unit (unit 1, 37 m) of this formation. Fresh surfaces are light grey and the quartzite is very fine to fine grained. Interbedded with the quartzite is medium greenish grey siltstone (25 per cent) that is medium grey on fresh surface. At the top of the unit is 4 m of limy quartz sandstone in thin, wavy beds that weather the same colour as the quartzite below.

Unit 2 (81 m) is composed of medium brownish grey weathering, limy siltstone in thick to thin parting, planar laminated beds that are medium grey to medium dark grey on fresh surface. Orange weathering lenses and nodules of siltstone that is slightly more limy than the surrounding matrix are common.

Thin bedded, platy limestone comprises most of unit 3 (141.5 m). In interval 0 to 61 m is limestone weathering medium grey (0 to 29 m), medium brownish grey (29 to 43 m), and light brownish to yellowish grey (43 to 61 m) that is medium to dark grey on fresh surfaces. An interval (61 m to 79 m) containing bright orange weathering limestone (33 per cent) is present in the middle of unit 3. This limestone, together with medium blue grey weathering limestone (33 per cent) and medium brownish grey siltstone (33 per cent) forms a recessive "knick point" in the middle of the unit. Interval 79 to 141.5 m contains medium light grey, brownish grey, and medium brown weathering limestone in thin to very thin plates. Subinterval 84 to 112.5 m has some (33 per cent) interbedded light brownish grey weathering siltstone.

An abundance of limy shale and siltstone in unit 4 (164.5 m) is responsible for the weak topographic expression of this unit. The lower 43.5 m comprises siltstone and shale that weather light brown and is medium grey on fresh surfaces. The upper 121 m contains siltstone (50 per cent) that weathers light grey and is medium grey on fresh surfaces, and limestone (50 per cent) in thin plates, thin wavy beds, and nodules. The limestone weathers medium light grey with orange mottled parting surfaces, and fresh surfaces are medium dark grey. One bed of penecontemporaneous breccia 0.5 m thick was noted 0.5 km south of the section and 86.5 m above the base of the unit.

Unit 5 (66 m) is composed of medium grey weathering limestone in thin, wavy beds that are medium grey to medium dark grey on fresh surfaces and finely crystalline. Parting surfaces 0 to 24 m above the base are mottled bright red and those 42 to 66 m above the base are mottled bright orange. Limestone (siliceous?) in the latter interval produces a tinkling sound under foot.

Overlying unit 5 and a short distance below a fault at the top of the section is light grey weathering and unweathered dolomite in thin wavy beds that are medium and thick parting. It was not determined whether this dolomite is widespread or whether it represents local alteration related to the nearby fault.

Rockslide Formation (432 m)

Thin bedded, platy limestone with medium brownish grey, light yellow grey, and some light orange parting surfaces comprise the basal unit (unit 1, 139 m) of the Rockslide Formation. The limestone is planar laminated, finely crystalline, and fresh surfaces are dark grey. Interval 0 to 3.5 m contains medium blue grey weathering limestone in thin, wavy beds. Some rust weathering, dark grey siltstone is present in the upper one-fourth of the unit. Penecontemporaneous folds 0.5 m high are exposed 60.5 m above the base of the unit, and sponge spicules in local float were noted 59 m above the base.

From a distance, unit 2 (43 m) is a medium brown band between medium grey units above and below. It is composed of thin (7.5 mm) plates that weather medium brown to medium brownish grey and are medium grey to medium dark grey on fresh surfaces. A distinctive orange weathering bed 0.3 m thick is present 19.5 m above the base and sponge spicules were observed 38.5 m above the base.

Very thin to thin (6 mm to 36 mm), platy beds that weather medium grey, light orange and light orange brown comprise this unit (unit 3, 87 m). The limestone is planar laminated, finely crystalline, and fresh surfaces are dark grey. Penecontemporaneous slump structures are present 36 m (folds 0.5 m high), 51.5 m (breccia bed 1.5 m thick), and 65 m (breccia bed 0.25 m thick) above the base.

Unit 4 (100.5 m) is mainly limestone in very thin (6 mm), platy beds, many of which combine to weather in thick parting "books". The remaining limestone is thin bedded and platy. Limestone of both types are medium grey, light grey, and medium grey brown on weathered surfaces and are medium and dark grey on fresh surfaces. Minor interbeds of rust weathering siltstone that is black on fresh surface are present in the upper half of the unit. A thin bed of very fine grained quartzite is present 72 m above the base of the unit.

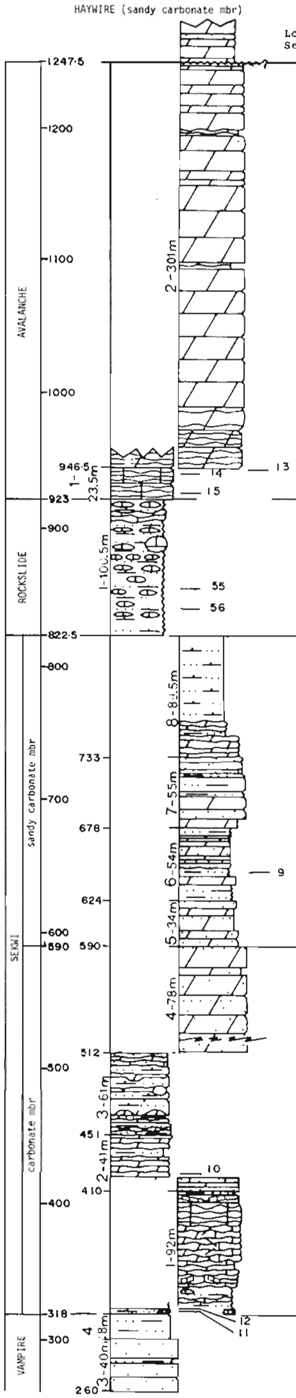
An abundance of very fine grained quartz sand is present in this uppermost unit (unit 5, 62.5 m) of the Rockslide Formation. The lowermost 22 m is medium brownish grey to rust weathering silty sandstone in very thin plates that are medium light grey on fresh surface. This is overlain by 31.5 m of medium grey to medium grey brown limestone containing varying amounts of quartz sand. At the top of the unit is 9 m of greenish grey weathering, limy siltstone with limestone nodules (33 per cent) both of which are medium light grey on fresh surfaces.

(continued)

97		Ptychaspis-Prosaukina Zone and Saukia Zone, Late Cambrian
98	1877.5	Ptychaspis-Prosaukina Zone and Saukia Zone, Late Cambrian
99	1835.5	Ptychaspis-Prosaukina Zone and Saukia Zone, Late Cambrian
100	1826.5	Ptychaspis-Prosaukina Zone and Saukia Zone, Late Cambrian
101	1773.5	Ptychaspis-Prosaukina Zone and Saukia Zone, Late Cambrian
102	1516	Dunderhergia Zone, Elvinia Zone, Canaspis Zone, part Ptychaspis-Prosaukia zones barren or absent Aphelaspis Zone, Late Cambrian
103	1508.5	Dunderhergia Zone, Elvinia Zone, Canaspis Zone, part Ptychaspis-Prosaukia zones barren or absent Aphelaspis Zone, Late Cambrian
104	1485.5	Cedaria-Crepicephalus Zone, Late Cambrian
105	1432	Cedaria-Crepicephalus Zone, Late Cambrian
106	1431.5	Cedaria-Crepicephalus Zone, Late Cambrian
41	1381.5	Cedaria-Crepicaphalus Zone, Late Cambrian
42	1371	Cedaria-Crepicaphalus Zone, Late Cambrian
43	1346	Cedaria-Crepicephalus Zone, Late Cambrian
44	1344	Belaspidella Zone, Middle Cambrian
45	1304	Belaspidella Zone, Middle Cambrian
46	1204	Belaspidella Zone, Middle Cambrian
47	1190.5	Belaspidella Zone, Middle Cambrian
48	1159	Belaspidella Zone, Middle Cambrian
49	1140.5	Bathyuriscus-Elratnina Zone, Middle Cambrian
50	1015	Bathyuriscus-Elrathina Zone, Middle Cambrian
51	998	Glossopleura Zone, Middle Cambrian
52	972.5	Albertella Zone, Middle Cambrian
54	966.5	Plagiura-Poliella Zone, Middle Cambrian

Location given on section - - 105I-8 meas: W.H. Fritz desc: W.H. Fritz
Section from Fritz (1981) with modification of formation names only

SECTION 23



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6	62°23'30"	128°15'30"
5	62°24'00" (top) 62°24'30" (base)	128°15'30" 128°15'00"
4	62°24'30"	128°15'00"
3	62°24'30"	128°15'15"
2	62°24'30"	128°14'30"
1	62°24 30"	128°14'45"

Avalanche Formation (324.5 m)

Unit 1 (23.5 m) consists of medium grey weathering limestone in thin wavy, thick parting beds. Fresh surfaces are medium dark grey and finely crystalline. Except for the change from lenses to thin beds and the lack of shale and siltstone interbeds, the limestone in this unit resembles that in the Rockslide Formation below.

Resistant, medium light grey to cream weathering dolomite in thick beds comprise the upper unit (unit 2, 301 m) of this formation. At various levels faint outlines of thin wavy beds suggest that at least part of the unit was originally limestone similar to that in unit 1. Some fine to coarse "floating" grains of quartz sand are present 17.5 m below the top of the unit, and the uppermost 5.5 m is composed of cream weathering and unweathered dolomite in thin planar laminated beds.

Overlying the Avalanche Formation is an unmeasured succession of varicoloured strata that are here referred to as the sandy carbonate member of the Haywire Formation. At the base of the succession is dolomite in bright, light orange and brick red weathering interbeds. The dolomite is thin to thick bedded and is planar laminated. Some maroon layers of silty dolomite are present, many of which display mudcracks. Higher in the section are beds containing "floating" quartz sand and minor white sandstone interbeds are present. In these beds quartz grains are mainly in the fine range, but sparse coarse grains were seen.

13	946.5	Glossoppleura Zone, Early Cambrian
14	943	Albertella Zone, Early Cambrian
15	928.5	Albertella Zone, Early Cambrian

Rockslide Formation (100.5 m)

Medium brownish grey weathering siltstone predominates in the one unit (unit 1, 100.5 m) of this formation. The siltstone weathers to irregular slabs and fresh surfaces are medium grey. Above the 13 m level, limestone is present in lenses averaging 8 cm thick and 30 cm long. The limestone is medium grey weathering and fresh surfaces are medium dark grey and finely crystalline. At the 75 m level limestone mounds that are 4 m high are present. Two beds of maroon weathering siltstone 0.5 m thick are located 30 m and 50 m above the base of the unit.

55	849.5	Albertella Zone, Early Cambrian
56	832	Plagiura-Polliella Zone, Early Cambrian

Sekwi Formation (504.5 m)

Unit 5 (34 m) is half medium light brownish orange weathering dolomite in medium and thick beds that are light brown and finely crystalline on fresh surfaces, and half light grey weathering and unweathered quartzite that is fine to coarse grained. At the top of the unit is 5.5 m of fine to coarse grained quartzite in thick beds that are white on weathered and fresh surfaces. Skolithos sp. is present on these upper quartzite beds.

Unit 6 (54 m) contains a mixture of siltstone, dolomite, and quartzite. At the base of unit (0 to 12 m) is medium brown to orange weathering siltstone that is medium dark grey on fresh surface. This is overlain (12 to 18 m) by orange weathering, thin and medium bedded dolomite which in turn is overlain (18 to 25.5 m) by orange to medium brown weathering siltstone containing sparse trilobites. The upper half of the unit (25.5 to 54 m) contains mostly medium light orange brown and bright orange weathering dolomite in thin and medium beds. Skolithos sp. bearing quartzite is present in the interval 25.5 to 30 m above the base of the unit and 5 m or orange to medium brown weathering siltstone is present at the top.

Strata of Unit 7 (55 m) are equally as resistant as those of unit 4 and the two units form small peaks on the ridge crest used as the measuring route for the Sekwi Formation. The basal 22.5 m is composed of orange weathering dolomite and light brown weathering, fine and medium grained quartzite. Interval 22.5 to 55 m contains maroon and purple weathering siltstone and sandstone in thin to thick beds. The sandstone is mainly concentrated at the top of the unit where it is fine to coarse grained.

The highest unit (unit 8, 89.5 m) in the Sekwi Formation is composed of dolomite and siltstone. Light orange weathering (0-15.5 m) and light brownish grey weathering (19.5 to 25.5 m) dolomite in thin and medium, broadly wavy beds are concentrated in the lower part of the unit. Orange weathering platy dolomitic siltstone occupies the remainder or the unit.

9	645	Bonnia-Olenellus Zone, Early Cambrian

The basal unit (unit 1, 92 m) in the Sekwi Formation is mainly composed of thin, wavy bedded limestone that is thin to thick parting, weathers medium grey to medium blue grey, and is medium dark grey and finely crystalline on fresh surfaces. Beds of this limestone have been locally altered to medium grey weathering, finely crystalline dolomite. At the base of the unit is 5 m of light yellow to orange brown weathering siltstone with sparse, orange weathering limestone nodules. A similar, but less resistant siltstone occupies the interval 5 to 21 m above the base. Within this interval are limestone nodules that increase in number and coalesce up section into thin, wavy beds of medium grey limestone constituting 50 per cent of the strata near the top. At the top of the unit is 0.5 m of medium dark brown weathering shale. Penecontemporaneous limestone breccia is present 28.5 to 29 m and 83.5 m above the base of the unit.

Medium grey weathering dolomite in thin, broadly wavy beds predominate in unit 2 (41 m). Fresh surfaces are medium dark grey and finely crystalline. Dolomitic quartz sandstone that is fine to medium grained is present in the basal 2 m of the unit and orange weathering siltstone with dark grey fresh surfaces is present in the interval 27.5 to 32 m above the base.

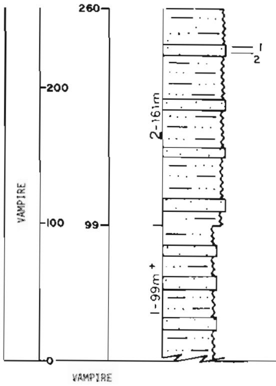
Unit 3 (61 m) is composed of dolomitic siltstone and silty dolomite. The siltstone is medium brownish grey weathering and is medium grey to medium dark grey on fresh surface. The dolomite is in orange weathering thin to thick irregular beds and in pods that are up to 0.5 m high, all of which have fresh surfaces that are medium dark grey and are finely crystalline. A thick bed of fine to coarse grained quartzite is present 26 to 27 m above the base of the unit. In the interval 51 to 61 m above the base are thin beds of both medium grey dolomitic sandstone that is fine and very fine grained and orange weathering dolomite.

Cream weathering and fresh dolomite in thick, resistant beds distinguishes this unit (unit 4, 78 m) from other, darker strata in the formation. The dolomite is finely crystalline and is mixed with fine to coarse quartz sand that is "floating" or is in sandy dolomite beds at various horizons.

10	422.75	Nevadella Zone, Early Cambrian
12	322.75	Fallotaspis Zone, Early Cambrian
11	318-323	Fallotaspis Zone, Early Cambrian
1	232.3	early early Cambrian
2	227.5	early early Cambrian

(continued)

SECTION 23



(continued)

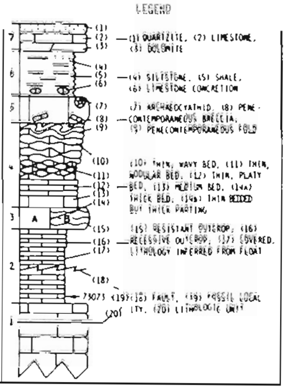
Vampire Formation (318 m+)

Only the upper part of this formation was measured between a fault at the base of the section and the overlying Sekwi Formation. Above the fault, the lowest unit (unit 1, 99 m+) is predominantly rust weathering siltstone that is dark grey on fresh surface. Interbedded with the siltstone is a subordinate amount (25 per cent) of rust of medium light brownish grey weathering quartzite that is very fine grained. The beds are medium to thick and fresh surfaces are medium grey. Quartzite forming ball and pillow structures is present 28.5 m above the base of the section.

Siltstone like that in unit 1 and siltstone that is light greenish grey weathering with medium greenish grey fresh surfaces comprise most of unit 2 (161 m). Some (15 per cent) quartzite is present in medium light greenish grey weathering beds that are medium grey on fresh surface. The quartzite is thin to thick bedded and very fine grained. Burrows are present 4, 23.5, 28, and 59.9 m above the base and microripples are exposed 4, 23.5, 62.5, and 128.5 m above the base.

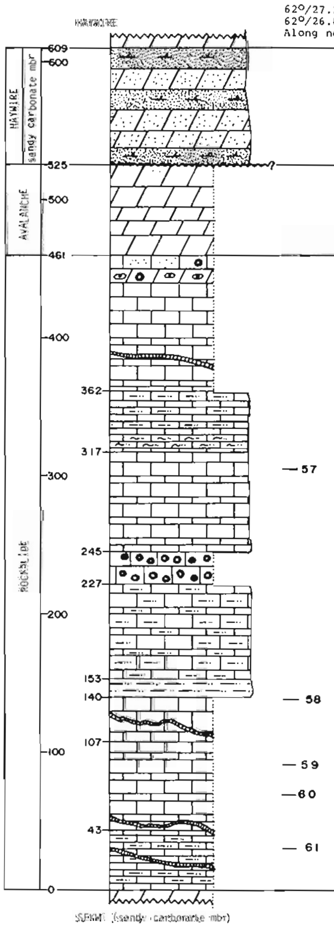
Unit 3 (40 m) is composed of resistant, thick bedded quartzite. The basal 10.5 m is white on both weathered and fresh surfaces, and is fine to very fine grained. Quartzite in the interval 10.5 to 21 m above the base weathers rust, medium greenish grey and orange, and is light greenish grey on fresh surfaces. The upper half of the unit (21 to 40 m) weathers rust to light orange and fresh surfaces are light brown. The quartzite is very fine grained in the upper two intervals. Interbedded in the upper half is siltstone (33 per cent) that is rust weathering and olive grey on fresh surface.

At the top of the unnamed formation is a unit (unit 4, 18 m) of medium light brownish grey weathering siltstone in thick parting beds that are olive grey on unweathered surfaces.



SECTION 24

62°/27.2';128°/23.3' A24801-33 (30,77) 105 I-8 meas: P.F. Coleman desc: D.H. Wood
62°/26.8';128°/24.0' (20,62)
Along northeast-trending ridge. Distribution of outcrop shown is approximate.



pink to red weathering, rose coloured, fine to very fine grained, moderately rounded and sorted, thick bedded (1 m) dolomitic sandstone and sandy dolostone, sandy dolostone weathers yellow to buff or orange and is interbedded with the dolomitic sandstone; top of section at contact with grey weathering dolostone

buff to orange weathering, light grey, fine- to medium crystalline, dolostone; unit is scree and poorly exposed outcrop

buff to dark grey weathering, grey to dark grey, medium- to coarse crystalline, limestone grading to dolostone; transition from limestone to dolostone gradational from approximately 440 to 460 meters; top of limestone oolitic to sandy; dolostone locally oncolitic and oolitic; basic dyke at 390 meters; unit is predominantly scree

buff to rusty orange weathering, grey to dark grey, fine- to medium crystalline, thin bedded, locally fossiliferous, limestone and silty limestone; bioturbation between 316 and 330 m

buff to orange weathering, dark grey, fine crystalline, thin to medium bedded, locally laminated or fossiliferous, pyritic limestone; laminae 1 - 3 mm

grey weathering, dark grey, medium- to coarse grained, well rounded and sorted, thick bedded, oolitic limestone; matrix is fine- to medium crystalline limestone; oolites approximately 1 mm diameter; unit predominantly scree with minor scattered outcrop

dark grey weathering, dark grey, fine crystalline, thin- to medium bedded (< 0.2 m), laminated silty to sandy limestone

dark grey weathering, dark grey, laminated, calcareous sandy siltstone

tan to brown weathering, dark grey, fine crystalline, interbedded, medium- to thick bedded (0.1-0.3 m), locally fossiliferous limestone; basic dike at 125 m; unit is predominantly scree, locally partially covered, and scattered outcrop

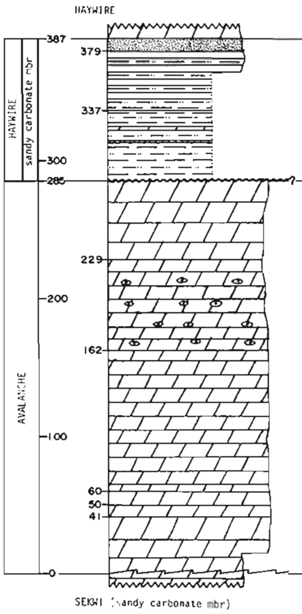
dark greyish tan weathering, dark grey, fine crystalline, fossiliferous limestone; partially grass-covered scree with isolated outcrop; basic dike at 51 m

buff and tan to grey weathering, light greenish grey to dark grey, fine- to very fine crystalline, thin bedded to laminated limestone and silty limestone with minor laminated siltstone; diabase dyke at 27 m; limestone locally fossiliferous; unit is scree with scattered outcrop

57	305	*Bolaspidella* Zone, Middle Cambrian
58	138	*Bathyuriscus-Elrathina* Zone, Middle Cambrian
59	91.5	*Glossopleura* Zone or *Bathyuriscus-Elrathina* Zone, Middle Cambrian
60	69	*Glossopleura* Zone or *Bathyuriscus-Elrathina* Zone, Middle Cambrian
61	30	early or medial Middle Cambrian

SECTION 25

62°/23.1';128°/12.7'   A24801-31   (4,-55)   105 I-8   meas: S.P. Gordey   desc: S.P. Gordey
62°/23.0';128°/13.4'   (-7,-58)
Along short east trending ridge



blue-grey weathering, grey, fine- to medium grained, laminated, quartz sandstone; local large scale cross lamination; immediately overlying the redbed member is yellow weathering, silty dolostone succeeded by grey-buff weathering, grey, finely crystalline dolostone; outcrop of this unit and top of underlying unit is poor

in this interval red mudstone is less predominant than in interval below (forming 40%): common yellow weathering, grey, medium crystalline, ripple marked, dolostone and dolomitic siltstone; rare quartz sandstone; floating quartz sand is common in the mudstone and siltstone; mudstone and siltstone locally burrowed; mudcracks common; raindrop imprints at one locality in red mudstone; minor grey weathering, grey dolostone

mostly deep red to maroon weathering, maroon mudstone and siltstone; minor yellow weathering, laminated dolomite and dolomitic siltstone; rare, poorly sorted, red weathering, red, coarse grained quartz sandstone; rare red weathering, red, mudship conglomerate; mudcracks common; topmost meter of underlying unit is yellow weathering; basal contact of redbed member , although in scree, is sharp

pinkish cream weathering, white, finely crystalline, massive dolostone; locally well laminated at base of unit; at top of unit dolostone contains a few percent medium to coarse quartz sand; base of unit begins at small knick in ridge at which very similar dolostone, although not pinkish, caps underlying unit

dark grey weathering, grey, medium crystalline, medium bedded, poorly bedded to massive dolostone; oncolites to 2 cm in diameter are abundant; base of unit is a gradational contact with respect to weathering color, the color changing to dark grey to black upwards; top 5 m of unit grades upward to white weathering, white, medium crystalline dolostone

grey weathering, grey to white, fine- to medium crystalline, medium bedded dolostone; coarse quartz sand common, very locally concentrated to form dolomitic sandstone; bedding defined by 0.2 m thick parting; base of unit begins in yellow-grey weathering, grey, finely crystalline, laminated dolostone

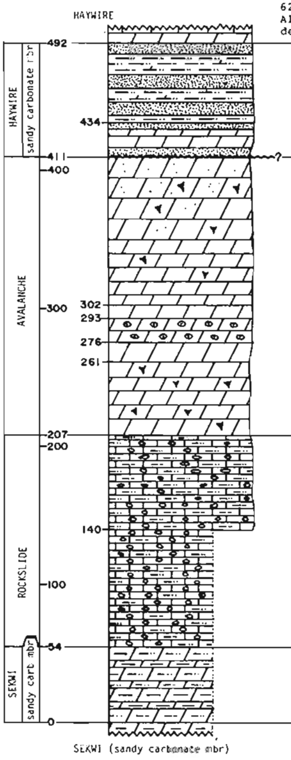
grey weathering, grey, fine- to medium crystalline, massive dolostone; 5-10% scattered coarse quartz sand, very locally concentrated to minor, coarse grained, dolomitic quartz sandstone

yellow-grey weathering, grey to white, fine crystalline, thick bedded dolostone; bedding defined by 0.5 m thick parting; scattered few percent floating coarse quartz sand; base of unit defined by change from grey to yellow weathering

grey weathering, grey, fine- to medium crystalline, very poorly bedded (bedding 1 m+ thick) to massive dolostone; rare lamination shows on weathered surfaces; Avalanche Formation at base of section is faulted against orange-yellow weathering, pale yellow-green, very fine crystalline, laminated dolostone of the Sekwi Formation; cliff outcrop begins 15 m above base of section

SECTION 26

62°/23.8';128°/15.0'   A24801-31   (-29,-31)   105 I-8   meas: P.F. Coleman   desc: D.H. Wood
62°/23.6';128°/15.9'   (-41,-35)
Along northeast-trending spur southwesterly to peak. Same section as later measured by W.H. Fritz in greater detail (see section 22).



interbedded (beds 0.2-0.5 m thick) maroon to red weathering, dolomitic siltstone and yellow to buff weathering, coarse grained, poorly sorted, well rounded dolomitic quartz sandstone; well preserved dessication cracks, flame structure, and ripple cross-lamination; near top of unit are interbeds of grey weathering, light grey, very fine crystalline, vuggy limestone with minor well rounded quartz grains and calcite filled vugs; top of measurement is at the uppermost maroon weathering, dolomitic siltstone beds and is overlain by dolostone and limestone with minor cross-bedded quartz sandstone

grey, pink, or buff weathering, sandy dolostone; at base of unit is medium bed of coarse grained, dolomitic, quartz sandstone with base channeled into underlying unit

light grey to buff or pink weathering, light grey to white, medium crystalline, vuggy dolostone; vugs partially filled with sparry dolomite; oncolites locally preserved; locally sandy; disconformity with slight relief marks contact with overlying sandstone

tan to maroon and pink weathering, pink or maroon to grey, fine crystalline, silty dolostone

dark grey weathering, dark grey, medium crystalline, oncolitic dolostone; oncolites are teardrop or oval in cross-section with long axes about 1-1.5 cm long

grey and buff weathering, grey, fine- to medium crystalline dolostone similar to that in underlying unit

tan to light grey with minor pink and maroon weathering, grey, fine- to medium crystalline, locally vuggy and bioturbated, dolostone; transition from underlying limestone is gradual and uneven over about 1.5 m; nodular texture of underlying limestone is poorly preserved as 'ghosts' within the dolostone at the base of this unit; vugs are filled with ankeritic carbonate

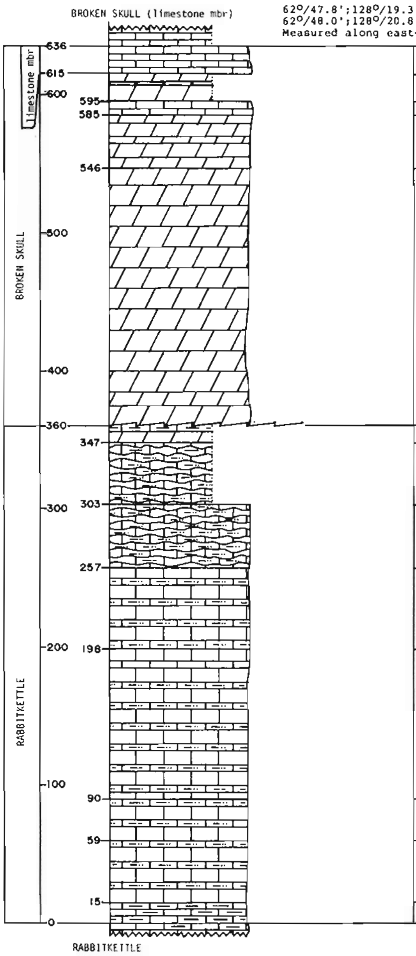
tan to buff and grey weathering, dark grey, fine crystalline, nodular limestone; nodules range from 3-4 cm in diameter at base of unit and towards top of unit coalesce and diminish in size to form 2 cm thick beds; limestone nodules weather slightly greyer than silty limestone matrix; maroon weathering color minor and at base of unit

brown to pink and maroon weathering, dark grey, fine- to medium crystalline, nodular, silty limestone; limestone nodules average 7-10 cm in diameter

orange weathering, light greenish grey to grey with minor maroon, very fine crystalline, argillaceous to silty dolostone and dolomitic siltstone; at base of unit is one-half meter of calcite cemented dolostone breccia; below base of section is similar weathering argillaceous to silty dolostone

SECTION 27

62°/47.8';128°/19.3'   A24778-61   (23,101)   105 I-16   meas: P.F. Colemen   desc: D.H. Wood
62°/48.0';128°/20.8'   (3,101)
Measured along east-trending ridge



pink weathering, pink, fine crystalline, silty limestone scree for basal 3 meters, overlain by orange weathering, dark grey, very fine crystalline, thin bedded, laminated limestone; top few meters of unit are pink weathering silty limestone scree as at base, top of section at contact with overlying grey weathering limestone scree

tan weathering, grey, fine crystalline laminated, silty dolostone grading upward to dark grey weathering, dark grey, very fine- to fine crystalline, laminated dolostone with minor black weathering, black and grey, bedded chert at 609 meters; minor outcrop

pink weathering, dark grey, fine crystalline, thin bedded limestone; top 2 meters are transition to dolostone

brownish orange weathering grey, fine crystalline, laminated dolostone

light and dark grey weathering, light and dark grey, medium crystalline, thick (0.3 - 1.5 m) interbedded, silty to sandy dolostone; brecciated at base of unit

scree of light grey, blocky weathering, grey dolostone (basal 10 m) and orange, pink, burgundy, and grey weathering, dark grey and burgundy to grey, fine- to medium crystalline, argillaceous to silty limestone; contact with overlying unit is a fault trending nearly perpendicular to bedding; probably less than 20 m of overlying unit is cut out across fault along line of measurement

buff and grey weathering, thin bedded, wavy bedded, silty limestone as in underlying unit; at top of unit the limestone is extensively fractured; unit predominantly covered, with outcrop on north side of ridge; top 5 eters of unit is mixed scree of silty limestone and talus of overlying light grey weathering dolostone

buff and grey weathering, grey, fine crystalline, thin bedded, wavy bedded, interbedded, silty limestone and limestone

orange and grey weathering limestone similar to that in underlying units; at top of unit limestone is wavy bedded

orange and grey weathering limestone similar to that in underlying units

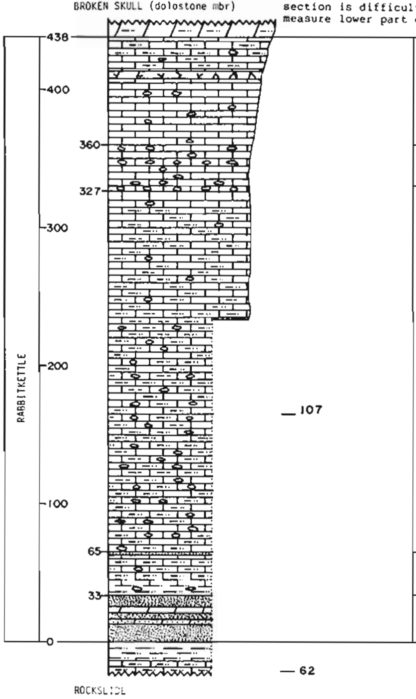
orange and buff to grey weathering, grey and dark grey, fine crystalline, interbedded, thin-to medium bedded, silty limestone and limestone, similar to that in underlying unit.

interbedded orange weathering, grey very fine crystalline, thin bedded (3 - 8 cm), laminated, argillaceous to silty limestone, and buff to grey weathering, dark grey, very fine crystalline, medium bedded (up to 15 cm) limestone

tan to brown weathering, very fine crystalline, thin bedded (3-6 cm), locally laminated, argillaceous limestone; lithology continues beneath base of measurement

SECTION 28

62°/34.0';128°/9.7'   A24778-125   (39,-24)   105 I-9   meas: T.J. Frakes   desc: S.P. Gordey
62°/33.7';128°/10.2'   (36,-33)
Section measured south-southwesterly along ridge from southwest side of saddle to just before peak. Base of section is difficult to locate (in felsenmeer) within homogeneous tan brown weathering sequence. Dip used to measure lower part of section (estimated) was 15° towards 220°.



includes lithology of underlying unit as well as much grey weathering, grey, fine crystalline, thin bedded limestone; from 407-413 m is a lens-shaped intrusion of grey weathering, hornblende-feldspar porphyry; thickness of porphyry shown is the apparent thickness as measured along line of section; top 10 m of unit is orange-tan weathering, blue-grey, thin bedded, silty limestone with red coloration along bedding planes; contact with overlying light grey-tan weathering, grey, fine crystalline, thick bedded silty dolostone of the Broken Skull Formation is sharp; transition to white weathering dolostone of the Broken Skull Formation is estimated at 20 m above limit of measurement

blue-grey weathering with orange weathering limestone nodules, blue-grey, very fine crystalline, thin bedded, well bedded limestone

orange weathering, blue-grey, very fine crystalline, silty, nodular limestone; nodules of grey weathering, blue-grey, very fine crystalline limestone weather out preferentially to form 'swiss-cheese' texture; minor silty limestone with similar texture, but grey weathering with greenish-orange weathering nodules; above 246 m unit includes grey weathering, grey, fine- to medium crystalline limestone with thin irregular parting; in places the grey limestone is highly fossiliferous (fossils mostly broken); above 230 m the nodular limestone becomes less abundant and grades into grey weathering, grey, very fine crystalline, thin bedded limestone with orange weathering parting, or laminations to thin beds of orange weathering silty limestone

107 164 Late Cambrian Elvinia Zone

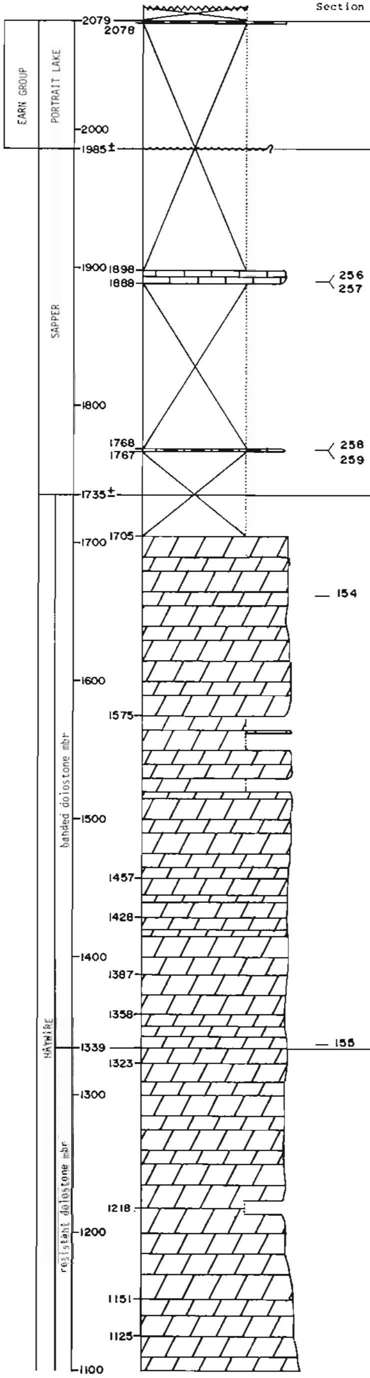
grey-green weathering, grey siltstone with grey weathering, grey, fine crystalline elongate limestone lenses and beds (40%) a few centimeters thick; recessive weathering of limestone forms cavities within the siltstone; this lithology grades upwards into orange weathering, nodular, very silty, laminated limestone; interval also contains scattered float of coarse grained quartz sandstone; top of interval marks approximate topmost occurrence of quartz sandstone

white weathering (locally covered with dark grey lichen), grey, very fine- to fine grained quartz sandstone; local ripple cross-lamination and herringbone cross-stratification; orange weathering, grey, fine crystalline dolostone and sandy dolostone; gradational contact with overlying unit; beneath the Rabbitkettle Formation, in apparently gradational contact is quartz rich siltstone with limestone lenses, in turn underlain by tan weathering, platy, silty limestone from which trilobites were collected (Rockslide Formation); locating the base of the quartz sandstone is difficult in felsenmeer and scree exposure

62 -21 Late Middle Cambrian *Bolaspidella* Zone

62°/32.5';128°/5.5'　A24778-124　(6,-62)　105 I-9　meas: B.S. Norford　desc: B.S. Norford
62°/32.5';128°/1.5'　(59,-60)
Section measured along rugged east-trending ridge

SECTION 29



cherty shale, weathers dark bluish grey; talus and poor, frost-heaved outcrop; forming low knoll

covered interval, float of cherty shale in upper part. Thickness estimated

argillaceous limestone, microcrystalline, yellowish grey, weathers very light grey and light olive-grey, platy; very thinly bedded; forming low knoll.

covered interval. Thickness estimated

limy mudstone, brownish grey, weathers light grey and pale pinkish grey.

dolostone, microcrystalline to very fine crystalline, grey, weathers light grey and pale olive-grey; bedding 10-50 cm, many beds laminated, some with mudcracks; small algal(?) domes at 1587. With about 20 per cent interbedded dark grey dolostone, very fine crystalline, weathers dull dark grey and dull oliver-grey; bedding 5-50 cm, some beds laminated, some bedding planes red stained when weathered. Covered intervals at 1698-1702, 1690-1695, 1645-1645½ m. Unit forms stratigraphically highest resistant outcrops on ridge, its top beds dip eastward at 53°.

dolostone, very fine crystalline, grey and dark grey, weathers light grey and yellowish grey, somewhat recessive; bedding 15-150 cm, some beds laminated. Rare dull dark grey weathering dolostone. Covered intervals of 1565-1575, 1550-1562, 1523-1527, 1521-1523 m.

dolostone, aphanitic to fine crystalline, dark grey, weathers dull dark grey and dull grey; bedding 5-70 cm, some beds mottled (burrowed), some bedding planes red stained when weathered. With about 50 per cent light grey weathering beds (giving striped appearance to unit), dolostone locally siliceous, very fine crystalline, grey; bedding 20-50 cm, many beds laminated

dolostone, with siliceous content, very fine crystalline, light grey and light pinkish grey, weathers light grey and yellowish grey, somewhat recessive; bedding 5-50 cm, many beds laminated. Mudcracks at 1415 (infilled by superjacent dark grey dolomite), 1407½, 1407 m. Dull grey weathering dolostone beds at 1415-1415½, 1408-1409 m; bedding planes red-stained

dolostone, with siliceous content, very fine crystalline, dark grey and grey, weathers dull dark grey and dull grey; bedding 20-70 cm, some beds coarsely laminated, some beds mottled (burrowed), dolomite stringers common. Rare light grey and very pale orange-grey weathering interbeds. Minor erosion surface at 1362 with chanelling of upper surface of light grey bed and pebbles of dark grey dolostone within base of overlying dull dark grey dolostone bed. Dolomitised gastropods

dolostone, very fine- to fine crystalline, dark grey, weathers dull dark grey and grey; bedding 10-30 cm, some beds coarsely laminated, some beds mottled (burrowed), dolomite stringers common, many bedding planes stained red when weathered. With about 30 per cent interbedded light grey and yellowish grey weathering dolostone, commonly laminated. Minor erosion surface at 1387 with channelling of upper 7 cm of dark grey bed with pockets and burrow filling of yellowish grey dolomite and quartz sand. Dolomitised gastropods

dolostone, very fine crystalline, light brownish grey, weathers yellowish grey and light grey, blocky; bedding 15-150 cm, well developed, some beds laminated. At 1329-1329½, 1328-1328½ m two beds of mottled dolomite (burrowed), siliceous, microcrystalline to very fine crystalline, dark grey, weather mottled dull grey and light olive-grey. Covered interval at 1323-1325 m

dolostone, very fine- to medium crystalline, light brownish grey and pale pinkish yellow-grey, weathers pale yellow-grey, light grey and very light grey, blocky, resistant; bedding 10-100 cm, many of upper beds laminated. Fine vuggy and pin-point porosity common. Covered interval at 1218-1223 m.

dolostone, fine- to medium crystalline, light grey and light brownish grey, weathers light grey and pale yellowish grey, resistant, granular; bedding 50 cm to massive, mostly massive, rare beds laminated. Pin-point porosity amounting to 1 per cent of many beds, sparse beds with fine to medium vuggy porosity. Covered interval at 1213-1218 m.

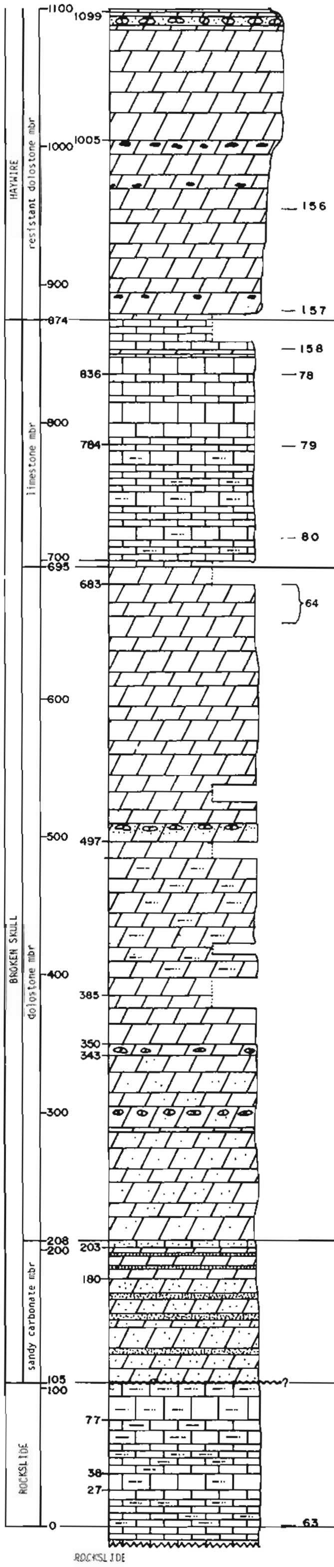
dolostone, fine crystalline, dark grey, weathers dull grey and dark grey; bedding 10-300 cm, some beds with abundant creamy-white dolomite as stringers, pseudobreccia, and lining vugs, some beds indistinctly mottled; many beds with 1-2 per cent fine to medium vuggy porosity. With 20-60 per cent interbedded light grey weathering dolostone.

dolostone, fine crystalline, light grey, weathers pale yellowish grey, very resistant; bedding 300 cm to massive, most beds with about 1 per cent fine to medium vuggy porosity

(continued)

256	1888- 1898	within Zlichovian of Late Early Devonian to Eifelian of early Middle Devonian
257	1888- 1898	mid-Early Devonian, Pragian *kindlei* Zone
258	1767 1768	Early Devonian, Pragian *M. yukonensis* zone
259	1767 1768	late Lochkovian and Pragian, early Early Devonian
154	1662- 1685	A late Middle or early Late Ordovician age is probable based on the range of similar elements
155	1340- 1343	Early Middle Ordovician, late Arenig-Early Llanvirn

SECTION 29



(continued)

dolostone, some with slight siliceous content, fine- to medium crystalline, pale brownish grey and very light grey, weather light grey, very resistant; bedding 40 cm to massive, mostly massive, some beds with fine vuggy porosity. At 1087-1095 m, boulder conglomerate with rounded monomict boulders and cobbles of similar dolomite, some bedded layers within the single massive bed. At 1060 m, laminated dolostone, weathers granular, bedding 100-200 cm. Peak of cliff at about 1060 m

dolostone, locally with slight siliceous content, fine- to medium crystalline, grey and light brownish grey, weathers dull grey, brownish olive-grey and light grey, blocky, resistant; bedding 15-80 cm, white dolomite common as stringers in many beds and as pseudobreccia in a few beds between 981 and 1003 m. Mottled (burrowed) dolostone at 993 m. Layers of sparse irregular chert nodules at 1003, 1001, 971-972, and 892 m. Covered interval at 859-874 m.

limestone, locally with slight siliceous content, aphanitic, dark grey, weathers light grey and light brownish grey, platy and flaggy; bedding 15-200 cm, some beds with mottled and nodular fabric with yellowish grey weathering tracery of siliceous and dolomitic layers. At 850-852.5 m, dolostone, fine crystalline, light grey, weathers dull light olive-grey, blocky; bedding 30-50 cm with wispy layering of siliceous dolostone. Brachiopods, trilobites and echinoderm fragments. Covered interval at 874-879 m.

limestone, aphanitic to microcrystalline, dark grey, weathers light grey, pale yellowish grey, pale greyish orange, light red, slightly flaggy and platy and fairly resistant; bedding 5-50 cm, some beds with nodular texture separated by wispy yellowish grey weathering fabric. Unit dips eastward at 42°; peak of cliff at 827 m. Rare trilobites and brachiopods

limestone , some slightly argillaceous, microcrystalline to very finely crystalline, dark grey, weather light olive-grey, light grey and pale greyish orange with orange-pink weathering argillaceous partings, platy; bedding 1-15 cm. Minor light grey limestones, bedding 10-30 cm, weather flaggy, with nodular fabric, trails on some bedding planes. At 753-754, recessive, very platy, argillaceous limestones, weather yellowish grey. Large inarticulate brachiopods, rare trilobites, echinoderm debris

covered interval with outcrop at 693-694 m of dolostone, with siliceous content, very fine crystalline, light pinkish grey, weathers light grey, blocky; bedding 10-20 cm

dolostone, locally limy, very fine- to fine crystalline, brownish grey and grey, weathers dull olive-grey, dull light grey and dull light olive-grey, some beds mottled (burrowed) in these colours; bedding 10-80 cm, many beds laminated; irregular white dolomite stringers and layering in some beds. Interbedded dolostone, locally limy, very fine- to fine crystalline, light grey, weathers pale yellowish grey and light grey; bedding 15-50 cm, some beds laminated. At 637, flat-pebble conglomerate in dull grey bed; at 507-508½, oncoliths and quartz sand in dull grey beds. Covered interval at 526-537 m.

dolostone, commonly with quartz silt content, microcrystalline to very fine crystalline, light brownish grey and dark grey, weathers yellowish grey, light grey, dull light olive-grey, pale greyish orange, blocky, somewhat recessive; bedding 10-80 cm. Covered intervals at 483-497, 415-422, and 385-397 m.

dolostone, with siliceous content, very fine crystalline, light grey, weathers dull olive-grey, with interbedded pale greyish orange and pale reddish orange weathering dolostone; bedding 10-200 cm. Covered interval at 376-385 m.

dolostone, with siliceous content, very fine crystalline, dark grey, weathers dull pale yellowish brown, recessive, some beds weather platy; bedding 6-20 cm, well developed; oncoliths common in some beds. Interbedded light brown and reddish orange weathering dolostone

dolostone, some limy, very fine- to fine crystalline, many beds with significant siliceous content, laminae rich in quartz silt or sand or discrete well rounded fine to very coarse quartz sand; light brownish grey, light grey and grey, weathers light grey, very pale yellowish brown, yellowish grey, very light grey, pale greyish orange, resistant; bedding 20-150 cm. Layers with oncolites common at 296-305. At 287-289, intraformational dolostone conglomerate with about 40 per cent well rounded coarse and very coarse quartz sand. Contact with underlying unit, abrupt, concordant

calcarenite, very fine- to fine crystalline, with quartz sand, greyish orange, weather greyish orange and dark yellowish orange, platy, recessive; bedding 2-10 cm

dolostone, medium to coarse crystalline, with layers of quartz sand, very light grey, weathers light grey, very light grey; bedding 20-40 cm. Interbedded dolomitic quartz sandstone amounts to about 30 per cent of unit, fine to coarse grained, whitish grey, weathers very pale orange, off-white, with abundant lichen; bedding 2-20 cm, laminated beds

dolostone, locally limy, very fine- to fine crystalline, most beds with abundant quartz sand and silt, both discrete and as layers and laminae; yellowish brown and light olive-grey, weathers dark yellowish orange, greyish orange, yellowish brown, reddish orange, with abundant lichens, resistant; bedding 10-150 cm, many beds laminated and cross laminated. Interbedded dolomitic quartz sandstone and minor platy weathering, recessive dolostone

limestone, very fine crystalline, with common layers of quartz silt, dark grey, weather light grey, dark yellowish orange, greyish orange, blocky, some beds mottled; bedding 20-80 cm. With about 15 per cent interbedded recessive platy limestone

limestone, locally argillaceous, microcrystalline to very fine crystalline, dark grey with silty layers that weather greyish orange and yellowish brown, platy, recessive; bedding 1-20 cm. Trilobites

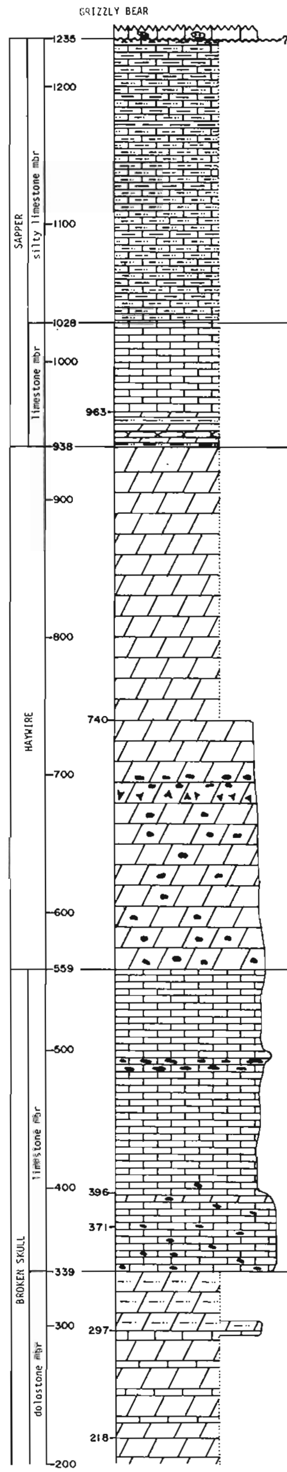
limestone, microcrystalline with biogenic fragments and irregular laminae with quartz silt, dark grey, weather light grey; bedding 20-100 cm

limestone, very fine crystalline, dark brownish grey, weathers grey with greyish orange silty layers, platy, recessive; bedding 2-15 cm. Trilobites and inarticulate brachiopods. Outcrop continues below zero; beds dip southeasterly at 15°.

156	952-956	Early Ordovician, Early Arenig
157	881-883	Early Ordovician, Early Arenig
158	844-850	Early Ordovician
78	836-844	Early Ordovician, late Tremadoc to Early Arenig, Canadian trilobite zone C to G
79	782-783	possibly Early Ordovician, Arenig
80	716-717	possibly Early Ordovician, Arenig
64	656-683	Early Ordovician, probably Tremadoc
63	0-2	Late Middle Cambrian *Bolaspidella* Zone

62°/38.9';128°/7.5'   A24778-50   (-8,-32)   105 I-9   meas: P.F. Coleman   desc: S.P. Gordey
62°/39.8';128°/7.2'   (-5,-8)
Along north-trending ridge. Dip of strata ranges from 80° towards 40° near base of section to 80° towards 220° (overturned) above 340 m.

SECTION 30



buff-orange weathering, grey-brown, very silty, platy limestone; 3% grey to tan weathering, grey, platy limestone; contact with overlying blue-grey weathering, dark blue-grey to black, fine crystalline, crinoidal limestone of the Grizzly Bear Formation is abrupt

light blue-grey weathering, grey, very fine- to fine crystalline limestone

mixed scree of tan weathering, grey, graptolitic siltstone, minor black chert, and light grey to black weathering, fine crystalline, black dolostone (2%); base of unit defined at sharp contact of underlying white weathering dolostone and tan weathering, grey siltstone

alternating in intervals from 1-4 m thick are grey, black, or white weathering, grey, black or white, fine- to medium crystalline dolostone; lamination on weathered surface is in shades of the weathering color; base of unit is at base of lowest white weathering dolostone bed

dark grey weathering, dark grey to black, medium crystalline, thick bedded dolostone; at base of unit dolostone is well laminated on weathered surface in grey to white; ellipsoidal chert nodules to 6 cm maximum diameter diminish in abundance upwards from 10% at base of unit to 0% at 684 m; from 687-693 m are irregularly distributed black chert lenses (30%) to several centimeters thickness; at 684 m is coarse crystalline, white dolomite filling vugs (50%) a few centimeters in maximum dimension, of irregular shape but with preferred elongation along bedding

blue-grey to tan-grey weathering, blue-grey to black, very fine- to fine crystalline, thin bedded (10 cm thick beds or less) limestone; rare small chert nodules in lower part of unit; at 488 m is 1% black chert as thin beds (1-2 cm thick) and elongate nodules

grey weathering, black, very fine- to fine crystalline, thin bedded limestone; 1 cm thick beds and elongate nodules of black chert are common; upper part of unit contains grey weathering, grey dolostone

buff-tan weathering, blue-grey to black, very fine- to fine crystalline, thin bedded limestone

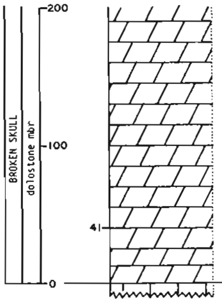
basal 5 m of unit is yellow weathering, laminated, black, nodular, silty, dolostone to dolomitic siltstone with dolostone nodules (2 cm diameter) in an anastomozing silt matrix; basal dolostone succeeded by 2 m of buff weathering, platy limestone; rest of unit is yellow weathering, grey, fine crystalline, burrowed, silty dolostone to dolomitic siltstone

a mixture of black weathering, black, medium crystalline dolostone, white weathering, white, medium crystalline dolostone, and platy limestone (30%); interval ends at top of rib of blue-grey weathering, grey, medium crystalline dolostone

(continued)

SECTION 30

(continued)



equal proportions of dark grey weathering, grey, fine crystalline, locally fetid dolostone and white weathering, greyish white, fine crystalline dolostone; at 195 m is red coloration on bedding surfaces

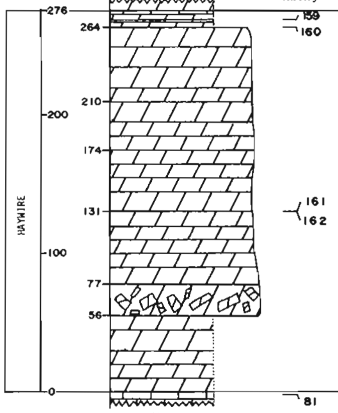
orange to grey weathering, grey, fine crystalline, locally laminated dolostone; contact placed between upper limit of orange weathering, platy limestone scree of the Rabbitkettle Formation and a small, poor outcrop of the overlying dolostone

RABBITKETTLE (REFERENCE SECTION FOR HAYWIRE F./BROKEN SKULL F. CONTACT)

SECTION 31

62°/50.3';128°/8.5' A24778-116 (1,-30) 105 I-16 meas: P.F. Coleman desc: D.H. Wood
62°/50.3';128°/7.5' (12,-28)
Along overall east-trending segment of ridge-crest

HAYWIRE



orange weathering, light grey, silty dolostone; 0.5-1.0 m thick beds of orange to buff weathering, light grey to cream-colored, very fine crystalline, fossiliferous limestone at 268 m and 276 m; dolostone continues an estimated 75 m above limit of measurement until fault contact with Sapper Formation

buff to light grey weathering, dolostone similar to that found in underlying unit; dark grey weathering for 210 - 220 m; fossiliferous at top of unit.

buff weathering, light grey, fine crystalline, thick bedded (0.3 - 0.5 m), locally laminated dolostone; 15% of unit is dark grey dolostone similar to that in underlying units.

light and dark grey weathering, alternately banded, light and dark grey, fine- to medium crystalline, medium- to thick bedded (0.1 - 0.3 m) dolostone; light grey bands approximately 10 m thick, dark grey bands about 3 m thick.

light and dark grey to black weathering, alternately banded, grey and dark grey, fine- to medium crystalline, medium bedded (0.1 - 0.15 m), locally laminated, fetid dolostone; thin lense of light blue-grey and rusty orange weathering, dark grey, very fine crystalline, sparsely fossiliferous limestone is at top of unit.

grey weathering, dolostone breccia composed of angular fragments (1-5 cm diameter) of light and dark grey to black, fine- to medium crystalline dolostone, similar to that in underlying unit, floating in a white coarse crystalline calcite and dolomite matrix

orange and buff weathering scree of alternating light and dark grey, fine- to medium crystalline, vuggy dolostone; vugs are calcite filled; dark grey dolostone has slightly fetid odor when scratched; unit is underlain by buff and light blue-grey weathering, light grey, limestone and dolomitic limestone

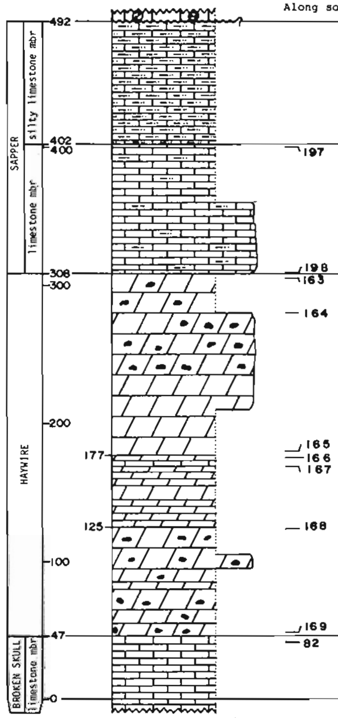
159	268.5	Late Middle to Late Ordovician, late Caradoc-Ashgill
160	264	late Middle or Late Ordovician, late Caradoc or Ashgill
161	130.5	late Middle or Late Ordovician, probably Caradoc, possibly Ashgill
162	130.5	Late Middle to Late Ordovician, late Caradoc-Ashgill
81	-2 to 0	Ordovician

BROKEN SKULL (limestone mbr)

SECTION 32

62°/47.1';128°/28.4' A24778-62 (10,57) 105 I-16 meas: B. Fischer desc: R.G. Anderson
62°/46.4';128°/28.5' (11,40)
Along south-trending ridge. Dip used in measurement was 25° towards 210°.

GRIZZLY BEAR



buff weathering, tan-grey to black, fine crystalline, laminated silty limestone; top 5 m of unit is rouge weathering; the apparent thinness of this interval compared to thicknesses regionally may indicate stratigraphic omission through faulting between 402-492 m, or sub-Grizzly Bear erosion; unit overlain by white weathering, black, crinoid limestone (with abundant crinoid stem fragments with twin axial canals) of the Grizzly Bear Formation

grey weathering, with pink weathering on bedding planes, black, cryptocrystalline, thin bedded (5-10 cm) limestone; locally silty; upper 30 m dominated by grey weathering, black, microcrystalline, thin bedded to laminated (0.1-3 cm) limestone

grey to dark grey weathering, grey, in places calcareous, fine crystalline dolostone; upper one-half of unit contains 1-5% of rounded to oblong, locally elongate, black weathering, black chert nodules, to 20 cm long, but averaging 10 cm long

grey and buff weathering, grey, very fine- to fine crystalline dolostone, size of felsenmeer suggests bed thickness of about 5-10 cm; locally, towards top of unit is light buff-grey weathering, grey, dolomitic limestone

brown to green-brown weathering, grey to dark grey, thin- to thick bedded, fine crystalline, calcareous dolostone; round, black weathering, dark grey chert nodules to 6 cm diameter, averaging 2-3 cm in diameter, locally comprise up to 50% of the rock; towards top of unit nodules become green to brown-grey weathering

light grey weathering, black to grey, cryptocrystalline limestone; lithology continues below limit of measurement

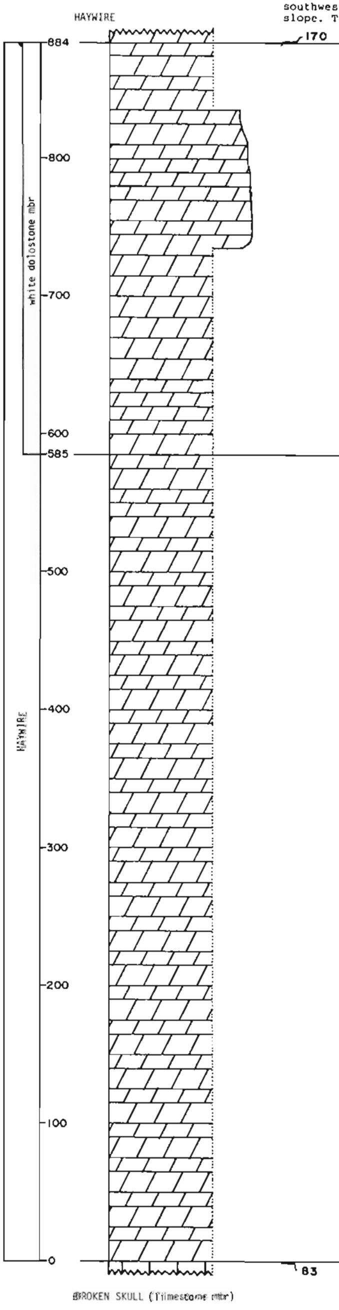
197	400	late Early to early Middle Silurian, late Llandovery-early Wenlock, celloni-amorphognathoides Zones
198	309	Middle to Late Ordovician
163	306	late Middle to Late Ordovician, late Caradocian-Ashgill
164	280	probably Late Ordovician, possibly Early Silurian
165	180	Middle to Late Ordovician
166	175	Middle to Late Ordovician
167	168	probably late Middle or Late Ordovician
168	123	Ordovician to early Devonian
169	48	Middle to Late Ordovician, probably Caradoc
82	42	Middle to Late Ordovician

BROKEN SKULL (limestone mbr)

SECTION 33

62°/34.8';128°15.15' A24778-126 (64,3) 105I-9 meas: T.J. Frakes desc: S.P. Gordey
62°/34.2';128°/16.0' (55,-12)

Measured along felsenmeer covered, short, southwest-trending ridge. First half of section is measured southwesterly, upslope from deep saddle to peak. The last half is measured on low ridge down southwest facing slope. Thickness measured using dip of 38° towards 205° determined below base of section.



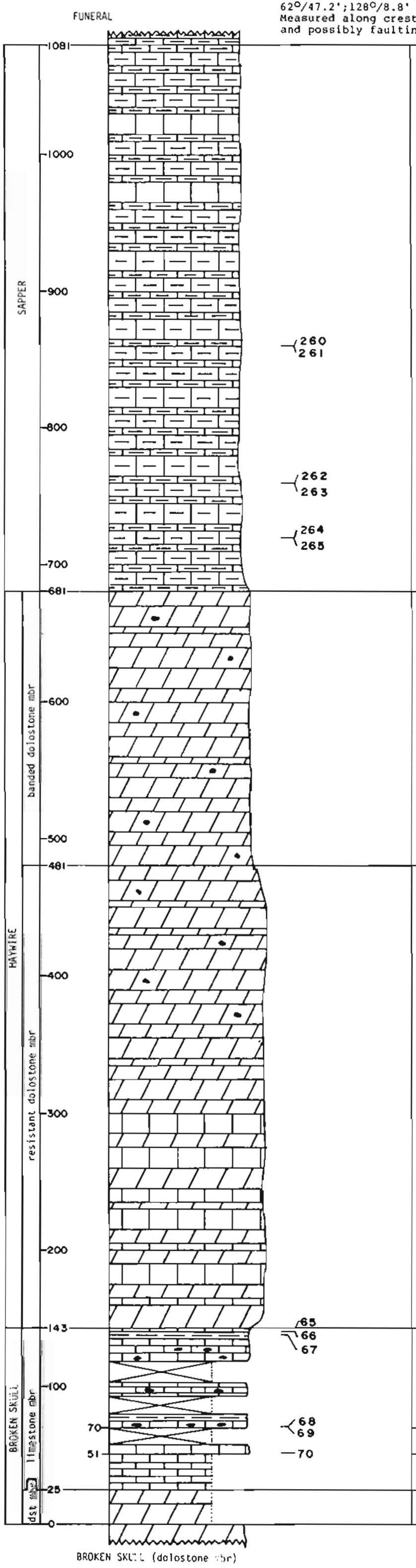
light grey to white weathering, light grey to white, fine- to medium crystalline dolostone; fine laminated on weathered surface; bedding defined as 0.1 m thick parting locally in outcrop; base of unit at sharp weathering color change in felsenmeer from dark grey to light grey; top of measurement at base of thick bed of conspicuous dark grey weathering, dark grey to black, fine- to medium crystalline dolostone with scattered dolomitized fossil hash

dark grey weathering, dark grey, fine- to medium crystalline, vaguely laminated dolostone; much veining of sparry white dolomite; locally very poorly preserved fossil hash (gastropods?); local vuggy porosity of a few percent; at 121-123 m approximately is dolostone breccia with subangular grey dolostone clasts to 0.1 m in diameter and much sparry white dolomite filling original void space between clasts; at 452-455 m is white weathering, white, medium crystalline dolostone; base of section is on a small bench, on the south side of saddle at abrupt transition from tan-buff weathering, grey-black, fine crystalline, silty limestone (Broken Skull Formation) to dolostone

170	885	Early Middle Ordovician, Late Arenig-early Llanvirn
83	-2 to 0	Late Early or Middle Ordovician

62°/47.8';128°/10.4' A24778-59 (-30,113) 105 I-16 meas: B.S. Norford desc: B.S. Norford
62°/47.2';128°/8.8' (-9,97)
Measured along crest of northwest trending ridge. Exposures are not good and contortions indicate minor folding and possibly faulting within the sequence so that measurements are approximate.

SECTION 34



argillaceous limestone, microcrystalline, dark grey and brownish grey, weathers light grey, light pinkish grey, light orange pink, yellowish grey, pale greyish orange, platy; very recessive; bedding 5-40 cm. Rare limestone, very fine crystalline, dark grey, weathers light grey, resistant; as individual beds, 30-80 cm thick. Unit very poorly exposed on ridge crest except for limestone beds; corals, brachiopods, fish fragments in limestone beds. Unit overlain by limestone, argillaceous, dark grey, weathers yellowish grey, grey and pinkish grey, platy, cleaved (Funeral Foramtion).

260	860.0- 860.4	late Lochkovian, early Early Devonian
261	860- 860.4	Early Devonian, mid-Lochkovian to mid-Pragian (stratigraphic position above C-092572, suggests *pesavis* to *kindlei* Zones).
262	760- 761	late Lochkovian, early Early Devonian
263	760- 761	Early Devonian, late Lochkovian (*pesavis* Zone)
264	720.0- 720.8	early Lochkovian, early Early Devonian
265	720.0- 720.8	Late Silurian to Early Devonian

dolostone, very fine crystalline, dark grey, weathers dull grey, dull olive-grey, and dull dark grey; bedding 5-70 cm, white dolomite stringers and veins common and pseudobreccia with white dolomite matrix; some red-stained bedding plains, sparse greyish black nodules and irregular silicification; rare ghost gastropods. Interbedded light grey weathering dolostone, some with echinoderm debris.

dolostone and limestone (lower half of unit), microcrystalline to fine crystalline, dark grey and grey, weathers light grey, and yellowish grey, resistant; bedding 5-200 cm, dolomite and calcite stringers. Minor dull grey and dull dark grey weathering dolostone in upper part, locally with rare chert nodules. Recessive, platy dolostone about 25 m from top, weathers yellowish grey, pale greyish orange and pink. Small folds common within unit to peak of ridge at 451 m.

65	143	Early Ordovician, Early Arenig
66	140- 141	possibly Early Ordovician, Arenig

limestone, aphanitic to microcrystalline, dark grey and dark olive-grey, weathers light grey, yellowish grey, and pale pink, platy; bedding 1-10 cm Interbedded very limy shale, poorly fissile, weathers olive-grey. Dark grey chert as thin layers and elongate nodules within limestone; locally amounting to 10 per cent of rock. Covered intervals at 142-143 m 102-119 m, and 80-93 m. Large inarticulate brachiopods (140-141 m) and graptolites (71-72 m).

limestone, aphanitic, dark olive-grey, weathers light grey with layers and mottled laminae that weather yellowish grey, platy; bedding 15-40 cm. Trails on some bedding planes. Covered interval from 58-70 m.

float of platy limestone, weathers yellowish grey and yellowish orange

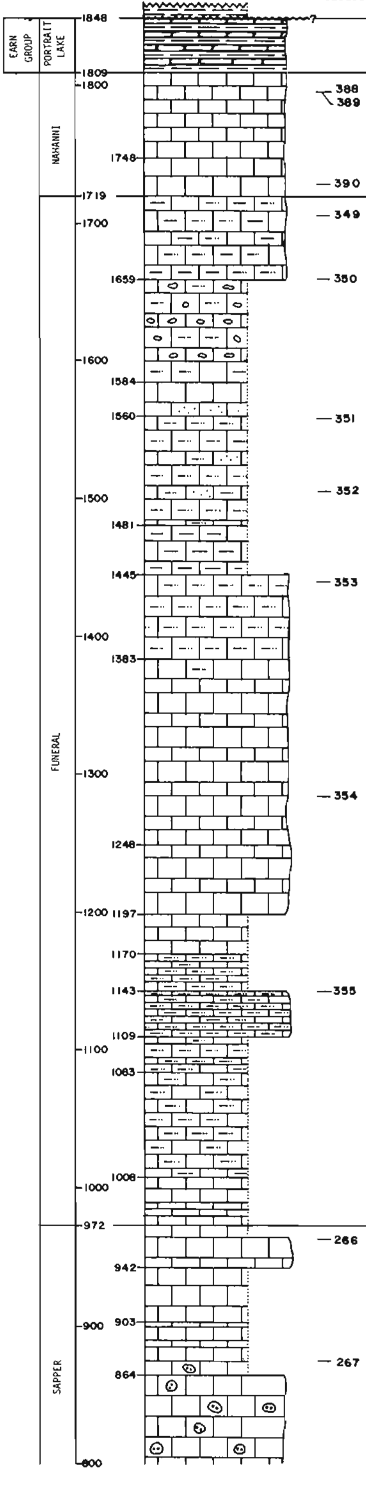
float of light grey weathering dolostone. Below base of measurement is dolostone with siliceous content, very fine crystalline, light grey and yellowish grey laminae, weathers light grey, resistant; bedding 10-50 cm, well developed, laminated. Interbedded dull dark grey weathering dolostone, bedding 20-100 cm, abundant dolomite as stringers and irregular lattices.

67	138	Early Ordovician, Arenig
68	71-72	probably Early Ordovician, Arenig but possibly early Middle Ordovician, Llanvirn
69	71-72	Ordovician
70	52	Early Ordovician, ?Tremadocian

62°/47.7';128°/7.8' A24778-59 (2,114) 105 I-16 meas: P.F. Coleman desc: D.H.Wood
62°/47.2';128°/5.4' (35,103)
Measured along a long east-southeast trending ridge. Distribution of outcrop shown is approximate.

SECTION 35

PREVOST (EARN GROUP)



silvery grey weathering, dark grey to black, chert and cherty argillite; top of section above 1848 m overlain by scree and poor outcrop of dark brown weathering, dark brown to black, muddy argillite

grey and buff weathering, dark grey to black, very fine- to fine crystalline, medium bedded (0.1 - 0.2 m), sparsely fossiliferous limestone

dark grey weathering, black, fine crystalline, medium- to thick bedded (0.2 - 0.3 m), fossiliferous limestone

orange and grey weathering, grey to dark grey, fine- to coarse crystalline, argillaceous to silty limestone and bioclastic limestone

orange and grey weathering, dark grey to black, fine crystalline limestone and silty limestone; banded limestone and silty limestone has a nodular texture; minor outcrop

buff to orange weathering, dark grey to black, fine- to medium crystalline, fossiliferous limestone with minor argillite; exposed as poor outcrop and scree

buff to orange weathering, dark grey, fine- to medium crystalline, silty to sandy limestone with minor bioclastic limestone at top of unit; interval is predominantly scree with scattered poor outcrop

buff to orange weathering, dark grey to black, fine crystalline, thin-to thick bedded (0.02 - 0.3 m) argillaceous limestone; thinner bedded and more argillaceous from 1445 to 1455 m; unit is predominantly scree with scattered poor outcrops

orange weathering, dark grey, fine crystalline, laminated to thick bedded (0.3 - 0.5 m), silty limestone; from 1383 to 1410 m laminae are pronounced and contorted; from 1410 to 1445 m laminae are poorly preserved and bedding well preserved

grey, buff and orange weathering, dark grey to black, fine crystalline, medium- to thick bedded (0.2 - 0.5 m), laminated limestone

grey and orange weathering, dark grey, fine crystalline, medium- to thick bedded (0.2 - 0.6 m), poorly laminated limestone

grey to buff weathering, dark grey, very fine crystalline, limestone

orange platy weathering, dark grey, fine crystalline, laminated, silty limestone

orange to buff weathering, dark grey to black, fine crystalline, thin laminated, silty limestone; at top of unit is 1 m thick bed of crinoidal limestone

orange, platy weathering, dark grey to black, fine crystalline, laminated, silty limestone, similar to that of underlying unit

orange, platy to blocky weathering, dark grey to black, fine crystalline, laminated, silty limestone; talus and scree with scattered poor outcrop

buff to orange weathering, black, fine crystalline, laminated limestone

dark grey and pink weathering, dark grey to black, fine crystalline limestone; pink weathering color restricted mainly to bedding surfaces between 942 and 954 m

dark grey and minor buff and pink weathering, dark grey, fine crystalline, medium- to thick bedded (0.1 - 0.5 m), limestone; interval predominantly scree with minor poor outcrop

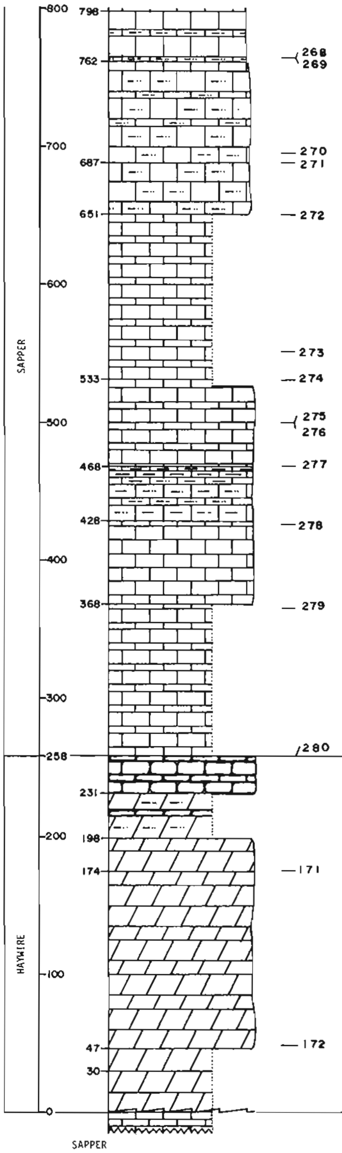
dark grey to buff weathering, dark grey, fine- to medium crystalline, medium bedded (0.1 - 0.15 m), limestone; upper limit of crinoid stem fragments with twin axial canals at about 875 m; interval is predominantly coarse scree with scattered poor outcrop.

interbedded buff to dark grey weathering, black fine- to medium crystalline, thick bedded (1.0 - 1.5 m) bioclastic limestone and pinkish grey weathering, dark grey to black, fine- to medium crystalline, thin bedded, silty bioclastic limestone; abundant crinoid stems fragments with twin axial canals.

(continued)

388	1795.5	Middle Devonian, probably mid- to late Eifelian
389	1795.5	probably Eifelian, early Middle Devonian
390	1728	adoceta Zone, early Eifelian, early Middle Devonian
349	1707	Middle Devonian, Eifelian, o. costatus Zone up
350	1659	adoceta Zone, early Eifelian, early Middle Devonian
351	1557	probably Eifelian, early Middle Devonian
352	1506	probably Eifelian, early Middle Devonian
353	1440	presumably Middle Devonian, Eifelian (fauna is bracketed)
354	1284	Middle Devonian, Eifelian, o. costatus-australis Zones
355	1143	Eifelian, early Middle Devonian
266	963	Middle Devonian, bracketed as Eifelian
267	874.5	Middle Devonian, late Eifelian, c. costatus-australis Zones

SECTION 35



(continued)

interbedded, dark grey weathering, black, fine crystalline, thick bedded (1.0 - 1.5 m), crinoidal limestone and buff to pink weathering, dark grey, thin bedded (0.1 m), silty limestone (abundant dacryoconarids) with minor pink weathering, grey, dense (possibly baritic), calcareous siltstone to very fine grained sandstone

interbedded, pink weathering, dark grey, fine- to medium crystalline, laminated silty limestone and black to dark grey weathering, black fine- to medium crystalline, locally silty limestone; dacryoconarids are abundant.

dark grey to buff weathering, fine- to medium crystalline, thick bedded (0.3 - 1.5 m), locally silty, fossiliferous limestone; silty limestone is laminated

buff and dark grey weathering, dark grey, fine crystalline, locally fossiliferous limestone; predominantly scree with poor outcrop from 532-542 m

grey and buff weathering, dark grey, fine crystalline, thin laminated to medium bedded, locally fossiliferous limestone; fossiliferous limestone is medium bedded (0.2 - 0.3 m) and comprises 5% of interval.

buff, dark grey and pink weathering, dark grey, black and pinkish grey, cryptocrystalline to fine crystalline, silty to argillaceous limestone; top 10 m of unit is poorly fissile, graptolitic, argillaceous limestone.

buff and burgundy weathering, dark grey, fine crystalline, medium bedded (0.1 - 0.2 m) limestone.

dark grey weathering, dark grey to black, fine crystalline, bioclastic limestone; sparsely fossiliferous, poorly laminated

orange to buff weathering, orange to grey, thin- to medium bedded chert; locally poorly laminated

light grey and reddish, platy weathering dark grey, fine- to medium crystalline, laminated, silty dolostone with interbeds of black chert.

light and dark grey weathering (30% dark grey), light and dark grey dolostone as in underlying unit.

light and dark grey weathering, light and dark grey, fine crystalline, medium (0.1 - 0.2 m for dark grey) to thick (0.3 - 0.5 m for light grey) bedded, locally laminated (dark grey) dolostone; 80% of lithology is light grey color; most dark grey dolostone shows calcite veins and brecciation;

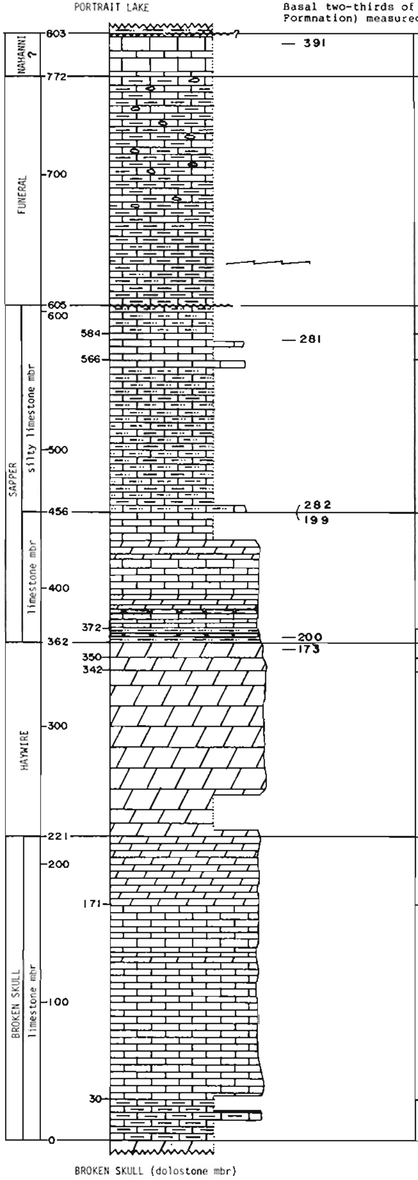
light and dark grey weathering, fine crystalline dolostone as in underlying unit; first scree of brecciated dolostone marks top of unit

light and dark grey weathering, light grey, very fine- to fine crystalline, laminated dolostone and dark grey, fine crystalline dolostone; calcite veins; in fault contact with orange weathering, platy, recessive limestone of the Sapper Formation

268	764	early Zlichovian of late Early Devonian
269	763.5	Early Devonian, Pragian, kindlei Zone
270	694.5	Pragian of Early Devonian to Frasnian of early Late Devonian
271	687	Early Devonian, Pragian, kindlei Zone
272	651	late Lochkovian to Pragian
273	552	late Lochkovian to Pragian, Early Devonian
274	532.5	latest Silurian-Early Devonian, late Pridolian-mid Lochkovian
275	498	probably Late Silurian, ?Ludlow
276	498	Silurian, probably Middle or Late
277	468	Late Silurian, Ludlow
278	426	probably Silurian
279	364.5	Silurian, probably Middle or Late
280	258	late Early to early Middle Silurian, late Llandovery to early Wenlock, celloni-amorphognathoides Zones
171	174	latest Middle Ordovician, late Caradoc
172	48	latest Middle Ordovician, late Caradoc

62°/46.8';128°/20.1' A24778-61 (15,77) 105 I-16 meas: P.F. Coleman desc: S.P. Gordey
62°/46.0';128°/20.5' (13,48)
Basal two-thirds of section measured southerly along south trending ridge, upper one third (mostly Funeral Formnation) measured down south-southwest facing dip slope.

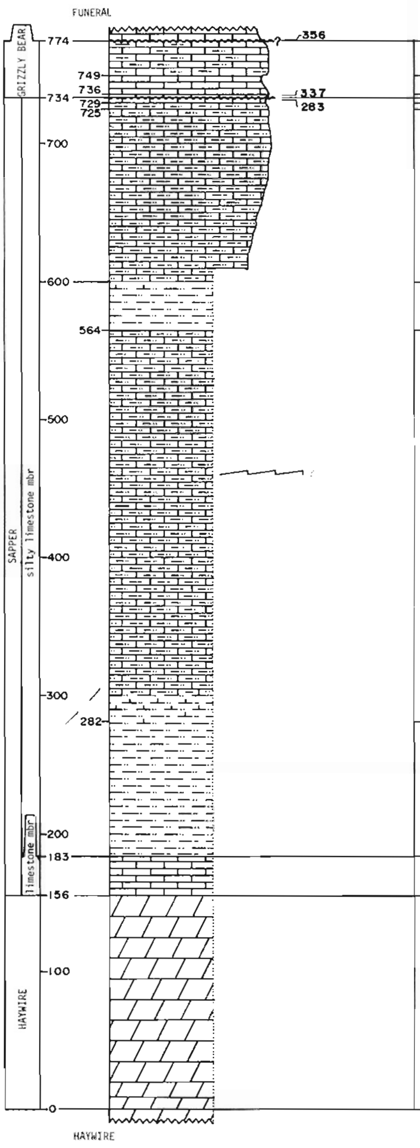
SECTION 36



blue-grey weathering, black, very fine- to fine crystalline limestone; top of section at abrupt contact with gun-blue to white weathering, grey to tan, siliceous shale and siltstone	391	795	Middle Devonian, Eifelian, australis-kockelianus Zones
orange weathering, blue-grey, laminated, argillaceous limestone; from about 675-723 m is orange weathering, blue-grey limestone, with small nodules of blue-grey weathering limestone; contact of similar lithologies of Sapper and Funeral formations is located approximately, at change from silty to predominantly argillaceous limestone, corresponding to a subtle change to slightly lighter and more orange weathering color upsection; thickness of Funeral Formation measured on scree-covered dip slope and is approximate; relative thinness of Funeral Formation could result from ommission across an undetected fault(s) in lower part of unit			
orange weathering, grey, fine crystalline, silty limestone and abundant float of grey weathering, grey, fine crystalline, bioclastic limestone with small crinoid and shell fragments (no crinoid stem fragments with twin axial canals)	281	580.5	Late Silurian to Early Devonian, Pridoli to Pragian
tan weathering, black, fine crystalline, limestone; tan weathering on ridge but black and earthy weathering on adjacent valley headwall			
buff-orange and minor mauve weathering, tan to black, silty to argillaceous, laminated limestone; laminations show on weathered surfaces only, in black or grey; interval includes minor blocky, grey-green weathering, black, fine crystalline limestone; top of interval is resistant 5 m thick rib with bed thickness of 0.1-0.2 m, of blue-grey weathering, black, fine crystalline limestone	282	456	late Early to early Middle Silurian, Late Llandovery-early Wenlock, ?Amorphognathoides Zone
grey to blue-grey weathering, black, fine- to medium crystalline limestone; bed thickness less than 0.1 m; minor blue-grey weathering, grey to black, fine- to medium crystalline dolostone and calcareous dolostone (386-396 m; 423-435 m)	199	455	Early or Middle Silurian, Llandovery or Wenlock
grey to tan weathering, thinly interbedded siltstone and chert; chert forms thin beds to elongate nodules; mudcracks in siltstone are common	200	364.5	Early Ordovician to Middle Silurian, Arenig to Wenlock
sharp contact in small saddle between white (interval below) and tan weathering, tan to grey, medium crystalline, coralline dolostone	173	357	Silurian
resistant, grey to white weathering, grey, medium- to coarse crystalline dolostone			
grey, black, or white weathering, grey, massive, predominantly medium crystalline dolostone; basal 24 m of interval is white weathering; top of interval very rubbly and recessive weathering, and cut by numerous quartz-calcite veins			
grey to black weathering, grey, fine crystalline dolostone; bed thickness less than 0.1 m			
blue-grey weathering, black, very fine crystalline limestone; rouge coloration on bedding surfaces is common; bed thickness less than 0.1 m			
yellow weathering, blue-grey, very fine crystalline, very shaley limestone; base of section at contact with underlying yellow weathering, blocky dolostone, about one and one-half meters above distinctive black weathering, black dolostone			

62°/33.2';128°/13.2   A24778-126   (94.-40)   105I-9   meas: T.J. Frakes   desc: S.P. Gordey
62°/32.8';128°/13.9   (83,-53)
Section mostly scree and possibly faulted. Lower part (i.e. before outcrop) was measured using estimated dip of 45° towards 220°

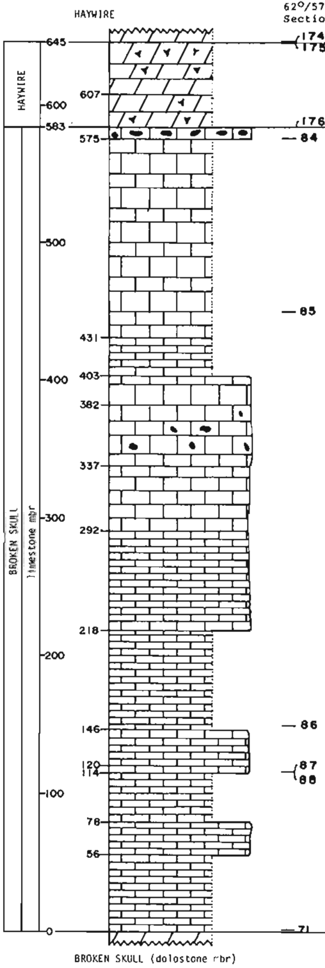
SECTION 37



white weathering, black, fine crystalline, platy, silty limestone; sharp contact with overlying orange weathering, grey, fine crystalline, thin bedded limestone of the Funeral Formation	356 775	Middle Devonian, probably Eifelian
lower half of unit is black weathering, black, crinoidal limestone; crinoid stem fragments with twin axial canals are common; upper half of unit is tan-grey weathering interbedded, black, fine crystalline, platy limestone, and black, fine crystalline limestone strikingly laminated on weathered surfaces in black and white		
light grey weathering, grey, crinoid limestone; crinoid stem fragments with twin axial canals common	337 735	Early Devonian, Dalejan, <u>serotinus</u> Zone
black weathering, black, fine crystalline limestone; gradational contact with underlying unit; poorly preserved brachiopods and dacryoconarids	283 732	Early Devonian, Pragian, <u>kindlei</u> Zone
tan weathering, grey, fine crystalline, laminated, silty limestone; poorly preserved dacryoconarids; gradational contact with underlying unit		
dark orange weathering, tan-grey, well laminated, fine crystalline, silty limestone		
tan-brown weathering, grey to brown, siltstone		
at 282 m is a subtle change to more orange weathering, laminated siltstone and a gradual grading upward to dark orange weathering, grey, fine crystalline, laminated, silty limestone; includes minor grey weathering, grey, fine crystalline limestone; high in the unit rouge to pink weathering cast is common; relations along strike to the northwest suggest that fault(s) causing stratigraphic repetition may occur between 350-564 m		
tan-orange weathering, minor blue-grey weathering, tan to brown, locally black siltstone; poorly preserved monograptid graptolites locally		
dark grey weathering, grey, very fine- to fine crystalline limestone; contact with overlying unit sharp in scree		
black, grey and white weathering, black to grey, fine crystalline dolostone, locally well laminated; dark colored varieties tend to be massive and carbonate veined; felsenmeer occurs as thick intervals of alternating weathering color (above); base of section at subtle change from overall light grey weathering beneath to dark grey weathering above (a change more easily seen from a distance); at top of interval is float bearing chain and cup corals like those seen elsewhere immediately beneath the Sapper Formation		

62°/57.8';128°/22.2'　A24516-47　(-48,18)　105 I-16　meas: J.G. Beekmann　desc: D.H. Wood
62°/57.2';128°/22.2'　(-48,5)
Section measured southerly, directly up a steep north-facing slope

SECTION 38



dark grey weathering, black, fine- to very fine crystalline, vuggy dolostone; sparsly crinoidal near top of unit; vugs filled with calcite; top of section at contact between black vuggy dolostone and overlying tan weathering dolostone

light grey, blocky weathering scree of light grey, medium crystalline, massive, vuggy dolostone; vugs filled with calcite

light to dark grey weathering, dark grey, fine crystalline, thick bedded (0.3 m), silty limestone; contains up to 10% nodular black chert.

grey to orange and minor pink, blocky weathering scree of dark grey to black, fine crystalline, limestone and silty limestone; worm burrows common; nodular chert (5% of lithology) near top contact; bedding thickness estimated from scree is 0.3 m

grey and pastel pink weathering scree of black, cryptocrystalline, thin bedded, porcelaneous limestone; bedding planes have well preserved horizontal worm burrow casts

dark grey weathering, black, fine crystalline, thick bedded limestone becoming thin bedded toward top of unit

light grey weathering, black, fine- to very fine crystalline, medium- to thick bedded (0.2 - 0.7 m), porcelaneous limestone; minor thin bedded (2 cm) light grey weathering, black limestone with black chert nodules

grey to buff weathering, dark grey, fine crystalline, medium- to thick bedded (0.2 - 0.3 m) silty limestone; exposure is in part moss-covered scree

grey to buff weathering, dark grey when fresh, fine crystalline, predominantly thin bedded (2 cm) but with beds ranging from 1 cm - 30 cm, silty limestone

grey, rusty grey, and pastel yellow and pink weathering, black, cryptocrystalline to very fine crystalline with minor medium crystalline, thin bedded, porcelaneous limestone; predominantly scree.

orange to dark grey weathering, dark grey when fresh, fine crystalline, thin bedded, in part thin laminated, limestone and slightly dolomitic limestone

interbedded buff and dark grey weathering, light grey (buff) and black (dark grey), thin bedded (1 - 6 cm), silty limestone (buff) and dolostone (dark grey)

dark grey and yellow and pink pastel weathering, dark grey to black, angular scree of porcelaneous limestone

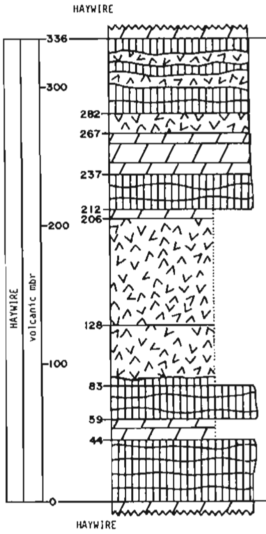
tan and grey, platy weathering, dark grey, very fine crystalline, thin bedded (1-2 cm), becoming at top of unit, thick bedded but thin laminated silty limestone

tan to grey, platy weathering scree of dark grey, very fine crystalline, silty limestone with minor pastel yellow and pink weathering, black, cryptocrystalline, thin bedded, porcelaneous limestone; base of section at contact with massive light grey dolostone.

174	646	Late Middle to Late Ordovician
175	644	mid- to Late Ordovician
176	583	mid- to Late Ordovician
84	576	Early Middle Ordovician, Late Llanvirn-Llandeilo
85	450	Middle to Late Ordovician
86	149	Ordovician, probably latest Arenig, Zone J (I. victoriae graptolite Zone)
87	116	Early Ordovician to early Middle Ordovician, Tremadoc to Llanvirn
88	116	Ordovician, very probably late Arenig, (I. victoriae graptolite Zone)
71	1.5	Ordovician, ?Early

SECTION 39

62°/18.3';128°/10.7' A19439-64 (8,56) 105I-8 meas: P.F. Coleman desc: D.H. Wood
62°/18.1';128°/11.0' (4,63)
Measured up northeast-facing cliffs alongside prominent gulley. Distribution of outcrop shown is approximate.



orange weathering, orange to greenish grey, amygdaloidal basalt and ankeritic volcanic tuff, amygdules (2-4 mm diameter, 10-15%) dolomite filled; top of section at sharp contact between rusty weathering volcanic rocks and light grey weathering, overlying dolostone

rusty brown weathering, dark grey, calcareous phyllite; possibly cleaved and chloritized tuff

light grey to orange weathering, light grey to buff, fine- to medium crystalline, dolostone with minor light grey weathering, light grey, fine crystalline limestone at top of unit

dark rusty grey weathering, dark to light greenish grey, cleaved to massive, amygdaloidal (amygdules 3 mm diameter, 10-15%) basalt; cleaved rocks lighter green and more chloritic

buff to orange weathering, light grey, fine-to medium crystalline, sandy dolostone; unit mainly scree with some scattered poorly exposed outcrops

dark grey weathering, dark greenish grey, fine grained, chlorite phyllite; calcite in veins; most likely an altered massive tuff; mostly scree with some scattered outcrops

greenish grey weathering, dark greenish grey, fine grained, amygdaloidal (amygdules 2 - 6 mm diameter, 10-15%) basalt and volcanic tuff; alteration to chlorite extensive; amydaloidal from 83 - 90 m; mainly tuff from 90 - 127 m; mostly covered interval with scattered well exposed outcrops; tuff has angular volcanic fragments up to 2 cm across

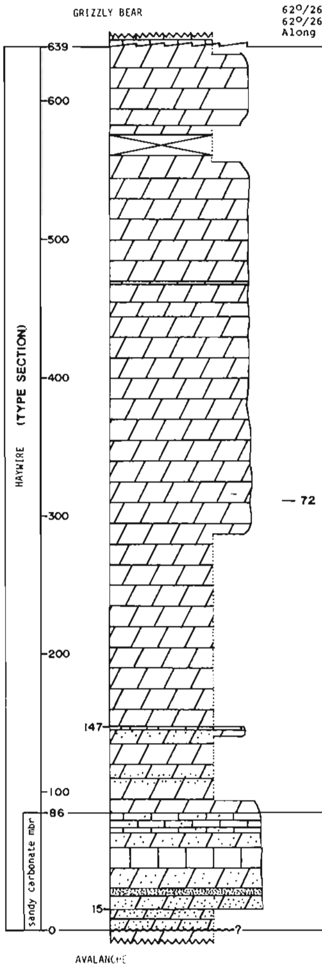
rusty greenish grey weathering, dark greenish grey, fine grained, cleaved, chloritic, amygdaloidal basalt; amygdules (3 mm diameter) calcite filled

buff to orange weathering, light grey to buff, fine- to medium crystalline, limestone and dolostone, mostly scree with poorly exposed outcrops

rusty dark greenish-grey weathering, dark greenish grey, cleaved, chloritic amygdaloidal basalt; amygdales (1 6 mm diameter, 20%) and veins filled with ankeritic carbonate and quartz; base of section underlain by light grey weathering, grey, fine crystalline dolostone which is altered to ankeritic? carbonate + epidote + quartz at contact with volcanics

SECTION 40

62°/26.8';128°/23.9' A24801-33 (22,64) 105 I-8 meas: P.F. Coleman desc: S.P. Gordey
62°/26.3';128°/25.9' (-8,48)
Along southwest trending ridge



monotonous succession of grey to white, locally black or yellow weathering, grey to dark grey, fine- to medium crystalline dolostone; outcrop is massive to thick bedded; carbonate veins locally abundant; from 468-471 m is blue-grey weathering, black, fine crystalline limestone; top of section is at fault contact with blue-grey weathering, dark grey, crinoidal limestone of the Grizzly Bear Formation; poorly preserved Sapper Formation siltstone found adjacent to line of section indicates probably less than 50 m of Broken Skull Formation is cut out by fault at top of section along line of measurement

72 312 Early Ordovician, late Tremadoc-Arenig

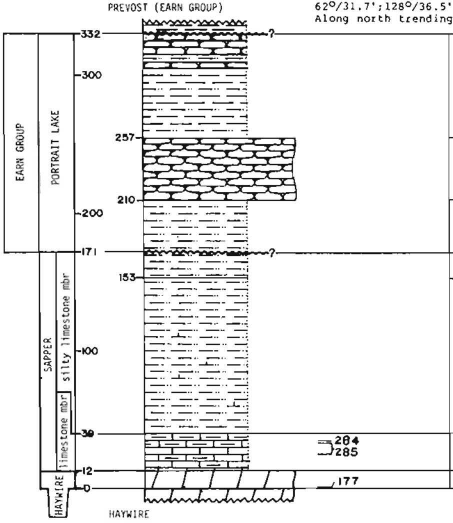
grey to yellow-white weathering, grey to white, medium crystalline dolostone; blocky felsenmeer and scattered poor outcrop; from 109-111 m is sandy; from 143-147 m is orange weathering dolomitic sandstone; unit is capped by a 0.1 m thick bed of blue-grey weathering, blue grey, fine crystalline, sandy limestone

basal one-third of unit is red to orange weathering, light grey, sandy dolostone to coarse grained quartz sandstone; planar laminated, with minor large scale cross-lamination; middle part of unit is blue-grey weathering, grey, fine crystalline limestone (50%) interbedded (beds 2 m thick) with orange to pink weathering, light colored, medium crystalline, sandy dolostone (50%); top one-quarter of interval is predominantly orange to grey weathering, fine- to medium crystalline, grey limestone; top of interval marks the upper limit of orange weathering strata

cream to light yellow weathering, light grey, medium crystalline, very silty to sandy dolnstone; locally cross-laminated; less sandy towards top of unit; base of section defined in blocky talus at base of influx of sand; Avalanche Formation beneath is similar, but non-sandy, cream-yellow weathering, grey, medium crystalline dolostone

SECTION 41

62°/31.9';128°/36.5' A24778-128 (-17,-87) 105 I-9 meas: K.B. Heather desc: S.P. Gordey
62°/31.7';128°/36.5' (-18,-92)
Along north trending ridge



(REFERENCE SECTION FOR BASAL CONTACT OF PREVOST F.)

(REFERENCE SECTION FOR HAYWIRE F./SAPPER FORMATION CONTACT)

mixed scree of blue-grey weathering platy black siltstone, shale and chert; in lower two-thirds of interval chert is minor, in upper one-third it is predominant; top of section is at upper limit of chert scree against blue-grey shale of overlying Prevost Formation

blue-grey weathering, thin-bedded, well-bedded black chert with shaly partings

blue-grey weathering, faintly laminated black siliceous siltstone; contact with underlying unit is sharp in scree

orange to locally brick-red weathering, well-laminated, tan platy siltstone; contains very poorly preserved monograptids

orange-mauve weathering black, brown, or tan siltstone; variably calcareous; at base of unit scree is granular, but becomes platy upwards

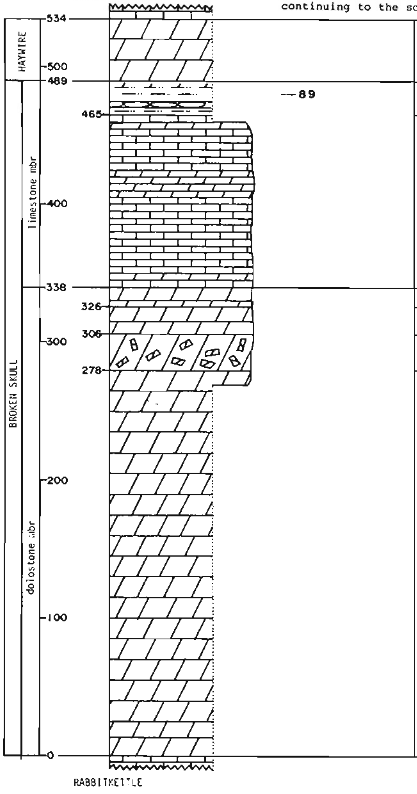
light grey to blue-grey weathering black limestone; locally burrowed; variably argillaceous

grey weathering, grey to black, finely crystalline dolostone; locally faintly laminated, otherwise massive; rare black weathering, black chert as scree; base of section at sharp contact with underlying white weathering, massive, white dolostone

284	34	Silurian, Llandovery to Wenlock, probably Late Llandovery or Wenlock
285	25-33	Silurian, probably later Llandovery
177	1	probably Silurian

SECTION 42

62°/42.3';128°/23.9' A24778-47 (54,41) 105 I-9 meas: P.F. Coleman desc: S.P. Gordey
62°/41.7';128°/25.4' (34,30)
Base of section near low peak. First half of section measured down southwest facing slope. Remainder measured continuing to the southwest up and along a low ridge.



grey weathering, grey to black, medium crystalline dolostone; blocky scree; irregular shaped black to grey chert nodules and lenses to a few centimeters diameter or thickness locally amount to 30-40%; contact with underlying unit located approximately; contact with overlying limestone of the Sapper Formation sharp in scree

tan to dark grey weathering, dark grey, dolomitic, platy siltstone; minor laminations to thin beds of black chert; contact with underlying unit is abrupt; uppermost part of unit by increase of dolomite over siltstone becomes blocky and similar to overlying unit, with which it is in apparent gradational contact

most of unit is grey to blue-grey weathering, black, very fine- to fine crystalline locally laminated, thin bedded limestone; from 347-351 m is yellow-brown weathering, grey, fine crystalline dolostone; from 408-423 m and from 456-461 m is grey weathering, grey, very fine- to medium crystalline, thin- to medium bedded dolostone

89	480	early Middle Ordovician, llanvirn, Paraglossograptus etheridgei Zone

yellow-brown weathering, grey, fine- to medium crystalline, thin- to medium bedded dolostone

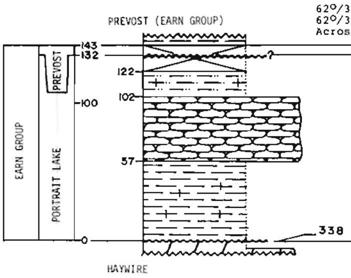
grey-white weathering, light grey to white, fine- to medium crystalline, thin- to thick bedded dolostone

grey-white weathering dolostone breccia; large angular blocks to 2 m in maximum dimension of grey, fine crystalline dolostone, in white, medium- to coarse crystalline dolostone matrix; long dimensions at diverse angles to regional bedding; some blocks matrix supported

grey, white and tan weathering, grey to black, fine- to medium crystalline, locally calcareous, locally laminated dolostone; lamination locally burrow-mottled and some bedding surfaces covered with trails; base of section defined at fairly abrupt lowermost appearance of blocky, grey-white weathering dolostone against underlying white to blue-grey and orange weathering limestone of the Rabbitkettle Formation

SECTION 43

62°/33.1';128°/43.3'   A24778-128   (-9,-52)   105 I-9   meas: K.B. Heather   desc: S.P. Gordey
62°/33.2';128°/43.6'   (-13,-50)
Across low saddle along ridge crest



mossy slope; position of contact with overlying brown weathering shale of Prevost Formation estimated

gun-blue weathering siltstone, faintly laminated in bluish white

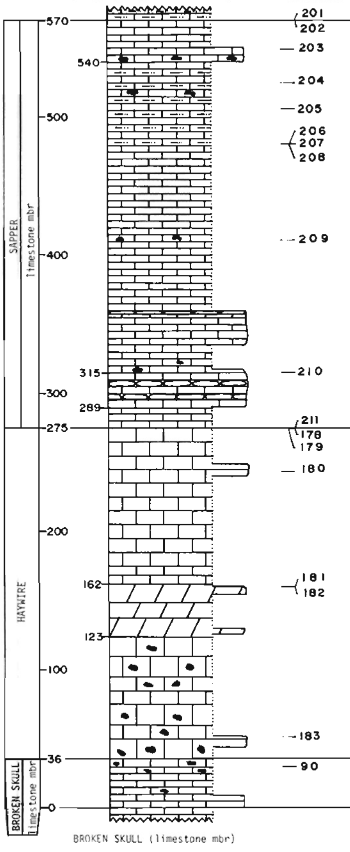
black weathering thin-bedded, well-bedded black chert with shaly partings; rare minor folds

base of section at abrupt contact of grey massive dolostone and brilliant blue-grey weathering, black shale; float of bioclastic limestone containing crinoids with twin axial canals at base of section may represent a thin erosional remnant(s) of Grizzly Bear Formation; rare float of graptolitic brown siltstone at base of section may represent erosional remnant(s) of Sapper Formation

338	0	Middle Devonian, Eifelian, probably c. costatus Zone

SECTION 44

62°/57.2';128°/23.7'   A24516-46   (25,6)   105I-16   meas: J.G. Beekmann   desc: R.G. Anderson
62°/56.7';128°/23.5'   (28,-10)
Section measured along north trending ridge. Outcrop located on section approximately. Dip used to measure thickness was 30° towards 195°.



white to light grey weathering, black, cryptocrystalline to very fine crystalline, thin bedded (beds 5-10 cm thick) limestone; at base of unit rounded pale brown weathering chert nodules to 0.5 cm diameter comprise up to 15% of the rock; unit is overlain sharply by recessive buff weathering, platy silty limestone of the upper part of the Sapper Formation

grey weathering, black, cryptocrystalline to very fine crystalline, thin bedded (beds 2-10 cm thick) limestone; rouge color on bedding surfaces common; rare round to elongate chert nodules to 15 cm in maximum dimension; from 481-540 m are alternating intervals 1-5 m thick of light grey weathering, black, cryptocrystalline limestone and rouge to grey weathering, tan-grey, fine crystalline, silty limestone

alternating light grey weathering, black, very fine crystalline, laminated limestone (beds 5-20 cm thick) and black weathering, black, laminated chert (beds 2-10 cm thick)

pinkish grey weathering, grey to black, thin bedded limestone

buff-grey weathering, grey, bioclastic (coarse crystalline) limestone; bed thickness 10-30 cm averaging 10-20 cm; top of unit capped by 2 m thick, white weathering, bioclastic limestone with brachiopods and corals

alternating in beds 3-6 m thick are white and grey weathering, grey, fine crystalline, slightly calcareous dolostone

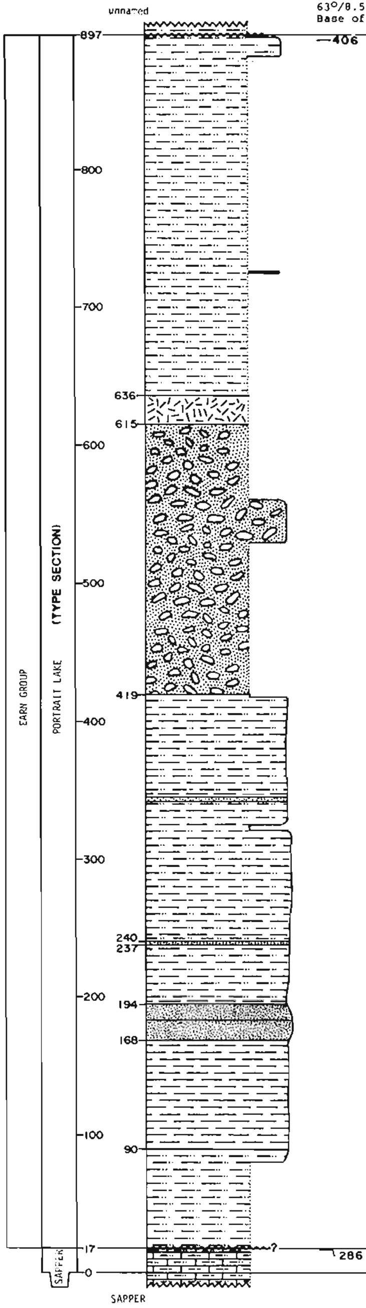
light grey weathering, black, very fine- to medium crystalline, medium- to thick bedded limestone; irregular shaped, black weathering, black chert nodules to 15 cm diameter comprise up to 10% of the rock; at 99 m limestone contains common crinoid ossicles and rare cup corals

light grey weathering, black, cryptocrystalline, thin bedded limestone; rare chert nodules

201	570	late Early or Middle Silurian, Late Llandovery to Wenlock
202	570	Silurian
203	548	Silurian, probably Ludlow, possibly late Wenlock
204	525	late Early or Middle Silurian, Late Llandovery to Wenlock
205	507	late Early or Middle Silurian, Late Llandovery to Wenlock
206	481	late Early or Middle Silurian, Late Llandovery to Wenlock
207	481	Silurian
208	481	late Early to early Middle Silurian, latest Llandovery-early Wenlock, amorphognathoides Zone
209	411	Early to early Middle Silurian, Llandovery-early Wenlock
210	315	probably Early Silurian, Llandovery
211	275	probably Middle or Late Ordovician
178	275	Silurian, probably Llandovery
179	275	Early Silurian, Llandovery
180	243	Late Middle to Late Ordovician
181	160	Middle to Late Ordovician
182	160	probably Late Ordovician, or possibly Early Silurian
183	52	Middle Ordovician, early Caradoc, gerdi subzone? of tvaerensis Zone
90	30	Ordovician

63°/8.0';130°/1.5' - - 1050-1 meas: S.P. Gordey desc: S.P. Gordey
63°/8.5';130°/1.0'
Base of section on small bench on southwest facing slope. Section measured directly upslope towards peak.

SECTION 45



light gun-blue weathering, black, platy siltstone; siliceous and black lichen weathering above 726 m; at 893 m is grey-brown weathering, black, coarse crystalline limestone (about 0.4 m thick); outcrop is poor and limestone cannot be traced laterally for more than 2 m; topmost outcrop of unit is overlain by scree of rust-brown weathering, black, laminated, quartz siltstone to very fine grained quartz sandstone whose lowermost outcrop is about 7 m above the top of the Portrait Lake Formation

sill? of orange-white weathering (with black lichen), felsic quartz porphyry with small scattered, chloritized hornblende?; thickness is apparent thickness measured along line of section

black weathering, massive, chert-pebble conglomerate; chert clasts mostly grey to black, some light grey to white, well rounded, commonly to 3 cm diameter, but in places to 10 cm diameter; many of dark colored clasts could be siliceous argillite; heavy black lichen obscures primary fabric, but conglomerate appears clast supported; matrix is black, to grey, fine- to coarse grained chert-quartz sandstone; interval includes minor? chert-quartz sandstone

same as interval from 194-237 m; above 324 m rock is commonly laminated with fine light grey weathering silt laminae spaced a few centimeters to less than one centimeter apart; from 324-383 m approximately are rare thin beds of dark colored, fine grained, sandstone; topmost lithology of unit is dark grey to bluish grey weathering, black, platy siltstone; contact with overlying unit is sharp in scree and poorish slumped outcrop

dark grey to black weathering, dark grey, coarse- to very coarse grained, quartz-chert sandstone

dark brown weathering, black, silty shale; poorly laminated in dark grey and black; at 215 m is thin? bed of fine grained, quartz-chert sandstone; bedding defined by thin to medium parting

black, with some rust weathering, black, coarse grained, quartz-chert sandstone; bedding 0.3-0.4 m thick; very minor black shale

overall dark brown weathering, black, siliceous shale; bedding defined by 0.1-0.3 m thick parting; contact with underlying unit looks sharp from a distance but is actually gradational over several meters

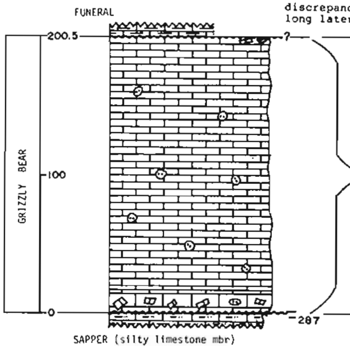
gun-blue to light bluish grey weathering, black, platy siltstone; lamination in grey and blue-grey on weathered surface, dark grey to black on fresh surface; lower 22 m of unit very poorly exposed, but float along southeast sidehill of ridge includes tan-brown weathering, grey-brown siltstone and bluish grey weathering, black siltstone

scattered float of grey-black weathering, black, fine crystalline, silty limestone; section begins at top of scree patch of buff-yellow weathering, dark grey-brown, fine crystalline, platy, silty limestone

406	893	Late Devonian, Frasnian, *gigas* Zone (Lower?)
286	16.5	Early Devonian, latest Pragian-Zlichovian, *dehiscens* or *gronbergi* Zones

62°/42.0';128°/26.0' A24778-47 (29,38)
62°/42.2';128°/26.5' (22,42) 105I-9 meas: J.G. Beekmann desc: M.J. Orchard
Same locality as section 51, remeasured (not redescribed) and collected systematically for conodonts. A discrepancy in thickness of the Grizzly Bear between the two measurements is about 30 m, and may partly arise from long lateral offsets required to measure the upper part of the section.

SECTION 46



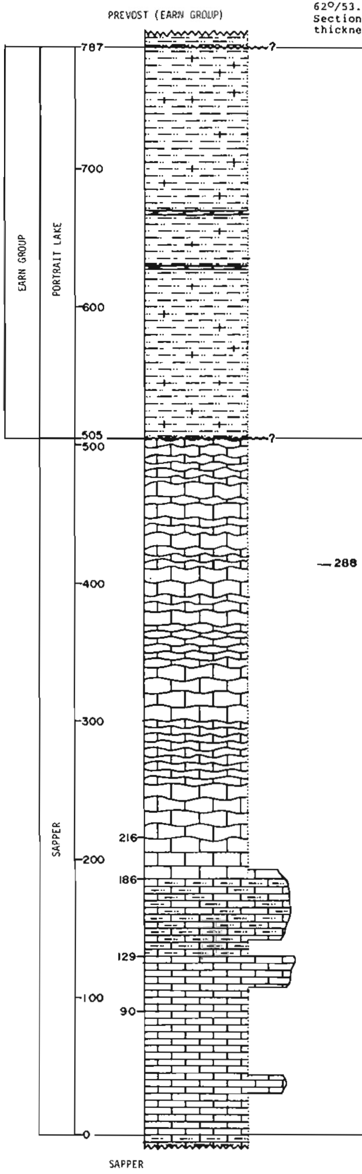
this section measured and systematically collected for conodonts, but not described; for lithologic description refer to note in section heading

Collections indexed to locality 339 show the following range in age:

	m	
339	200.5	Middle Devonian, Eifelian, probably c. costatus-australis Zones
	189-11	Early Devonian, late Zlichovian through Dalejan, inversus (11-81 m) and serotinus (93-189 m) Zones
	0.2	Early Devonian, Zlichovian, late gronbergi-early inversus Zones
	0	Early Devonian, Zlichovian, gronbergi Zone
287	-3.2	Ordovician-Late Devonian

62°/54.2';128°/49.4' A24516-43 (53,-29) 105 I-16 meas: R.G. Anderson desc: R.G. Anderson
62°/53.2';128°/49.3' (28,-27)
Section measured southerly along a south-trending ridge. Distribution of outcrop shown is approximate. Dip used in thickness measurement was 20° towards 180° for 0-216 m and 40° towards 120° for 216-787 m.

SECTION 47



light bluish grey weathering, platy, black, siliceous siltstone, rare black weathering, blocky intervals (to 2-3 m thick) of black chert; lower and upper contacts of unit are sharp; Portrait Lake Formation overlain by brown weathering, dull grey, siltstone of the Prevost Formation

288	413	Ordovician-Early Devonian

greyish white to greenish grey weathering, grey, resistant, very fine crystalline, wavy bedded, thin- to medium bedded (2-15 cm) limestone; change upwards from even bedding to wavy bedding (at about 216 m) is gradual; within 4-6 m of the top of the unit the limestone becomes increasingly orange weathering, and fractured

light grey weathering, grey very fine- to fine crystalline, thin bedded (3-5 cm) limestone

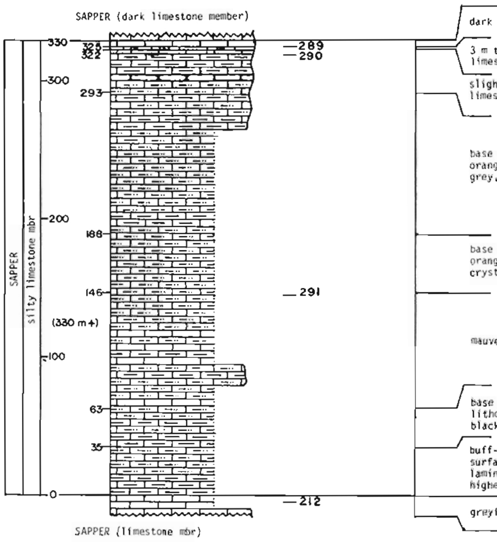
greyish brown weathering, flaggy, grey, fine crystalline, thin bedded (0.5-3 cm) silty limestone

dark brownish green weathering, dark grey, fine crystalline, thin bedded (5-10 cm) limestone; disseminated pyrite common

light grey to light brownish grey to rusty brown weathering, grey, very fine crystalline, thin bedded (1-3 cm) limestone; base of section at contact with underlying, greyish green weathering, dark grey, very fine- to fine crystalline, silty limestone

SECTION 48

62°/56.1';128°/25.2' A24516-46 (3,-27) 105 I-16 meas: S.P. Gordey desc: S.P. Gordey
62°/56.5';128°/25.6' (-2,-18)
Along north-northwest trending ridge



dark weathering, thin- to medium bedded, black, finely crystalline limestone

3 m thick bioclastic limestone bed; dark grey weathering black finely crystalline limestone matrix; contains abundant crinoids with twin axial canals

slightly darker weathering than interval below; tan to mauve weathering silty black limestone; minor black thin-bedded chert

base of interval marked by subtle gradational change from mauve or pink weathering to orange-buff weathering; laminated argillaceous to silty finely crystalline limestone, grey, black or tan on fresh surfaces

base of interval marked by subtle gradational change from mauve or pink weathering to orange-buff weathering; buff weathering laminated argillaceous to silty limestone, finely crystalline, grey, black or tan on fresh surfaces

mauve or pink weathering grey to pink silty limestone

base of this interval defined by a change from buff to mauve weathering color, otherwise lithology is same as dominant lithology of interval below; includes minor green weathering black silty limestone

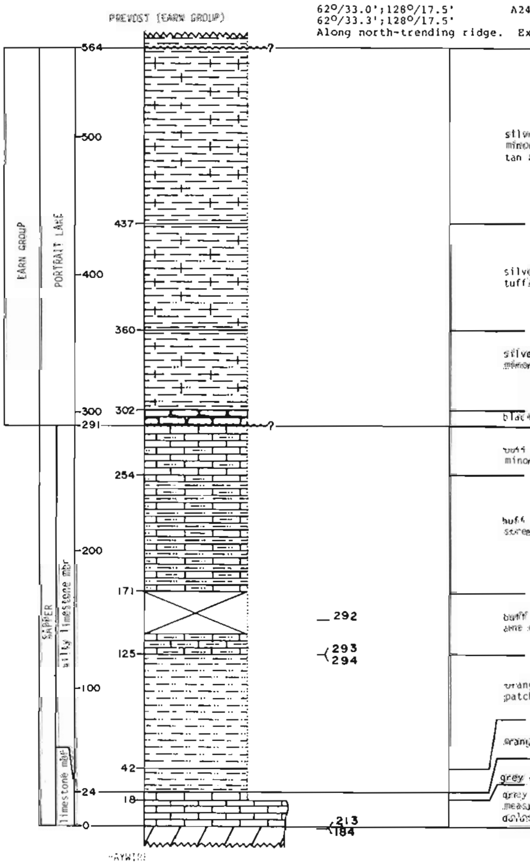
buff-orange weathering silty to argillaceous limestone, faintly laminated on weathered surfaces in orange, rust, or grey; minor black weathering black limestone strikingly laminated in grey and white; minor bioclastic limestone; base of section estimated at highest level of float of limestone of underlying unit

greyish purple to dark mauve weathering porcelaneous black finely crystalline limestone

289	325.5	Early Devonian, Dalejan, *serotinus* Zone
290	318–324	mid-Emsian of Early Devonian to earliest Eifelian of early middle Devonian
291	145	late Lochkovian to early Zlichovian of the Early Devonian
212	-5	late Early to early Late Silurian, Latest Llandovery-early Wenlock, *amorphognathoides* Zone

SECTION 49

62°/33.0';128°/17.5' A24778-126 (37,50) 105 I-9 meas: P.F. Coleman desc: D.H. Wood
62°/33.3';128°/17.5' (37,41)
Along north-trending ridge. Exposure very poor.



silvery grey, gun blue, and rusty weathering, black, siliceous shale; minor outcrop; top of section at contact in scree with overlying brown to tan weathering, dark brown shale

silvery grey, gun-blue, and tan weathering, black, locally silty and/or tuffaceous (?), siliceous shale

silvery grey to tan weathering, black, silty, siliceous shale; covered with minor scree

black weathering, black chert; minor scree patches

buff to grey weathering, dark grey, fine crystalline, poorly laminated limestone; minor outcrop

buff and grey weathering, grey, laminated, calcareous siltstone to silty limestone; scree patches

buff to grey weathering, dark grey, silty limestone; platy scree; top 30 m are covered

orange and grey weathering calcareous siltstone and silty argillite; scree patches

orange weathering calcareous siltstone

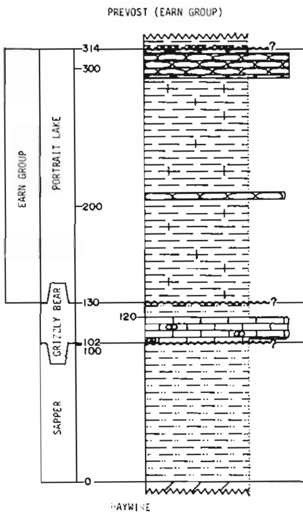
grey weathering limestone similar to that in unit 1; scree patches

grey weathering, dark grey, fine to medium crystalline limestone; base of measurement at contact with light grey weathering, grey, fine crystalline dolostone of the Haywire Formation; top 1 m of Haywire is dolostone breccia

292	150	*australis* Zone to Lower *varcus* Subzone (middle Eifelian to early Givetian, Middle Devonian)
293	124.5	Late Early Devonian through Mississippian
294	124.5	Lower *varcus* Subzone (early Givetian, early Middle Devonian)
213	0-1	Early Silurian, late Llandovery, *celloni* Zone
184	-1.5	Silurian or extremely late Ordovician

SECTION 50

62°/19.1';128°/0.2'   A24801-73   (37,-57)   105 I-8   meas: S.P. Gordey   desc: S.P. Gordey
62°/18.7';128°/0.5'   (33,-68)
Measured perpendicular to northwest trending ridge.



blue-black to black weathering, black siliceous shale, and black chert; top 15 m of unit is resistant rust and grey weathering, thin bedded (3-5 cm) black chert with shaley partings; a similar 5 m thick interval occurs in middle of unit (location approximate); top contact with overlying recessive, brown weathering, dark shale of the Prevost Formation is sharply delineated in scree

tan to orange weathering, tan siltstone

blue-grey weathering, black, finely crystalline, thin-bedded limestone; bedding 0.1 m thick or less; 10% of unit is thin beds of argillaceous to silty black limestone; about 15% of limestone is crinoidal, some crinoid stem fragments having twin axial canals; outcrop distribution approximate

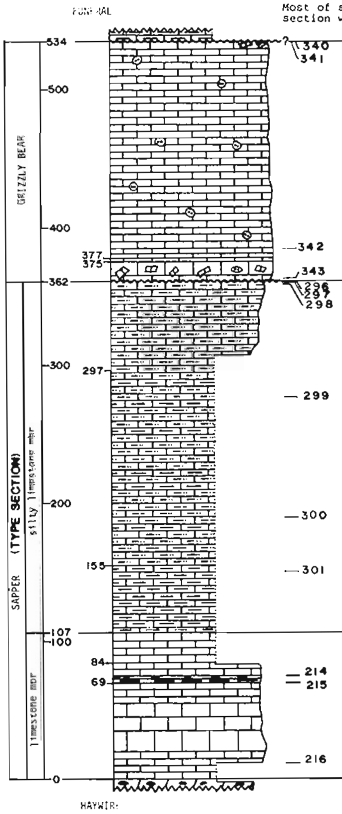
— 295

orange to tan weathering, tan to black, faintly laminated, graptolitic siltstone; distribution of scree exposure is patchy, the best exposure being near the overlying unit; estimated basal one-fourth of unit very poorly exposed as rare scree; base of section is very poorly exposed in moss-covered saddle, coincident with nearly lowest point of elevation; basal boundary placed by distribution of dolostone float and siltstone float in solifluction lobes and patterned ground

295	70	probably Late Silurian or Early Devonian

SECTION 51

62°/42.2';128°/25,6'   A24778-47   (32,40)   105 I-9   meas: P.F. Coleman   desc: S.P. Gordey
62°/42.2';128°/26.5'   (22,42)
Most of section measured southwesterly up a spur of the main north trending ridge. The uppermost part of the section was measured north-northwesterly along the ridge.



grey to blue-grey weathering, dark grey, crinoidal limestone; abundant crinoid stem fragments with twin axial canals; bedding defined by 0.1-0.03 m thick, even parting; at one locale the top 5 m of the unit is a limestone breccia with subrounded grey limestone clasts commonly to 0.1 m diameter and abundant crinoid and coralline fossil debris; contact with bright orange weathering shaly limestone of the Funeral Formation is abrupt; above the measured section small lenses of Grizzly Bear Formation occurring within the Funeral Formation are interpreted as small fault slices

grey weathering, grey, fine crystalline, burrowed limestone; laminated in light to dark grey

blue-grey weathering limestone breccia; subrounded, irregular-shaped clasts of dark grey fine- to coarse crystalline limestone (to 0.2 m diameter) and large crinoid stem fragments (including fragments with twin axial canals) rest in a slightly darker weathering, limestone matrix; breccia is apparently clast supported; the lowermost part of this interval, resting sharply above the underlying unit, is a lime-mudchip breccia with scattered lime mudstone clasts that persist a few centimeters upward above the base of the formation; the mudchip breccia passes rapidly upward into the coarse breccia

buff-orange to grey weathering, grey to black, fine crystalline, laminated, silty limestone; conchoidal fracture; resistant outcrops form ribs on cliff face beneath overlying unit

buff-orange to tan weathering, greyish balck, laminated, argillaceous to silty limestone; rare pink weathering limestone of similar type; section predominantly scree but includes rare poor outcrop

black weathering, black, fine crystalline, platy, argillaceous limestone

float, within predominantly grass-covered interval of blue-grey weathering, black, very fine- to fine crystalline limestone similar to that of underlying unit

blue-grey weathering, black, very fine- to fine crystalline limestone; bed thickness about 0.1 m; basal 2 m of unit are black graptolitic shale with two thin interbeds of black chert; black graptolitic shale also from 75-76 m.

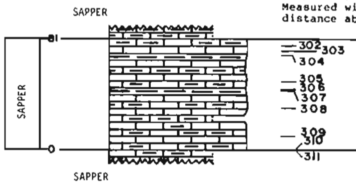
grey weathering, black, very fine- to fine crystalline limestone; bed thickness 0.1 to 0.5 m; bedding defined as a wavy and irregular parting with minor pinch and swell; minor orange weathering, blue-grey, fine crystalline limestone with rounded blue-grey weathering limestone nodules to 0.1 m diameter; base of section at topmost outcrop of underlying grey weathering dolostone (with chert nodules) of the Haywire Formation

340	534	dysmorphostrota Zone, late Eifelian, early Middle Devonian
341	534	Middle Devonian, Eifelian, c. costatus-?Australis Zones
342	384	Early Devonian, late Zlichovian-Dalejan, inversus-serotinus Zones
343	363	Early Devonian, late Zlichovian-early Dalejan, inversus Zone
296	360	Early Devonian, Pragian, kindlei Zone
297	360	late Lochkovian to Pragian of the Early Devonian
298	358.5	Pragian of Early Devonian to Frasnian of early Late Devonian
299	277	Early Devonian, probably Lochkovian
300	189	Middle Silurian, late Wenlock
301	150	late Early Silurian, latest Llandovery, late Monograptus spiralis Zone
214	75	late Early Silurian, latest Llandovery, Monograptus spiralis Zone
215	69	Middle Ordovician to Early Silurian
216	12	Ordovician-Silurian

SECTION 52

62°/47.5';128°/9.1'   A24778-59   (-13,107)   105 I-16   meas: B.S. Norford   desc: B.S. Norford
62°/47.4';128°/9.0'   (-12,105)

Measured within talus slope on northeast side of northwest-trending ridge. Base of section thought to be a short distance above top of the Haywire Formation section thought to fit within the interval 585-685 m of section 34.



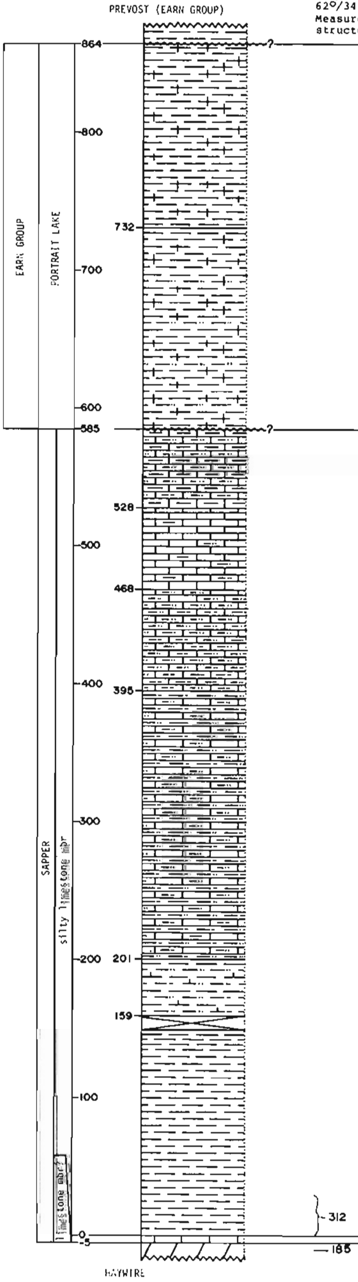
limestone, argillaceous, microcrystalline, dark grey, weathers dark grey, grey and yellowish grey, recessive, platy; bedding 1-30 cm. Interbedded very limy shale amounts to 1 to 20% of different parts of sequence, poorly fissile, weathers light grey, grey, yellowish grey, greyish orange pink. At 43 and 44 m thin nodular limestone, less recessive. At 16 m, thin layers of chert within a limestone bed. Scree-covered intervals at 77-80 m, 72-75 m, 20-25 m, 10.5-12 m, 3.5-5.5 m, 2-3 m and above and below stratigraphic section. Rare graptolites, rarer brachiopods.

302	75.5-76.5	Middle Silurian, Wenlock
303	71.5	Middle-Late Silurian
304	68.0-68.05	late Early or Middle Silurian, late Llandovery to Wenlock
305	48.00-48.25	Middle Silurian, Wenlock
306	44.00-44.05	Early or Middle Silurian, Llandovery to Wenlock
307	43	late Early to early Middle Silurian, latest Llandovery-early Wenlock _amorphognathoides_ Zone
308	30.50-36.55	Silurian
309	10.5-10.6	Silurian
310	0	late Early Silurian, Late Llandovery, _M. spiralis_ Zone
311	0	late Early-early Middle Silurian late Llandovery-early Wenlock, _celloni-amorphognathoides_ Zones

SECTION 53

62°/33.2';128°/22.3'   A24778-126   (-21,-46)   105 I-9   meas: P.F. Coleman   desc: D.H. Wood
62°/34.1';128°/22.7'   (-25,-22)

Measured along recessive weathering north trending ridge. Exposure is very poor and there is possibility of unseen structural complications. Although not shown there is minor scattered outcrop.



silvery grey to gun-blue weathering, black, cherty argillite; top of section at contact in scree with overlying rusty brown weathering argillite

silvery grey weathering, black, siliceous, silty argillite; locally bioturbated; orthocone cephalopods numerous; minor tan weathering, brown siltstone

black weathering, black very fine crystalline, argillaceous to silty limestone; minor outcrop

black weathering limestone

orange to grey weathering, dark grey, medium crystalline, silty limestone

buff to orange weathering, dark grey calcareous siltstone and silty limestone

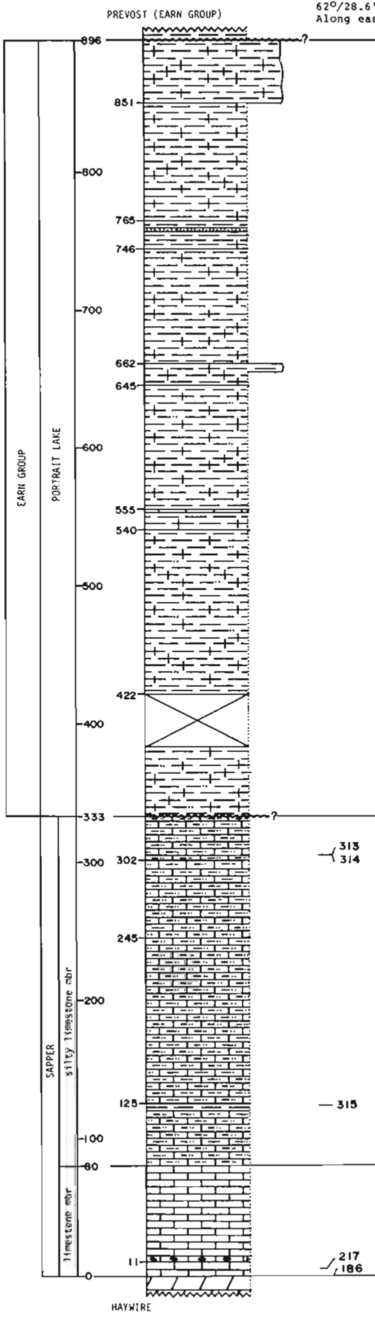
grey to orange weathering, calcareous siltstone and argillite

grey weathering, black, graptolitic shale; minor thin bedded, grey limestone; top 10 m of unit are covered; base of section at contact with dark grey weathering, dark grey, recrystallized limestone (5 m) beneath which is grey to dark grey weathering, dark grey dolostone

312	1-30	late Silurian, Ludlow
185	-30-0	Silurian

62°/28.4';127°/59.1' A24800-33 (17,-28) 95L -5 meas: D.H. Wood desc: D.H. Wood
62°/28.6';127°/58.0' (33,-21)
Along east trending ridge. Exposure is poor and there is possibility of unseen structural complications.

SECTION 54



grey and rust weathering, grey siliceous argillite; top of section at contact with brown weathering scree of dark brown to dark grey argillite

silvery grey to gun-blue weathering, dark grey, siliceous argillite; grass-covered with scree patches

silvery to bluish grey weathering, dark grey, siliceous argillite and minor (?) very fine grained black chert arenite; unit predominantly scree with scattered outcrops

silvery to blue-grey weathering siliceous argillitic; grass-covered with scree patches

silvery to bluish grey weathering, grey to dark grey, siliceous argillite

silvery grey weathering, grey to dark grey, silty to cherty argillite; grass-covered with scree patches

silvery grey weathering, grey, silty, siliceous argillite; 1.5m thick bed of dark grey weathering, dark grey, fine crystalline limestone at top of unit

silty siliceous argillite

silvery grey weathering, grey, silty, siliceous argillite, unit is scree for first 50 meters, then covered

dark grey weathering, dark grey to black, fine crystalline, laminated silty limestone; unit mostly scree with some outcrop

dark grey to buff weathering, dark grey to black, fine- to very fine crystalline, fossiliferous, laminated, silty limestone

platy buff weathering scree of dark grey fine crystalline, silty, laminated limestone

buff to orange weathering, buff to dark grey, fine crystalline, silty, laminated limestone and grey and rust weathering, dark grey, fissile shale; mostly shale above 120 m; shale graptolitic

dark grey weathering, dark grey to black, fine crystalline, poorly laminated, fetid limestone; basal 1.5 m of unit are black, banded to nodular, chert in dark grey limestone; unit mostly scree with scattered outcrop

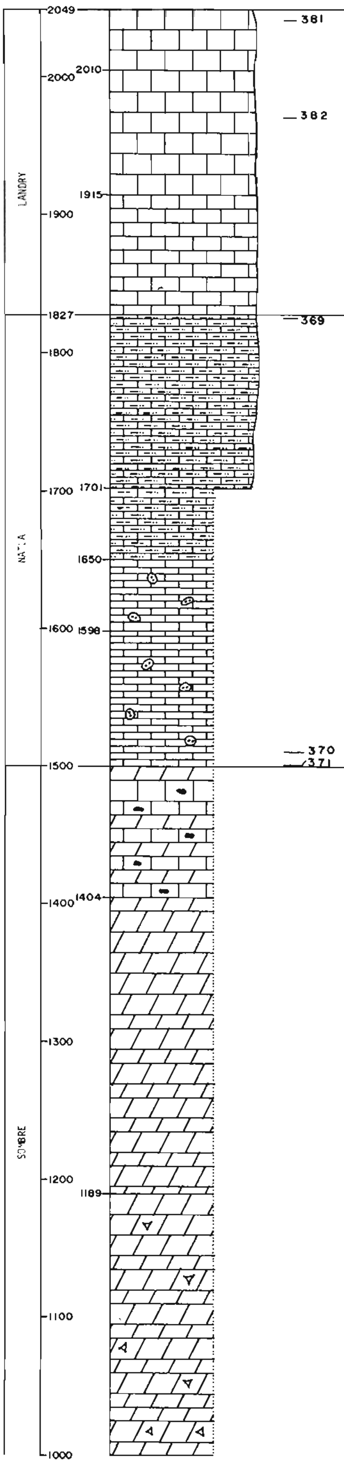
dark grey weathering, dark grey, medium crystalline fossiliferous limestone; unit is predominantly scree with scattered outcrop; contact with underlying light grey weathering, grey dolostone of the Haywire Formation is in scree

313	301- 305	Early Devonian, late Pragian-early Zlichovian, *dehiscens* Zone
314	301- 306	late Lochkovian to Pragian of the Early Devonian
315	122- 125	Late Silurian, Ludlow
217	5	probably late Middle or Late Ordovician, Caradoc or Ashgill
186	0- -7	Middle to Late Ordovician

SECTION 55

top of exposure

62°/54.5';128°/19.7'   A24516-47   (-14,66)   105 I-16   meas: J.G. Beekmann   desc: D.H. Wood
63°/0.4';128°/16.5'   (28,94)
Section measured northeasterly along ridge. Distribution of outcrop shown is approximate.



buff to grey weathering, grey, fine- to coarse crystalline, thick bedded, crinoidal limestone; top of section at top of slope

dark grey to orange and pastel red weathering, grey to black, very fine- to fine crystalline, thick bedded (0.2 - 0.5 m), porcelaneous limestone; locally poorly laminated and silty; sparsly crinoidal at top of unit

dark grey with minor orange and pastel pink weathering, dark grey, very fine crystalline, medium bedded (0.1 - 0.2 m), porcelaneous limestone

dark grey to buff weathering, dark grey, silty limestone; dark grey weathering brecciated limestone at top of unit

dark grey, platy weathering scree (?) of black, very fine crystalline, laminated, silty limestone; fewer crinoid stem fragments toward top of unit; dacryoconarids on bedding plane surfaces of platy scree are common

dark grey, with minor pink, blocky weathering talus of black, very fine- to fine crystalline bioclastic to sparsely crinoidal limestone; crinoid stem fragments showing twin axial canals common throughout unit

dark grey, blocky weathering talus of black, fine crystalline, bioclastic limestone; contains abundant crinoid stem fragments with twin axial canals

mixed scree of dark grey to reddish weathering, black, fine crystalline limestone, and light grey weathering, light grey, dolostone, similar in appearance to the dolostone in the underlying unit; the limestone contains approximately 2% black chert nodules

underlain mostly by scree of light grey weathering, light grey, fine crystalline, sparsely crinoidal dolostone; scree becomes blockier near top of unit

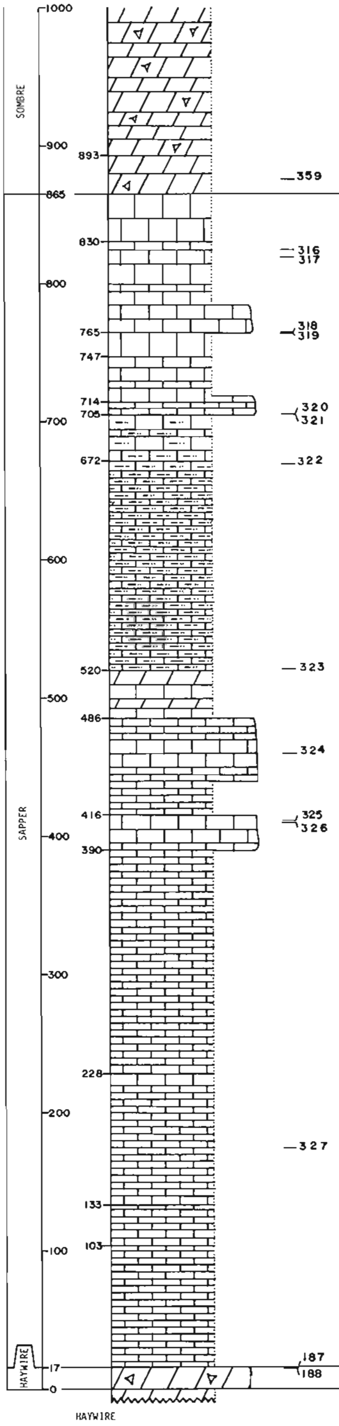
partially scree covered, underlain mostly by light grey weathering scree of light grey, fine crystalline, vuggy dolostone similar to that in underlying unit; some outcrop near top of unit

381	2042	Middle Devonian, Eifelian, c. costatus-australis Zones
382	1971	Middle Devonian, Eifelian, c. costatus-australis Zones
369	1825	Middle Devonian, Eifelian, c. costatus-australis Zones
370	1510	Pragian to Frasnian of the Devonian
371	1502	Early Devonian, late Zlichovian-early Dalejan, inversus-serotinus Zones

(continued)

SECTION 55

(continued)



black, light grey weathering talus of light grey, fine- to medium crystalline, vuggy dolostone; vugs partially filled with calcite; top of unit mostly covered

dark blue -grey weathering, dark grey, fine- to medium crystalline, thick bedded (0.3 - 0.5 m), bioclastic limestone; minor orange to buff weathering dark grey, fine crystalline, thin bedded, limestone

dark grey and brick red to pink weathering, black, very fine- to fine crystalline, thin (red weathering) to thick (dark grey weathering) bedded limestone; dark grey weathering limestone bioclastic; dacryoconarids at 830 m

light grey, blocky weathering scree and some outcrop of coralline limestone

mixed scree of light grey and pink to bright orange limestone; top of unit at contact in talus with light grey blocky weathering coralline limestone

dark grey weathering, black, fine crystalline, thin- (80% is 1.5 cm) to medium (20% is 0.2 m) bedded, fossiliferous limestone

mixed scree of orange weathering, silty limestone and blue-grey to buff weathering, bioclastic limestone similar to underlying unit; end of unit at break in slope where talus becomes more platy

mixed scree of orange weathering, dark grey, fine crystalline, laminated to thin bedded, silty limestone and blue-grey to buff weathering, black, fine- to medium crystalline bioclastic limestone; some outcrop at the top of the unit

mixed scree of light grey, blocky weathering, light grey, medium crystalline, vuggy dolostone and dark grey fossiliferous limestone

blue-grey and pastel pink and yellow weathering, black, very fine crystalline, thin bedded, in part laminated, porcelaneous limestone; below 440 m unit is predominantly scree; between 450 and 470 m unit is medium bedded (0.1 m) and fossiliferous

light grey, pink, and orange weathering, dark grey, medium bedded (0.2m), limestone; unit becomes coarse crystalline and fossiliferous toward top; unit partially scree covered; poor outcrop

mixed scree of blue-grey to pastel pink and yellow weathering, black, very fine- to medium crystalline porcelaneous limestone (50%), buff and grey platy weathering, dark grey limestone (40%), and buff to rusty grey weathering, dark grey, fine- to medium crystalline, crinoidal limestone (10%)

blue-grey weathering, black, very fine crystalline, porcelaneous limestone, and buff weathering platy limestone;

scree of buff to grey weathering, black limestone similar to that of underlying unit

buff to grey weathering, black, cryptocrystalline, sparsely crinoidal limestone; unit is predominantly scree covered with some poor outcrop

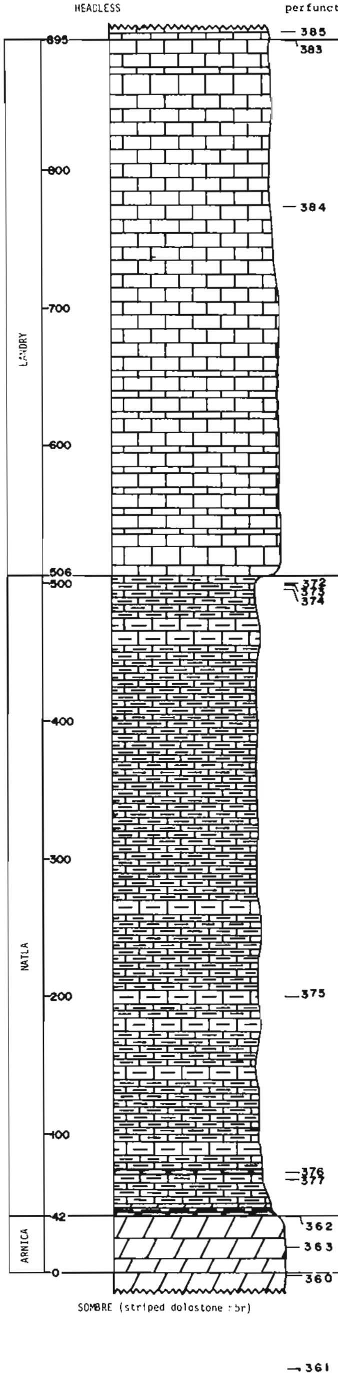
grey weathering, dark grey to black, fine- to medium crystalline, medium bedded (0.1 - 0.2 m), vuggy dolostone

359	877	Early Devonian, Pragian, kindlei Zone
316	826	Devonian
317	820	probably Pragian, Early Devonian
318	766	Silurian-Devonian (L)
319	764	Silurian-Early Devonian
320	706	mid-Lochkovian, Early Devonian
321	706	Early Devonian, middle Lochkovian (eurekaensis to delta Zones)
322	670	Lochkovian to Pragian, Early Devonian
323	521	Lochkovian to Pragian, Early Devonian
324	460	late Pridolian, late Late Silurian
325	412	Late Silurian, Ludlow
326	410	Pridolian, Late Silurian
327	174	Ordovician or Silurian
187	16.5	probably Late Ordovician
188	16	probably Ordovician

62°/56.7';128°/0.2'   A24516-49   (37,2)   1051-16   meas: B.S. Norford   desc: B.S. Norford
62°/57.3';128°/3.9'   (-10,14)

Section was examined along a long westward trending ridge crest; one fossil collection (C-092575) is from a subsidiary ridge crest one half km to the south and correlated into the measured section. Comments are perfunctory and complimented by descriptions of the same section by Gabrielse (Section 33, 1973).

SECTION 56



base picked at resistant light grey weathering limestone conformably above thinly bedded, recessive limestone with greyish black talus, From 7 to 22 m above base of Landry, thickly bedded (200-300 cm) biostromal limestone with about eight percent vuggy porosity, large clumps of colonial rugose corals, some not in growth position. Rugose and tabulate corals are abundant virtually throughout the Landry, silicified in some beds; echinoderm debris, brachiopods and trilobites locally are common. Top of section at conformable base base of overlying generally recessive, thin bedded limestone of the Headless Formation

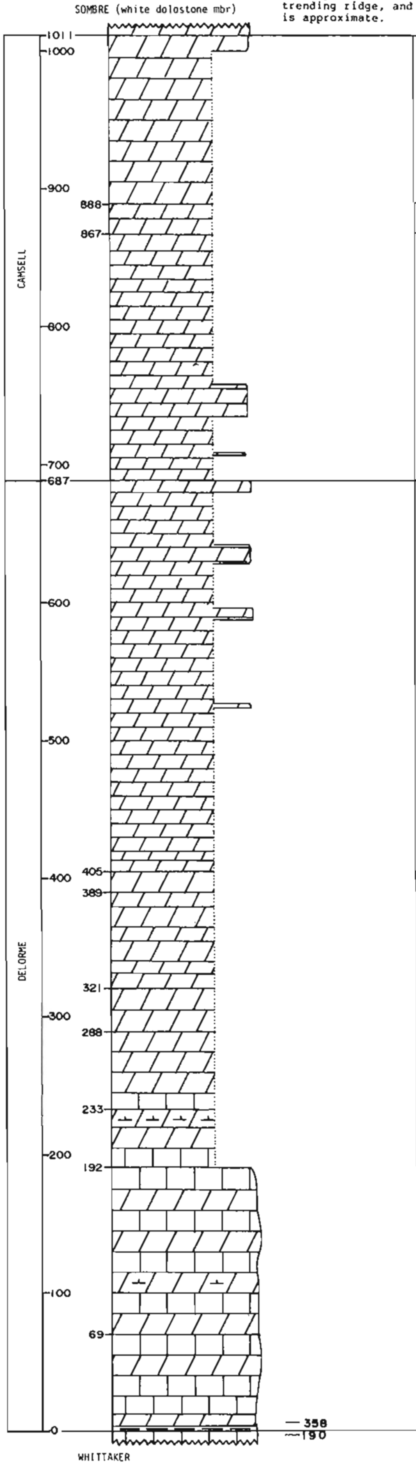
limestone, mostly argillaceous, aphanitic to microcrystalline, dark grey, weather light olive-grey, light grey, pale yellowish grey, olive-grey, pale reddish brown, recessive, platy; bedding 1-30 cm, some beds laminated. Interbedded very limy shale amounts to 5 to 100 per cent of various levels of the formation, poorly fissile, weather dark grey, reddish orange. Interbedded greyish black chert amounts to up to 2 per cent of basal 80 m. Basal 10 m platy argillaceous dolostone, dolomitic shale and bedded chert. Blocky weathering limestone at 463-476 m; discrete limestone mounds within bedded sequence at 195-205 m; depositional slump structures at 227-265 m indicate slope deposition. Tentaculitids common from 52-424 m; two-hole crinoids observed at 227, 198 m. Rugose and tabulate corals, brachiopods, trilobites, echinoderm debris (including long coherent stems) present at various horizons. Basal contact concordant, picked at lowest chert bed in platy dolostone sequence above thickly bedded resistant Arnica dolostone.

dolostone weathers dull olive-grey and dull grey, resistant; bedding 50-150 cm; white dolomite as stringers and filling vugs; sparse chert. Base of section at top of highest bed of very light grey weathering dolostone in a sequence of such dolostone interbedded with dull grey weathering dolostone.

385	900	Middle Devonian
383	895	Middle Devonian
384	773	Middle Devonian, Eifelian-Givetian, australis-L. varcus Zones
372	490-500	Middle Devonian, Eifelian to early Givetian
373	498	Middle Devonian, Eifelian, probably australis Zone
374	496	Middle Devonian
375	198-200	Middle Devonian, Eifelian, patulus-c. costatus Zones
376	71.5-72	Dalejan, late Early and earliest Middle Devonian
377	30-71.5	Early Devonian, late Zlichovian-Dalejan, inversus-serotinus Zones
362	42	Early Devonian, late Zlichovian-early Dalujan, inversus Zone
363	18	Early Devonian, late Zlichovian-early Dalejan, inversus Zone
360	-5-0	Early Devonian, late Zlichovian-early Dalejan, inversus Zone
361	aprox. -70	Early Devonian, late Pragian-Zlichovian, dehiscens-gronbergi Zones

SECTION 57

62°/59.8';127°/56.0' A24516-49 (89,90) 95L-13 meas: D.H. Wood desc: S.P. Gordey
63°/0.0';127°/58.9' (55,97)
Lower part of section measured upslope along southwest trending ridge, middle part along the connecting northwest trending ridge, and upper part along the connecting west-southwest trending ridge; distribution of outcrop shown is approximate.



alternating dark grey, black, and white weathering (in intervals 1.5-5 m thick), black to light grey, fine crystalline, massive to laminated dolostone; size of blocky felsenmeer probably caused by 0.1-0.2 m thick parting; top of the Camsell Formation is placed at the top of the highest black weathering, black dolostone bed above which is mostly grey-white weathering dolostone (Sombre Formation)

dark grey to black weathering, dark grey to black, fine crystalline dolostone; from 879-882 m is black weathering, black dolostone breccia with clasts to 3 cm diameter

grey, yellowish white and lesser black weathering, grey to black, fine crystalline dolostone; bedding defined as 0.1-0.2 m thick parting; from 807-808.5 m and 836-837 m are thick beds of yellow weathering, very rubbly and cavernous weathering, massive dolostone (breccia?); top of interval marks a change from overall grey weathering to overall dark grey to black weathering

orange, yellow, grey and tan weathering (predominantly the first two), grey, fine crystalline, fine laminated dolostone; rare, pale green, mudcracked, thin shale interbeds and partings and minor mudchip conglomerate; bedding defined as 0.1-0.3 m thick parting; from 551-554 m is pale green weathering, blue-green shale; from 642-680 m unit includes much black weathering, black, fine crystalline dolostone; upper contact of the Delorme Formation is placed at top of small bench of yellow weathering dolostone that is overlain by black weathering, black, fine crystalline, laminated dolostone of the Camsell Formation; above the contact the weathering color is mostly grey, immediately below it is mostly yellow

red-orange to orange weathering, grey, fine crystalline dolostone

orange to tan weathering, mostly grey weathering above 351 m, grey, fine crystalline dolostone; rare outcrop shows bedding defined by parting thicker than 0.2 m; top of interval is on hilltop where there is a color change from tan-orange weathering to red-orange weathering in felsenmeer

bright orange weathering, pale grey-green, very fine- to fine crystalline dolostone; rare outcrop shows bedding from 0.5-1.0 m thick; from 300-300.6 m is conspicuous bed of black weathering, black, fine crystalline limestone; interval capped by similar limestone bed 0.3 m thick

same as interval from 69-192 m except that above 255 m dolostone is predominant and becomes very bright orange weathering; top of interval is at top of 0.5 m thick bed of grey weathering, light grey, fine crystalline limestone

predominantly grey with some tan weathering, grey, very fine crystalline dolostone, calcareous dolostone (predominant?) and limestone

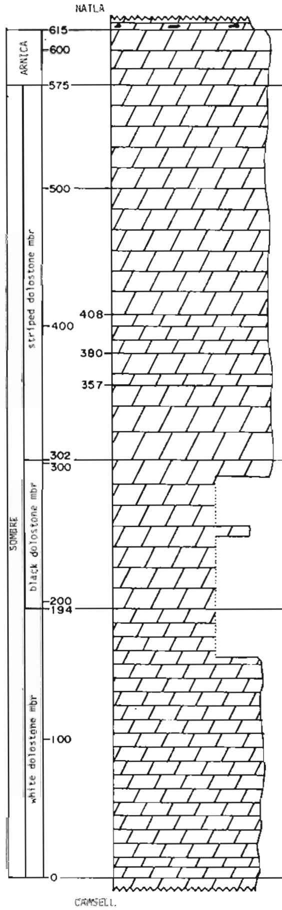
alternating (in units 3-5 m thick) blue-grey and buff-orange to tan weathering, light grey to light greenish grey, very fine- to fine crystalline, massive to finely laminated limestone; rarely the more orange weathering beds are dolostone or calcareous dolostone; parting within units is thin to thick

predominantly grey weathering with some orange weathering, grey, fine crystalline, thick bedded limestone, dolomitic limestone and minor? dolostone; at base of section is minor pale green shale, and maroon to grey-green, fine crystalline dolostone, limestone and calcareous dolostone; base of Delorme Formation corresponds to a weathering color change as seen from a distance from light grey (Whittaker Formation; here limestone at the top) to overall tan to orange weathering

358	6	Late Silurian, Pridolian-Early Devonian, mid-Lochkovian
190	-3	Probably Middle Silurian to Early Devonian

SECTION 58

62°/57.7';127°/58.8'   A24516-49   (48,30)   95L-13   meas: S.P. Gordey   desc: S.P. Gordey
62°/57.8';128°/0.6'   (26,29)
Along east trending ridge



dark grey to black weathering, black, fine crystalline, vuggy dolostone; vugs to 5 cm in diameter and lined with small white dolomite crystals; vuggy porosity reaching 10-15%, although vugs apparently not well interconnected; bedding by thick parting; base of the Arnica Formation is at the top of the highest white dolostone bed of the underlying Sombre Formation; top of the Arnica Formation is at a small grassy knoll at a change from thick bedded dolostone to black weathering, black, evenly bedded, thin bedded dolostone with thin beds and nodules of black chert (basal Natla Formation)

alternating in beds 1.5-2.0 m thick (locally to 4.0 m thick) are dark grey to black, or white weathering, light grey to black, very fine- to fine crystalline dolostone; white dolostone is commonly delicately laminated; black dolostone is commonly laminated near the base of the unit, but becomes more massive upwards and is locally riddled with amphipora-like, tubular white carbonate fillings (to 30-40%)

alternating in beds 0.5-1.5 m thick are black, yellow, and white weathering, black to grey, fine crystalline dolostone; beds internally are massive to delicately laminated

yellow-white and white weathering, fine crystalline, medium bedded dolostone; minor evenly interbedded black weathering, black, fine crystalline dolostone; bedding defined by 0.2 m thick parting

yellow-white weathering, grey, fine crystalline, medium to thick bedded dolostone; at 357 m, 371 m and 380 m are dark grey to black weathering, grey, fine crystalline dolostone in single beds 0.5-1.0 m thick

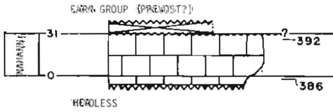
white weathering, grey, very fine- to fine crystalline, thick bedded dolostone; beds are internally massive to delicately laminated

grey to black weathering, dark grey, fine- to medium crystalline, fetid, bioclastic dolostone; bioclasts include some crinoid stem fragments, but are mostly unidentifiable fossil hash; also in basal one-half of this unit is abundant tan-brown weathering, tan-grey, fine- to medium crystalline dolostone

white to grey weathering, grey, very fine- to medium crystalline, medium bedded (0.1-0.2 m thick parting) dolostone; beds are internally massive to delicately laminated; above 159 m outcrop is sporadic (20%); base of section is on a small bench just below good cliff face of basal Sombre Formation; base of the Sombre is placed at the top of the highest black weathering, black, fine crystalline dolostone bed of the Camsell Formation

SECTION 59

62°/55.4';128°/4.0'   A24516-48   (83,-36)   105 I-16   meas: S.P. Gordey   desc: S.P. Gordey
62°/55.4';128°/4.1'   (81,-38)
Good exposure adjacent sharp bend in creek

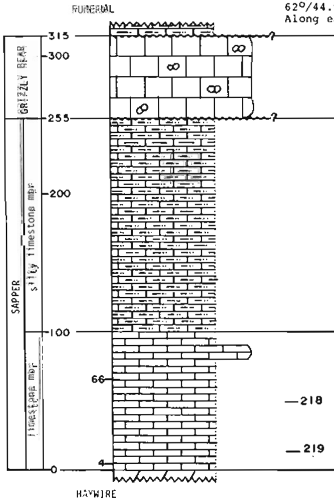


grey weathering, dark grey to black, very fine- to fine crystalline limestone; alternating resistant and recessive weathering intervals of equal thickness averaging 1 m; bedding within recessive intervals defined by 0.15-1 m thick irregular parting, that within resistant ribs by a similar, but more vaguely defined parting; on brief examination formation is sparsely fossiliferous, most common fossil types being crinoids and brachiopods; at 27 m is grey weathering, black, fine crystalline, crinoidal limestone from which conodonts collected; basal contact is gradational and placed at base of lowermost resistant rib above recessive weathering, lithologically similar, Headless Formation; upper contact not exposed, but the recessive, vegetation covered character of the immediately overlying interval suggests it to be shale of the Earn Group (Prevost? Formation)

392	26.6	Middle Devonian, probably Eifelian, australis Zone up
386	-0.5-0	Middle Devonian

SECTION 60

62°/44.8';128°/27.5'   A24778-62   (30,-4)   105 I-9   meas: P.F. Coleman   desc: S.P Gordey
62°/44.9';128°/28.4'   (21,-4)
Along east-trending ridge



grey weathering, dark grey to black, bioclastic, crinoidal limestone; crinoid stem fragments with twin axial canals common; fossil debris includes corals, pelecypods, and brachiopods; top of section at sharp contact with overlying buff-orange weathering silty limestone of the Funeral Formation

buff-orange weathering, green-grey, fine crystalline, laminated in tan to grey, silty limestone; above 153 m rock has pinkish weathering crust; contact with underlying unit is abrupt

blue-grey weathering, black, very fine- to fine crystalline, thin bedded limestone; from 66-78 m very poor exposure of tan weathering, laminated, silty limestone

dark grey to black, locally tan weathering, black, fine crystalline, laminated limestone; platy scree

blue-grey weathering, black, fine crystalline, laminated (in basal 40 m), platy to blocky limestone

grey weathering, grey to black, fine crystalline limestone; quartz-carbonate veins common; blocky scree; contact with underlying black to white dolostone of the Haywire Formation in scree

218	48	Silurian, late Wenlock to early Pridoli
219	13.5	Early Silurian to Early Devonian, Llandovery to Pragian

APPENDIX 4

Paleontological Determinations

The paleontological appendix presents fossil identifications grouped by formation. The formations are arranged in order of age from oldest to youngest. The heading for each fossil identification consists from left to right of: internal reference number, GSC locality number, latitude/longitude or meterage within measured section, and author. For internal reference, fossil localities are numbered within this report sequentially from 1 to 421. For citation purposes, the GSC locality number should be used. Acronyms identify the paleontologist who identified each collection as follows:

WHF	W.H. Fritz (trilobites, archaeocyatha)
MJO	M.J. Orchard (conodonts)
TTU	T.T. Uyeno (conodonts)
BSN	B.S. Norford (graptolites, corals, brachiopods)
AWN	A.W. Norris (dacryoconarids)
AEH	A.E.H. Peddar (Devonian corals)

Figure 4.1 shows the location of fossil localities and corresponding locality numbers.
Figure 4.2 presents summary diagrams of fossil determinations for each formation.

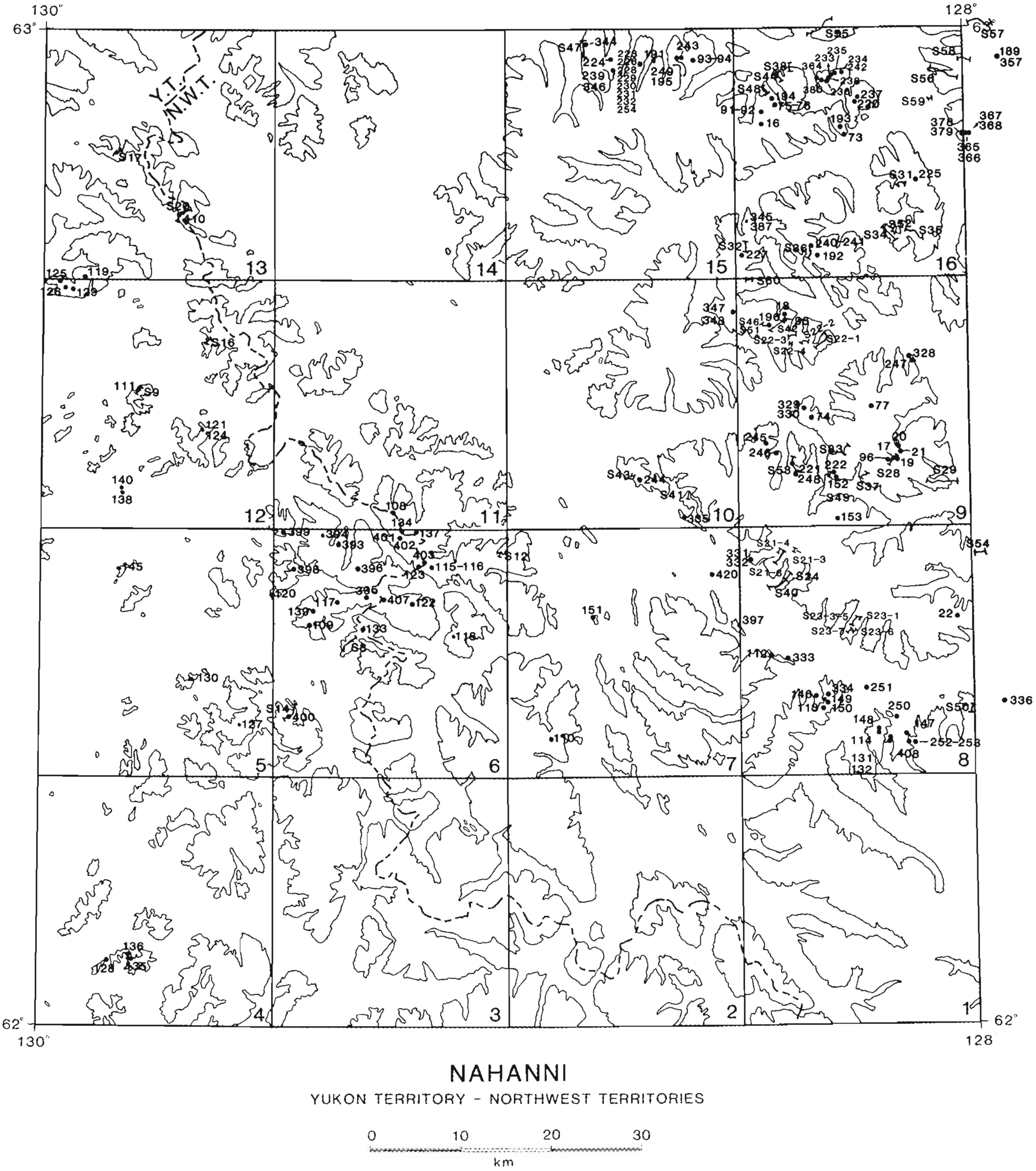


Figure 4.1. Location of fossil localities. Shown for reference are 5000 foot (1524m) topographic contours and 1:50 000 NTS map area (labelled 1 to 16). "S" indicates measured section from which fossils were recovered (eg. 59). Numbers assigned to spot localities correspond to those in Appendix 4.

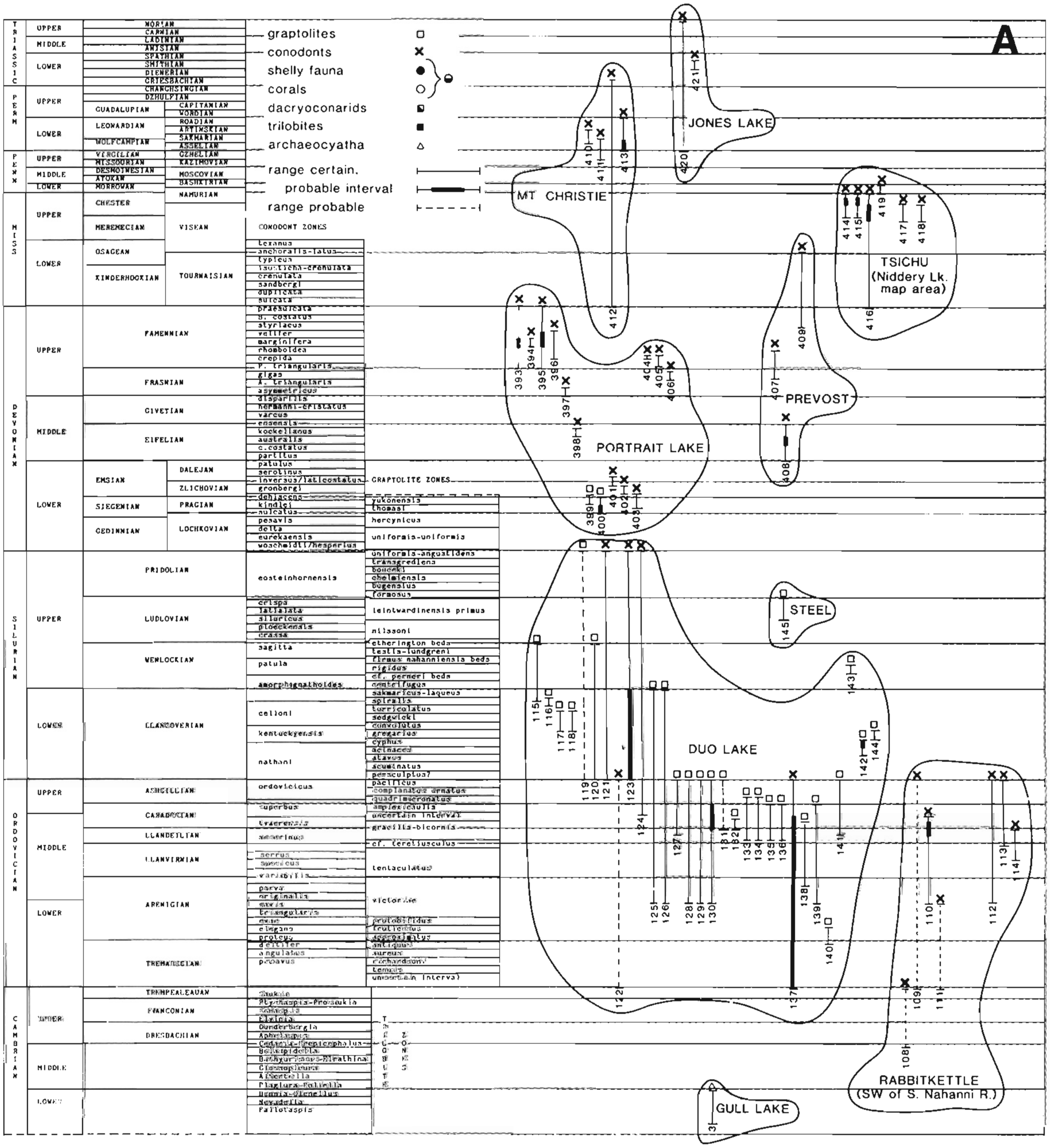


Figure 4.2. Plots af fossil ages. Collection numbers match those of appendix. **A.** Gull Lake, Rabbitkettle (southwest of South Nahanni River), Duo Lake, Steel, Portrait Lake, Prevost, Tsichu, Mount Christie, and Jones Lake formations. **B.** Vampire, Sekwi, Rockslide, Avalanche, Broken Skull, Rabbitkettle (northeast of South Nahanni River), and Haywire formations. **C.** Sapper Formation, **D**. Funeral, Grizzly Bear, Whittaker, Delorme, Sombre, Arnica, Natla, Landry, Headless, and Nahanni formations.

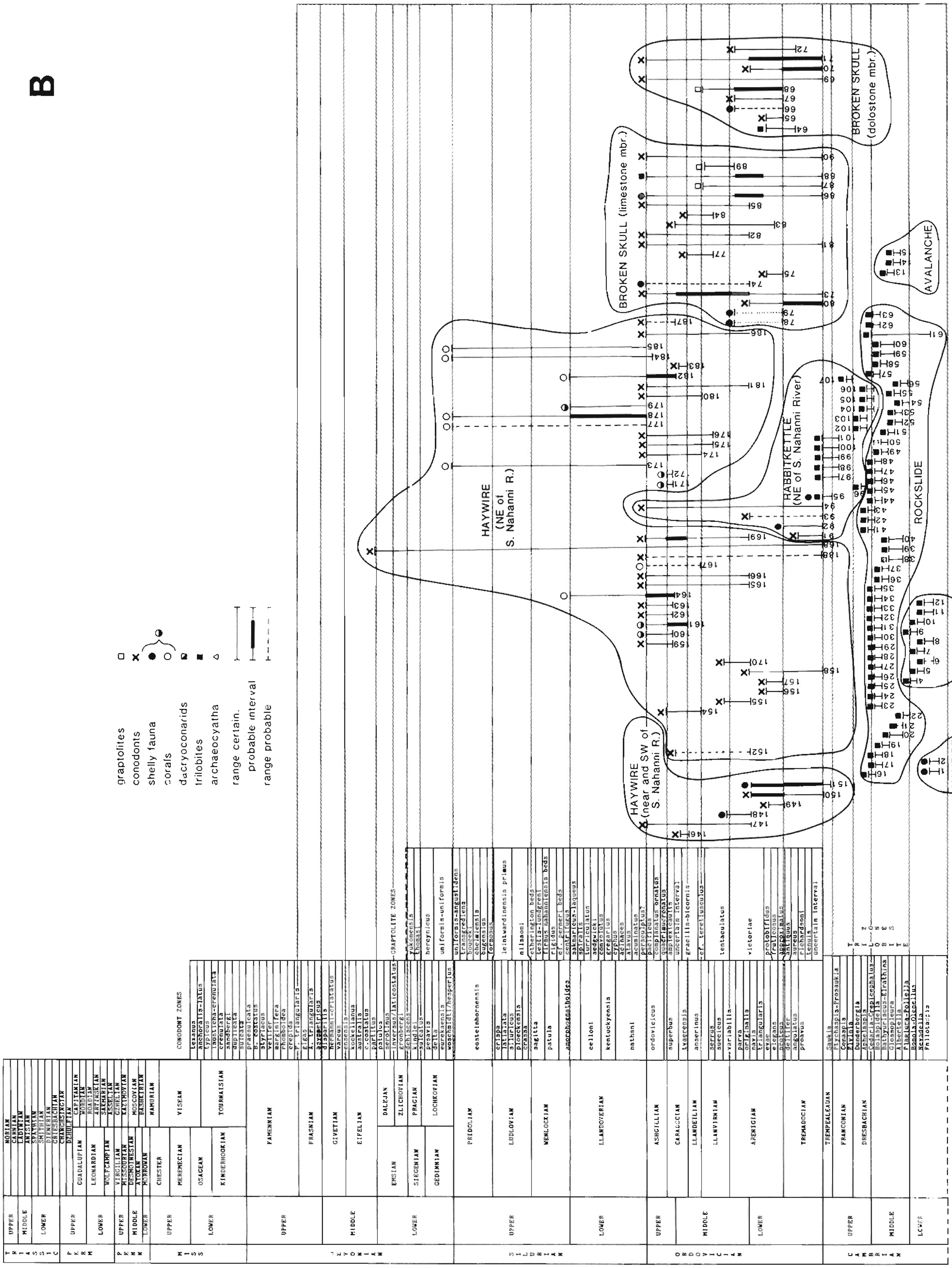


Figure 4.2. Continued.

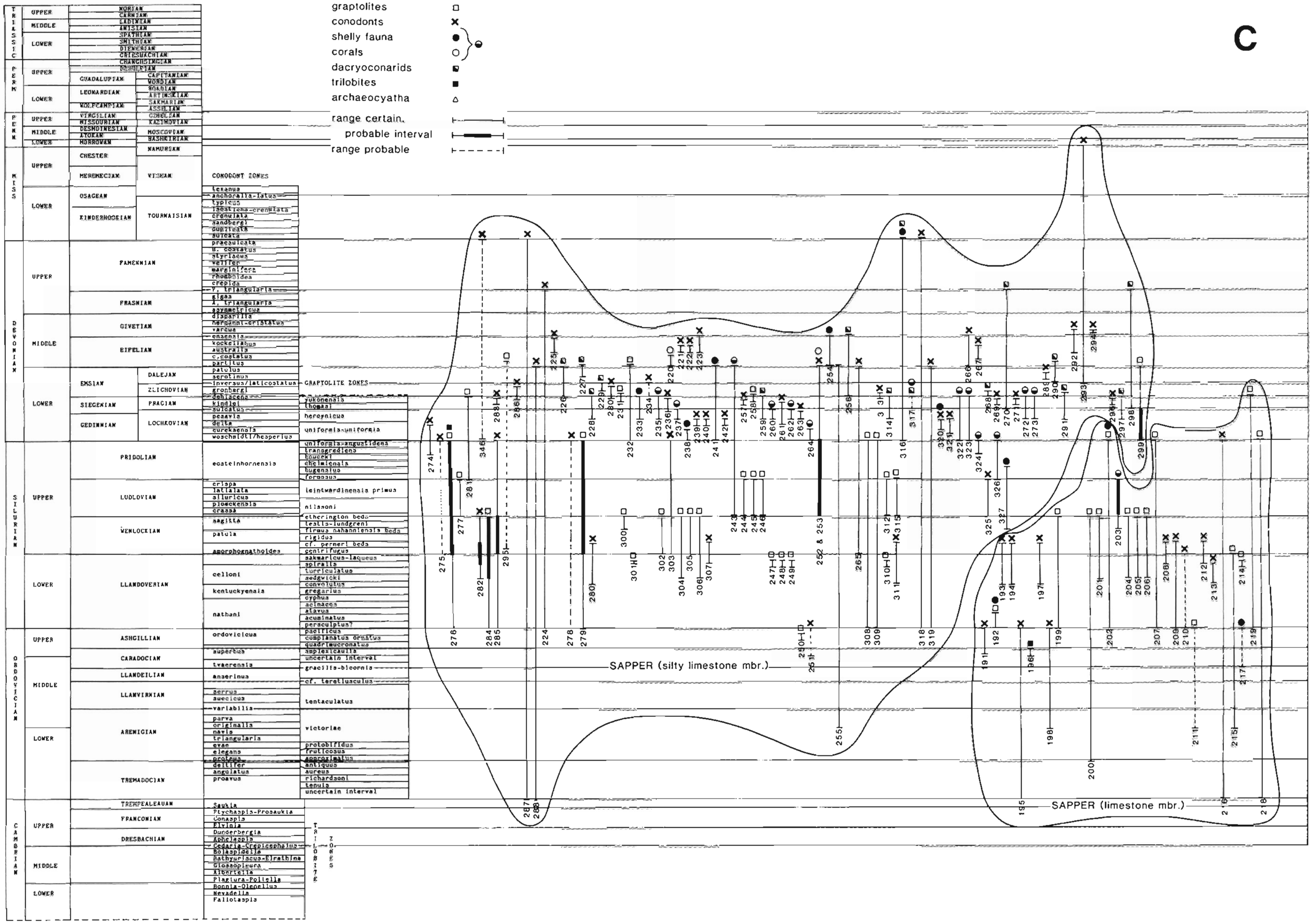


Figure 4.2. Continued.

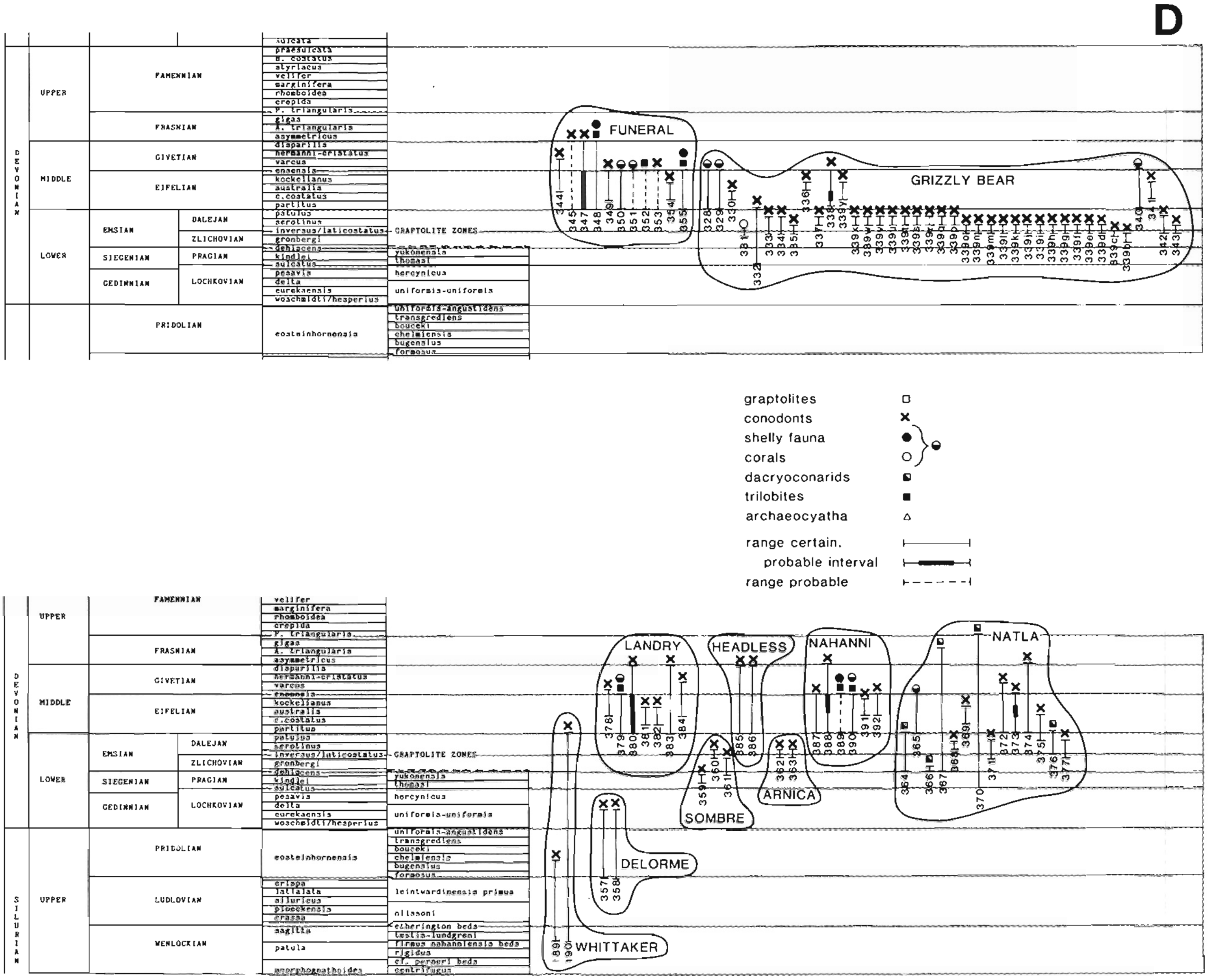


Figure 4.2. Continued.

VAMPIRE FORMATION

Section 23 (62°24.5′;128°14.8′)

1. 96991 232.3 m WHF
cone-shaped impressions, cf. *Circotheca* sp.
AGE: early Early Cambrian

2. 96990 227.5 m WHF
cone-shaped impressions cf. *Circotheca* sp.
AGE: early Early Cambrian

GULL LAKE FORMATION

Section 8 (62°23.5′;129°19.5′)

3. C-083030 0-1 m WHF
Tabulaconus sp.
other archaeocyathids
REMARKS: The range of *Tabulaconus* has not been adequately tested. Thus far I have only noted the genus in the lower part of the *Bonnia-Olenellus* Zone. This correlates with the lower part of grand cycle B2 in the Sekwi Formation. Collected from limestone conglomerate member at base of Gull Lake Formation.
AGE: Early Cambrian

SEKWI FORMATION

Section 21 (62°28.3′;128°23.0′)

4. 95670 606 m WHF
Nisusia sp.
Olenellus sp.
AGE: *Bonnia-Olenellus* Zone, Early Cambrian

5. 95669 336.5 m WHF
Holmiella sp.
Nevadella faceta Fritz
AGE: *Nevadella* Zone, Early Cambrian

6. 95668 232.5 m WHF
cf. *Parafallotaspis* sp.
REMARKS: The assignment of locality 95668 to the *Fallotaspis* Zone is questioned because more fossil material is needed for positive identification. The boundary between the *Nevadella* Zone and the *Bonnia-Olenellus* Zone is tentatively placed in the middle of a thick-bedded quartzite at the top of unit 7 of Section 21. This quartzite is believed to correlate with the quartzite in the lower half (B1) of grand cycle B that is known in numerous sections to the north (Fritz, 1976). Correlations with the northern sections also suggests that the top of the Lower Cambrian in the present section is located at the top of the Sekwi Formation.
AGE: *Fallotaspis* Zone(?), Early Cambrian

Section 22 (62°41.3′;128°19.0′)

7. 96965 562.5 m WHF
Nevadella sp.
AGE: Early Cambrian, *Nevadella* Zone

8. 96964 561 m WHF
Parafallotaspis grata Fritz
REMARKS: Index fossils for many of the Cambrian zones of the North American faunal province are missing in this section, perhaps because of an unsuitable depositional environment. The close proximity of localities 96964 and 96965 clearly demonstrates that the boundary between the *Fallotaspis* Zone and the *Nevadella* Zone is just above the base of the Sekwi Formation. No fossils were found to locate the boundary between the *Nevadella* Zone and the *Bonnia-Olenellus* Zone (same section, Rockslide Formation) but a lithological correlation of the 4.5 m *Skolithos*-bearing quartzite unit with the dated unit to the north (Fritz, 1976) indicates that the boundary is at or near this level.
AGE: Early Cambrian, *Fallotaspis* Zone

Section 23 (62°24.5′;128°14.8′)

9. 96995 645 m WHF
Olenellus sp.
AGE: *Bonnia-Olenellus* Zone, Early Cambrian

10. 96994 422.75 m WHF
Holmiella sp.
Keeleaspis sp.
Kootenia? sp.
Nevadella sp.
Sekwiaspis sp.
AGE: *Nevadella* Zone, Early Cambrian

11. 96993 318-323 m WHF
Parafallotaspis sp.
AGE: *Fallotaspis* Zone, Early Cambrian

12. 96992 322.75 m WHF
Parafallotaspis grata Fritz
AGE: *Fallotaspis* Zone, Early Cambrian

AVALANCHE FORMATION

Section 23 (62°24.5′;128°14.8′)

13. 97000 946.5 m WHF
Amecephalus sp.
Kootenia sp.
Oryctocephalus sp.
Pachyaspis sp.
Zacanthoides sp.
AGE: *Glossopleura* Zone, Early Cambrian

14. 96999 943 m WHF
Achlysopsis sp.
Paralbertella? sp.
Kootenia sp.
Pagetia sp.
AGE: *Albertella* Zone, Early Cambrian

15. 96998 928.5 m WHF
Caborcella sp.
Kootenia sp.
Pachyaspis sp.
Pagetia resseri? Kobayashi
AGE: *Albertella* Zone, Early Cambrian

ROCKSLIDE FORMATION

16. 96962 62°54.2';128°26.3' WHF
Agnostus? sp.
Cedaria sp.
Tricrepicephalus sp.
AGE: *Cedaria-Crepicephalus* Zone, early Late Cambrian

17. 96961 62°34.0';128°09.7' WHF
Bolaspidella sp.
Baltagnostus sp.
Helcionella sp.

Hypagnostus sp.
Modocia sp.
AGE: *Bolaspidella* Zone, Middle Cambrian

18. 96963 62°42.7';128°23.5' WHF
Hypagnostus sp.
Modocia sp.
AGE: *Bolaspidella* Zone, Middle Cambrian

19. 97072 62°34.0';128°09.1' WHF
Bathyuriscus adaeus Walcott
Elrathina sp.
Enmaniella sp.
Kootenia sp.
Pagetia sp.
Tonkinella sp.
AGE: *Bathyuriscus-Elrathina* Zone, Middle Cambrian

20. 97071 62°34.4';128°08.7' WHF
Ogygopsis sp.
Olenoides sp.
Oryctocephalus sp.
Pagetia sp.
Pachyaspis sp.
Peronopsis sp.
AGE: *Albertella* or *Glossopleura* Zone, Middle Cambrian

21. 97068 62°34.2';128°08.5' WHF
Pagetia clytia? Walcott
Paterina sp.
Spencia sp.
AGE: *Albertella* Zone(?), Middle Cambrian

22. 97073 62°24.6';128°01.9' WHF
Fieldaspis celer? (Walcott)
Kochiella? sp.
AGE: *Plagiura-Poliella* Zone, Middle Cambrian
REMARKS: Collection from 30 m thick tongue of Rockslide Formation calcareous siltstone between Sekwi and Avalanche formations.

Section 21 (62°28.3';128°23.0')

Bolaspidella Zone, Middle Cambrian

23. 95688 1307 m WHF
Boltagnostus? sp.
Hemirhodon? sp.
Hypagnostus sp.
Modocia sp.

24. 95687 1275 m WHF
Bolaspidella? sp.
Modocia sp.

25. 95686 1261 m WHF
Hypagnostus? sp.
Modocia sp.

26. 95685 1247 m WHF
Boltagnostus sp.
Eldoradia sp.
Hypagnostus sp.
Modocia sp.

27. 95684 1214.5 m WHF
Hypagnostus parvifrons (Linnarsson)
Modocia sp.

28. 95683 1199 m WHF
Modocia sp.

29. 95682 1197 m WHF
Boltagnostus sp.
Hypagnostus sp.
Modocia sp.

30. 95681 1180 m WHF
Modocia? sp.

31. 95680 1127 m WHF
Modocia? sp.

32. 95679 1079 m WHF
Modocia? sp.

33. 95678 1021 m WHF
Hemirhoden sp.
Modocia sp.
Olenoides sp.
Orria elegans Walcott

34. 95677 1010.5 m WHF
Brachyaspidion sp.
Helcionella sp.
Modocia sp.
Peronopsis sp.
Spencella sp.

35. 95676 993 m WHF
Modocia sp.
Ptychagnostus sp.
Zacanthoides sp.

Bathyuriscus-Elrathina Zone, Middle Cambrian

36. 95675 951 m WHF
Pagetia cf. Rasetti, 1951, Pl. 32, Fig.9-11
Peronopsis columbiensis? Rasetti

37. 95674 944 m WHF
alokistocare sp.
Oryctocephalus sp.
Peronopsis sp.
Ptychagnostus gibbus? (Linnarsson)

Albertella and/or *Glossopleura* Zone

38. 95673 938 m WHF
Amecephalus laticaudum? (Resser)
Oryctocephalus sp.
Peronopsis sp.
Poliella? sp.
Spencia sp.
cf. *Zacanthoides sexdentatus* Rasetti

39. 95672 914 m WHF
Ogygopsis sp.
Pagytia clytia Walcott
ptychoparioid trilobites

40. 95671 908 m WHF
cf. *Achlysopsis* sp.
Chancia? sp.
Kochina sp.
Oryctocephalus? sp.
Poliella sp.
cf. *Zacanthoides sexdentatus* Rasetti

REMARKS: In this section, identification of the early and medial zones in the Middle Cambrian is difficult, perhaps because the index fossils for these zones belong to a shallower water environment. Enough material is present, however, to show that these zones are thin and/or in part missing. The presence of a thick *Bolaspidella* Zone is consistent with the slump folds and penecontemporaneous breccia in the zone which indicate rapid deposition.

Section 22 (62°41.3′;128°19.0′)

Cedaria-Crepicaphalus Zone, Late Cambrian

41. 96979 1381.5 m WHF
Glyptagnostus sp.
Homagnostus sp.
Hypagnostus sp.
Ithycephalus? sp.

42. 96978 1371 m WHF
Bolaspidella spp.
Homagnostus sp.
Hypagnostus sp.
Talbotina sp.

43. 96977 1346 m WHF
Bolaspidella spp.
Elrathia? sp.
Glyptagnostus sp.
Talbotina sp.

Belaspidella Zone, Middle Cambrian

44. 96976 1344 m WHF
Baltagnostus sp.
Bolaspidella sp.
Hypagnostus sp.
Lejopyge sp.
Modocia sp.

45. 96975 1304 m WHF
Lejopyge calva Robison
Diplagnostus sp.

46. 96974 1204 m WHF
Bolaspidella sp.
Hemirhodon
Modocia sp.
Ptychagnostus sp.

47. 96973 1190.5 m WHF
Hypagnostus? sp.
Modocia sp.

48. 96972 1159 m WHF
Ptychagnostus punctuosus affinis (Brogger)

Bathyuriscus-Elrathina Zone, Middle Cambrian

49. 96971 1140.5 m WHF
Protospongia? sp.

50. 96970 1015 m WHF
Elrathina sp.
Peronopsis sp.
Ptychagnostus richmondensis? (Walcott)
Zacanthoides? sp.

Glossopheura Zone, Middle Cambrian

51. 96966 998 m WHF
Alokistocare sp.
Bathyuriscus sp.
Pachyaspus sp.
Peronopsis sp.
Ptychagnostus sp.
Spencia sp.

Albertella Zone, Middle Cambrian

52. 96969 972.5m WHF
Pagetia clytia? Walcott
aff. *Pagetia mucrogena* Fritz

53. 99698 696 m WHF
Amecephalus sp.
Helcionella sp.
Oryctocephalus sp.
Pagetia clytia Walcott
Yohoaspis sp.

Plagiura-Poliella Zone, Middle Cambrian

54. 96967 966.5 m WHF
Kochaspis? sp.
Pachyaspis sp.
Poliella sp.

REMARKS: Index fossils for many of the Cambrian zones of the North American faunal province are missing in this section, perhaps because of an unsuitable depositional environment. The presence of the *Plagiura-Poliella* Zone at locality 96967 is based upon the questionable presence of Kochaspis (head only) and the presence of the long-ranging genus *Poliella* (in Canada more common in the *Plagiura-Poliella* Zone, in U.S. more common in the *Albertella* Zone). *Pagetia clytia* in locality 96968 and questionably in 96969 suggests these two horizons are in the upper part of the *Albertella* Zone. At locality 96966 the combined presence of a short wide *Bathyuriscus* tail, *Pachyaspis* sp., *Peronopsis* sp., *Ptychagnostus* sp., and *Spencia* sp. suggests the *Glossopleura* Zone, but does not exclude the next overlying *Bathyuriscus-Elrathina* Zone. A similar reasoning is used to place localities 96970 and 96971 in the *Bathyuriscus-Elrathina* Zone, while admitting that these two localities cannot be definitely excluded from the *Bolaspidella* Zone. Localities 96972-96976 can be definitely placed in the *Bolaspidella* Zone because of *Ptychagnostus punctuosus affinis* in the lowest locality and *Lejopyge* in the highest.

Section 23 (62°24.5′;128°14.8′)

55. 96997 849.5 m WHF
Amecephalus sp.
Kootenia sp.
Pachyaspis sp.
Pagetia resseri? Kobayashi
Poliella sp.
Ptarmiganoides? sp.
Yohoaspis? sp.
AGE: *Albertella* Zone, Early Cambrian

56. 96996 832 m WHF
Amecephalus sp.
Caborcella? sp.
Kochiella? sp.
Ogygopsis sp.
Pagetia clytia? Walcott
Zacanthoides sp.
AGE: *Plagiura-Polliella* Zone, Early Cambrian

Section 24 (62°27.1′;128°23.3′)

57. 97066 305 m WHF
Marjumia? sp.
Olenoides sp.
AGE: *Bolaspidella* Zone, Middle Cambrian

58. 97069 138 m WHF
Elrathia? sp.
Helcionella sp.
Kootenia sp.
Peronopsis sp.
zacanthoides sp.
AGE: *Bathyuriscus-Elrathina* Zone, Middle Cambrian

59. 97065 91.5 m WHF
Kootenia sp.
Pachyaspis sp.
Pagetia sp.
Peronopsis sp.
AGE: *Glossopleura* Zone or *Bathyuriscus-Elrathina* Zone, Middle Cambrian

60. 97064 69 m WHF
Ogygopsis sp.
Olinoides sp.
Oryctocephalus sp.
Pagetia sp.
Peronopsis sp.
Spencia sp.
Zacanthoides sp.
AGE: *Glossopleura* Zone or *Bathyuriscus-Elrathina* Zone, Middle Cambrian

61. 97063 30 m WHF
Amecephalus? sp.
Caborcella? sp.
Ogygopsis sp.
Pagetia sp.
AGE: early or medial Middle Cambrian

Section 28 (62°34.0′;128°;9.7′)

62. C-099362 -21 m WHF
Eldoradia sp.
Elrathia? sp.
Helcionella sp.
Hypagnostus sp.
Modocia sp.
REMARKS: This collection is probably from a horizon in the upper part of the Rockslide Formation.
AGE: Late Middle Cambrian *Bolaspidella* Zone

Section 29 (62°32.5′;128°5.5′)

63. C-083040 0-2 m WHF
Baltagnostus sp.
Elrathia? sp.
Hypagnostus sp.
Lingulella sp.
aff. *Onchonotopsis* sp.
AGE: late Middle Cambrian *Bolaspidella* Zone

BROKEN SKULL FORMATION-DOLOSTONE MEMBER

Section 29 (62°32.5′;128°5.5′)

64. C-083042 655-683 m MJO
"*Acontiodus*" sp.
Cordylodus sp. indet.
Drepanoistodus? sp.
Oistodus? sp.
"*Oneotodus*" sp.
Scolopodus sp.
CAI: 5-6
AGE: Early Ordovician, probably Tremadoc

Section 34 (62°47.8′;128°10.4′)

65. C-087748 143 m MJO
Bergstroemognathus sp.
Drepanodus arcuatus Pander
Juanognathus variabilis Serpagli
Oepikodus evae (Lindstrom)
Oistodus sp.
Periodon sp.
Protopanderodus? sp.
Scolopodus sp.
Walliserodus australis Serpagli
CAI: 5-6
AGE: Early Ordovician, early Arenig

66. C-092563 140-141 m BSN
inarticulate brachiopods
echinodern and trilobite debris
AGE: possibly Early Ordovician, Arenig

67. C-087747 138 m MJO
Oepikodus cf. *O. evae* (Lindstrom)
inarticulate brachiopod
CAI: 5-6
AGE: Early Ordovician, Arenig

68. C-092562 71-72 m BSN
dichograptid(?) and didymograptid(?) fragments
Clonograptus sp.
Tetragraptus cf. *T. quadribrachiatus* (Hall)
AGE: Probably Early Ordovician, Arenig but possibly early Middle Ordovician, Llanvirn

69. C-092562 71-72 m MJO
fragments of oistodiform elements and other coniforms
CAI: 6
AGE: Ordovician

70. C-087746 52 m MJO
Drepanodus cf. *D. arcuatus* Pander
Drepanoistodus sp.
Protopanderodus sp.
Scolopodus sp.
CAI: 5-6
AGE: Early Ordovician

Section 38 (62°57.8′;128°22.2′)

71. C-087638 1.5 m MJO
coniform elements indet.
paraconodont? indet.
inarticulate brachiopod
AGE:Early(?) Ordovician

Section 40 (62°26.8′;128°23.9′)

72. C-087034 312 m MJO
Drepanoistodus sp(p).
Histiodella? sp.
"*Oneotodus*" sp(p).
"*Scolopodus*" *gracilis* Ethington and Clark
S. spp.
inarticulate brachiopod
CAI: 5
AGE: Early Ordovician, late Tremadoc-Arenig

BROKEN SKULL FORMATION-LIMESTONE MEMBER

73. C-087052 62°53.5′;128°15.7′ MJO
Phragmodus? sp.
indeterminate coniform fragments

stelliscaphate element, nov.?
CAI: 5
AGE: Ordovician, ?Middle

74. C-081885 62°36.5';128°20.2' BSN
sponge
Maclurites?
indeterminate brachiopods and trilobites
AGE: probably Middle or Late Ordovician

75. C-087035 62°55.4';128°24.5' MJO
Belodella sp.
Glyptoconus? *asymmetricus* Barnes and Poplawski
Juanognathus sp.
Oepikodus evae Lindstrom
Periodon aff. *P. flabellum* Lindstrom
"*Reutterodus*" *andinus* Serpagli?
Scolopodus sp.
Walliserodus australis Serpagli
phosphatic fragments, including rings
CAI: 5
AGE: Early Ordovician, early Arenig

76. C-082653 62°55.4';128°24.5' AWN
Carinatina? sp.-finely costate form
undet. brachiopod fragments
large echinoderm ossicle with single axial canal
REMARKS: The fauna contained in sample C-082653 is recrystallized and poorly preserved. The Carinatina? sp. is suggestive of an Early to Middle Devonian age.
AGE: suggestive of Early to Middle Devonian

77. C-102580 62°37.0';128°12.6' MJO
Histiodella? sp.
"*Tetraprioniodus*" *lindstroemi* Sweet and Bergstrom
CAI: 5
REMARKS: "*T.*" *lindstroemi* thought to be part of *Pygodus* apparatus.
AGE: probably Middle Ordovician, possibly late Arenig

Section 29 (62°32.5′;128°5.5′)

78. C-092553 836-844 m BSN
echinoderm debris
trilobite fragments
Nanorthis sp.
Nanorthis? sp.
AGE: Early Ordovician, late Tremadoc to Early Arenig, Canadian trilobite zone C to G

79. C-092552 782-783 m BSN
inarticulate brachiopods
AGE: possibly Early Ordovician, Arenig

80. C-092551 716-717 m BSN
inarticulate brachiopods
AGE: possibly Early Ordovician, Arenig

Section 31 (62°50.3′;128°8.5′)

81. C-087048 -2 to 0 m MJO
Plectodina? sp. indet.
Walliserodus? sp.
indeterminate fragments of coniform and "fibrous"(?) elements
CAI: 5-6
AGE: Ordovician

Section 32 (62°47.1′;128°28.4′)

82. C-087623 42 m MJO
Belodella sp.
Drepanoistodus? sp.
Plectodina? sp.
CAI: 6-7
AGE: Middle to Late Ordovician

Section 33 (62°34.8′;128°15.9′)

83. C-102578 -2 to 0 m MJO
Drepanoistodus sp.
Oepikodus sp.
Oistodus? sp.
Walliserodus sp.
CAI: 5
AGE: late Early or Middle Ordovician

Section 38 (62°57.8′;128°22.2′)

84. C-087640 576 m MJO
Belodella? sp.
Periodon sp. indet.
Pygodus sp. (primitive ramiforms)
inarticulate brachiopods
indeterminate coniforms
CAI: 6
AGE: probably Middle Ordovician, possibly middle to late Arenig

85. C-087639 450 m MJO
Belodella sp.
Plectodina? sp.
oistodiform and ramiform fragments indet.
CAI: 5
AGE: Middle to Late Ordovician

86. C-087818 149 m BSN
inarticulate brachiopods
sponge spicules
echinoderm plates
asaphid trilobite
Lachnostoma? sp.
AGE: Ordovician; probably latest Arenig, Zone J (*I. victoriae* graptolite Zone)

87. C-087819 116 m BSN
Clonograptus sp.
indeterminate trilobite
AGE: Early Ordovician to early Middle Ordovician, Tremadoc to Llanvirn

88. C-087817 116 m BSN
undetermined trilobite
pliomerid and raphiophorid trilobites
Megalaspides? sp.
Poronileus? sp.
AGE: Ordovician, very probably late Arenig (*I. victoriae* graptolite Zone)

Section 42 (62°42.3′;128°23.9′)

89. C-082888 480 m BSN
Caryocaris? sp.
undetermined dendroid graptolite
Acanthograptus? sp.
Callograptus? sp.
Climacograptus? sp.
Cryptograptus sp.
Didymograptus sp.
Glossograptus sp.
Glyptograptus sp.
Isograptus sp.
Pterograptus sp.
Tetragraptus 2 spp.

AGE: early Middle Ordovician, Llanvirn, *Paraglossograptus etheridgei* Zone

Section 44 (62°57.2′;128°23.7′)

90. C-087631 30 m MJO
scandodiform element
AGE: Ordovician

RABBITKETTLE FORMATION (northeast of South Nahanni River)

91. C-087033 62°54.9′;128°26.4′ MJO
Cordylodus sp(p).
Proconodontus? sp.
Teridontus nakamurai (Nogami)?
CAI: 3-4?
REMARKS: Collected from within a few metres beneath top of Rabbitkettle Formation.
AGE: latest Cambrian-Early Ordovician, Tremadocian, *Cordylodus proavus* Zone

92. C-082659 62°54.9′;128°26.4′ BSN
inarticulate brachiopod
Apheoorthis sp.
Syntrophina sp.
hystricurid trilobite
REMARKS: Collected from within a few metres from top of the Rabbitkettle Formation at same location as C-087033 above.
AGE: Early Ordovician, Tremadoc

93. C-087620 62°58.0′;128°34.9′ MJO
Acodus deltatus Lindstrom?
inarticulate brachiopod
AGE: probably Early Ordovician

94. C-087621 62°58.0′;128°34.9′ MJO
"*Oneotodus*" sp.
AGE: Ordovician

95. C-081817 62°42.3′;128°23.1′ BSN
inarticulate brachiopod
orthid brachiopod
unidentified trilobites, 2 or more genera
Bowmania sp.
Euptychaspis sp.
Eurekia sp.
Leicoryphe sp.
Pseudoagnostus? sp.
AGE: Late Cambrian, Trempealeaun *Saukia* Zone

96. C-097070 62°34.0′;128°10.0′ WHF
Aphelaspis sp.
Dunderbergia sp.
Olenaspella sp.
Ptychagnostus sp.
REMARKS: Collection from near the base of the Rabbitkettle Formation.
AGE: *Aphelaspis* Zone, Late Cambrian

Section 22 (62°41.3′;128°19.0′)

Ptychaspis-Prosaukina Zone and Saukia Zone, Late Cambrian

97. 96989 WHF
Eurekia? sp.
Leiocoryphe? sp.
REMARKS: This locality is approximately 0.2 km south of section 22. Its stratigraphic position is estimated to be several metres above the level of locality 96988 (below).

98. 96988 1877.5 m WHF
Eurekia? sp.

99. 96987 1835.5 m WHF
Eurekia sp.

100. 96986 1826.5 m WHF
Eurekia sp.

101. 96985 1773.5 m WHF
Rasettia sp.

The *Dunderhergia* Zone, *Elvinia* Zone, *Canaspis* Zone, and part of the *Ptychaspis-Prosaukia* Zone are barren or absent

Aphelaspis Zone, Late Cambrian

102. 96984 1516 m WHF
Olenaspella sp.

103. 96983 1508.5 m WHF
Aphelaspis sp.
Olenaspella sp.
Ptychagnostus sp.

Cedaria-Crepicephalus Zone, Late Cambrian ambrian

104. 96982 1485.5 m WHF
Coosella sp.
Crepicephalus sp.
Kormagnostus sp.

105. 96981 1432 m WHF
Agnostus sp.
Cedaria sp.
Kormagnostus sp.
Welleraspis sp.

106. 96980 1431.5 m WHF
Agnostus sp.
Blountia sp.
Kingstonia sp.
Kormagnostus sp.

REMARKS: Index fossils for many of the Cambrian zones of the North American faunal province are missing in the above section, perhaps because of an unsuitable depositional environment. *Glyptognostus* at locality 96977 (Section 22, 1346 m, Rockslide Formation) and *Crepicephalus* sp., *Coosella* sp., and *Kormagnostus* sp. at locality 96982 serve to place these and the intermediate localities in the *Cedaria-Crepicephalus* Zone, and to demonstrate that little or no erosion took place at the Rockslide-Rabbitkettle formational contact. *Aphelaspis* sp. at locality 96983 serves to place the locality in the *Aphelaspis* Zone and the nearby locality 96984 is tentatively placed in that zone. Between localities 96984 and 96985 there is ample room to accommodate the undocumented *Dunderbergia*, *Elvinia*, *Conaspis*, and part(?) of the *Ptychaspis-Prosaukia* zones. A large saukid head seen, but not collected, while walking over the 43.5 m siltstone and shale unit suggests the unit belongs to the *Ptychaspis-Prosaukia* Zone. Rasettia sp. in locality 96985 may belong to either the *Ptychaspis-Prosaukia* Zone or to the *Saukia* Zone. *Eurekia* sp. in collections 96986-96989 indicate that they belong to the *Saukia* Zone.

Section 28 (62°34.0′;128°09.7′)

107. C-099361 164 m WHF
Dunderbergia sp.
Iddingsia sp.
Irvingella sp.
Stenambon sp.
REMARKS: Strata containing the above collection (GSC Loc. 099361) correlate with the medial part of the Rabbitkettle Formation in Section 23 (Fritz, 1981, Fig. 19.1).
AGE: *Elvinia* Zone, Late Cambrian

RABBITKETTLE FORMATION (southwest of South Nahanni River)

108. C-103693 62°30.9';129°14.4' MJO
Proconodontus sp.
AGE: probably Late Cambrian

109. C-086283 62°24.2';129°25.3' MJO
Drepanoistodus? sp.
inarticulate brachiopod
AGE: probably Ordovician

110. C-087045 62°17.4';128°54.3' MJO
Amorphognathus sp. indet.
Belodina sp. indet.
Drepanoistodus cf. *D. suberectus* (Branson and Mehl)
D.? *venustus*? (Stauffer)
Panderodus sp. indet.
Periodon aculeatus (Hadding)
Protopanderodus sp. indet.
Scabbardella? sp.
Walliserodus? sp. indet.
microgastropods and bryozoan steinkerns
CAI: 5
AGE: Middle Ordovician, probably late Llandeilo-early Caradoc

111. C-087618 62°38.2';129°47.4' MJO
indeterminate coniform element
AGE: probably Early Ordovician

RABBITKETTLE FORMATION (near South Nahanni River)

112. C-087040 62°22.3';128°26.0' MJO
Drepanoistodus sp.
Panderodus sp.
Periodon sp. indet.
Protopanderodus sp.
Scabbardella? sp.
Walliserodus? sp.
gastropod steinkerns
CAI: 5
AGE: Middle to Late Ordovician

113. C-087044 62°18.8′;128°19.6′ MJO
Amorphognathus sp.
Drepanoistodus cf. *D. suberectus*
Oulodus? sp.
Ozarkodina? sp.
Panderodus? sp. indet.
Periodon sp.
Protopanderodus sp. indet.
Scabbardella? sp.
CAI: 5
AGE: late Middle Ordovician to Late Ordovician

114. C-087038 62°17.5';128°12.4' MJO
Drepanoistodus sp.
Eoplacognathus? sp.
Panderodus? sp.
Periodon cf. *P. aculeatus* (Hadding)
Protopanderodus cf. *P. varicostatus* (Sweet and Bergstrom)
Pygodus ramiform elements
CAI: 5.5
AGE: early Middle Ordovician, late Llanvirn-Llandeilo

DUO LAKE FORMATION

115. C-083035 62°27.7';129°9.5' BSN
Cyrtograptus sp.
Monograptus? sp.
Retiolites sp.
AGE: Middle Silurian (Wenlock) or latest Early Silurian, latest Llandovery

116. C-083034 62°27.7';129°9.5' BSN
Monograptus sp.?
M. ex gr. *M. spiralis* (Geinitz)
Retiolites sp.
REMARKS: C-083034 is within the M. spiralis Zone (top zone of the Llandovery graptolitic sequence); C-083035, collected 7 m above C-083034, could be within the uppermost part of the same zone, but more likely is higher and within the Wenlock.C-083035 was collected an estimated 16 m below the base of the Steel Formation.AGE: late Early Silurian, late Llandovery, *Monograptus spiralis* Zone

117. C-076438 62°25.5';129°21.8' BSN
Climacograptus sp.
Monograptus sp. (with triangulate thecae)
AGE: Early Silurian, middle to earliest late Llandovery, *millepeda* Zone to early *turriculatus* Zone

118. C-076434 62°23.4';129°6.7' BSN
Climacograptus sp.
Monograptus 3 spp. (two with triangulate thecae)
AGE: Early Silurian, middle to earliest late Llandovery, *millepeda* Zone to early *turriculatus* Zone

119. C-087884 62°45.2';129°54.7' BSN
Monograptus? sp.
AGE: probably Silurian

120. C-087887 62°26.0';129°30.0' BSN
Monograptus sp.
Retiolites? sp.
AGE: Silurian, Llandovery or Wenlock

121. C-087606 62°35.9';129°38.9' MJO
Dapsilodus sp. indet.
Ozarkodina? sp. indet.
CAI: 5
AGE: Silurian

122. C-086284 62°25.4';129°12.0' MJO
indeterminate coniform elements
AGE: probably Ordovician

123. C-086325 62°27.7';129°11.0' MJO
Dapsilodus sp. indet.
Oulodus? sp. indet.
mazuelloids, triaxial sponge spicules
CAI: 5
AGE: Silurian, probably Early

124. C-087605 62°35.9';129°38.9' MJO
Dapsilodus sp.
AGE: Late Ordovician-Silurian

125. C-087760 62°44.8';129°58.0' BSN
Orthograptus sp.
AGE: Middle Ordovician to Early Silurian

126. C-087761 62°44.4';129°56.6' BSN
Orthograptus sp.
AGE: Middle Ordovician to Early Silurian

127. C-087892 62°18.3.';129°34.2' BSN
Climacograptus ex gr. *C. bicornis* Hall
Cryptograptus? sp.
Orthograptus? sp.
AGE: Middle Ordovician to Late Ordovician, late Llandeilo to Ashgill

128. C-087258 62°3.9';129°50.8' BSN
Dicellograptus sp.
Glossograptus? sp.
graptolite fragments
AGE: Middle or Late Ordovician

129. C-087265 62°44.2';129°56.0' BSN
Climacograptus? sp.
Dicellograptus sp.
Orthograptus? sp.
AGE: Middle or Late Ordovician

130. C-087893 62°20.8';129°40.3' BSN
Climacograptus sp.
Dicellograptus sp.
Dicranograptus? sp.
Orthograptus? sp.
AGE: Middle Ordovician to Late Ordovician, probably Caradoc

131. C-107916 62°17.2';128°10.8' BSN
inarticulate brachiopod
Climacograptus? sp.
Orthograptus? sp.
AGE: probably late Middle or Late Ordovician, probably Caradoc or Ashgill

132. C-087041 62°17.1';128°10.8' MJO
Amorphognathus tvaerensis Bergstrom
Drepanoistodus cf. *D. suberectus* (Branson and Mehl)
Eoplacognathus or *Amorphognathus* sp(p).
Panderodus? sp. indet.
Periodon sp.
Phragmodus cf. *P. undatus* (Branson and Mehl)
Polyplacognathus ramosus Stauffer
Protopanderodus sp. indet.
Scabbardella? sp.
CAI: 6
REMARKS: Collection is from a tongue(?) of Duo Lake Formation near bend of South Nahanni River, eastern Nahanni map area.
AGE: late Middle Ordovician, Early Caradoc, *A. tvaerensis* Zone

133. C-076436 62°23.9';129°18.5' BSN
fragmentary graptolites
diplograptid
Climacograptus ex gr. *C. bicornis* (Hall)
Dicranograptus sp.
AGE: Middle Ordovician, Caradocian, *gracilis-bicornis* Zone to Orthograptus quadrimucronatus Zone

134. C-076435 62°29.9';129°13.5' BSN
fragmentary graptolites
?*Climacograptus* sp.
Dicellograptus sp.
Dicranograptus sp.
AGE: Middle Ordovician, Caradocian, *gracilis-bicornis* Zone to *Orthograptus quadrimucronatus* Zone

135. C-087260 62°4.0';129°47.9' BSN
inarticulate brachiopod
Cryptograptus sp.
Dicellograptus sp.
Orthograptus sp.
AGE: Middle Ordovician, Caradoc, *gracilis-bicornis* Zone to *amplexicaulis* Zone

136. C-087259 62°4.3';129°48.2' BSN
Climacograptus bicornis longispina Hall
Cryptograptus sp.
AGE: Middle Ordovician, Caradoc, *gracilis-bicornis* Zone to *amplexicaulis* Zone

137. C-103694 62°29.6';129°11.5' MJO
Protopanderodus sp.
oistodiform(?) element indet.
CAI: 5
AGE: Ordovician, probably Early or Middle

138. C-087789 62°32.2';129°49.5' BSN
graptolite fragments
Climacograptus sp.
Cryptograptus? sp.
Glossograptus sp.
AGE: Middle Ordovician, Llanvirn to early Caradoc, *tentaculatus* Zone to *gracilis-bicornis* Zone

139. C-076437 62°25.0';129°24.8' BSN
fragmentary graptolites
Climacograptus? sp.
Glossograptus? sp.
AGE: Ordovician, late Arenig to Caradoc

140. C-087798 62°32.2';129°49.3' BSN
Clonograptus? sp.
Tetragraptus sp.
AGE: Early Ordovician, *approximatus* Zone or *fruticosus* Zone

Section 9 (62°38.2';129°47.1')

141. C-087871 180-190 m BSN
Climacograptus? sp.
Dicellograptus sp.
Orthograptus? sp.
Reteograptus sp.
AGE: Middle or Late Ordovician, late Llandeilo to Ashgill

Section 12 (62°28.3';129°01')

142. C-079641 311 m BSN
Monograptus spp.
M. sp. or *Cyrtograptus* sp.
AGE: Middle Silurian, Wenlock, *rigidus* Zone

Section 14 (62°19.5';129°27.0')

143. C-083037 130 m BSN
Climacograptus sp.
Glyptograptus sp.
Monograptus 2 spp.
M. cf. *M. cyphus* Lapworth

AGE: Early Silurian, early Llandovery *Monograptus acinaces* Zone or *M. cyphus* Zone, probably the latter

144. C-083038 281 m BSN
Climacograptus sp.
diplograptid
Monograptus 3 spp.
M. cf. *M. communis* Lapworth
M. triangulatus cf. *M. triangulatus triangulatus* (Harkness)
Petalograptus sp.
Rastrites aff. *R. longispinus* Perner
AGE: Early Silurian, middle Llandovery, *Monograptus gregarius* Zone

STEEL FORMATION

145. C-060082 62°27.6';129°49.6' BSN
sponge spicules
Bohemograptus bohemicus (Barrande) cf.
B. bohemicus tenuis (Boucek)
REMARKS: The *Bohemograptus bohemicus* in C-060082 resembles the subspecies *tenuis* in the narrowness and strong curvature of the rhabdosome, and in the high position of the aperture of the first theca with regard to the sicula. The *leintwardinensis primus* Zone of the northwestern mainland is about equivalent, in the Arctic Islands, to the *fritschi linearis* Zone and most of the *bohemicus tenuis* Zone, an interval that Thorsteinsson and Uyeno (1981, p. 2) correlate with the *siluricus* Conodont Zone.
AGE: Late Silurian, Ludlow, probably *Saetograptus leintwardinensis primus* Zone of Jackson et al. (1978)

HAYWIRE FORMATION (near and southwest of South Nahanni River)

146. C-087042 62°19.8';128°20.1' MJO
Amorphognathus tvaerensis Bergstrom
Drepanoistodus cf. *D. suberectus* (Branson and Mehl)
Eocarniodus? sp.
Panderodus sp. indet.
Periodon cf. *P. aculeatus* (Hadding)
Phragmodus cf. *P. undatus* (Branson and Mehl)
Polyplacognathus ramosus Stauffer
Protopanderodus sp. indet.
CAI: 5
AGE: late Middle Ordovician, early Caradoc, *A. tvaerensis* Zone,

147. C-087043 62°17.6';128°08.6' MJO
Belodina sp. indet.
Drepanoistodus cf. *D. suberectus* (Branson and Mehl)
Panderodus sp. indet.
Periodon sp. indet.
Protopanderodus sp. indet.
CAI: 6-7
REMARKS: Collection is from donated specimen for which location is suspect; Haywire Formation not mapped at reported locality.
AGE: Middle-Late Ordovician

148. C-081854 62°17.8';128°12.2' BSN
echinoderm fragments
Palliseria sp.
**Trocholitoceras*? sp.
REMARKS: *Indicates placement in reference collection.
AGE: early Middle Ordovician, Whiterock

149. C-087036 62°19.5';128°19.0' MJO
Bergstroemognathus? sp.
Juanognathus? sp.
Protopanderodus sp.
Walliserodus australis Serpagli
REMARKS: Collection from donated specimen; location approximate
AGE: Early Ordovician, early Arenig

150. C-087046 62°19.3';128°18.6' MJO
Drepanoistodus sp. indet.
Oepikodus? sp. indet.
Scolopodus? sp. indet.
diverse gastropod fauna (steinkerns)
CAI: 5.5
AGE: Early Ordovician, probably Arenig

151. C-079639 62°24.7'128°48.9' BSN
Apheoorthis? sp.
AGE: probably Early Ordovician, possibly very Late Cambrian

HAYWIRE FORMATION (northeast of South Nahanni River)

152. C-102583 62°32.8';128°17.0' MJO
Drepanoistodus sp.
Protopanderodus leei Repetski?
CAI: 5
AGE: Early or Middle Ordovician

153. Collection lost

Section 29 (62°32.5′;128°5.5′)

154. C-092560 1662-1685 m MJO
Oulodus sp(p).
Panderodus sp.
CAI: 5
AGE: late Middle Ordovician through Early Silurian

155. C-092559 1340-1343 m MJO
Leptochirognathus sp. A of Tipnis et al. (1978)
Multioistodus sp.
CAI: 5-6
AGE: early Middle Ordovician, late Arenig-early Llanvirn

156. C-092556 952-956 m MJO
Oepikodus sp.
Scolopodus abruptus Repetski
Walliserodus australis Serpagli
CAI: 5
AGE: Early Ordovician, early Arenig

157. C-092555 881-883 m MJO
"*Acontiodus*" sp.
Drepanodus arcuatus Pander
Oepikodus? sp.
Oneotodus costatus Ethington and Brand?
Scolopodus sp(p).
Ulrichodina deflexa Furnish
Walliserodus australis Serpagli
CAI: 5
AGE: Early Ordovician, early Arenig

158. C-092554 844-850 m MJO
Acodus deltatus Lindstrom?
"*Acontiodus*" sp.
"*Scandodus*" sp.
Scolopodus? sp.
Ulrichodina sp.

CAI: 5
AGE: Early Ordovician

Section 31 (62°50.3′;129°08.5′)

159. C-087050 268.5 m MJO
Aphelognathus sp.
Belodina sp.
Ozarkodina cf. *O.* n. sp. A
Plectodina sp.
gastropods & ostracodes
CAI: 5-6
AGE: late Middle to Late Ordovician, late Caradoc-Ashgill

160 C-081846 264 m BSN
echinoderm columnals, streptelasmid coral
Catenipora sp.
Bighornia sp.
aff. *Estlandia* sp.
Lepidocyclus sp., *Paucicrura* sp.
indeterminate brachiopod
AGE: late Middle or Late Ordovician, late Caradoc or Ashgill

161. C-081841 130.5 m BSN
echinoderm columnals
gastropod fragment
Anataphrus? sp.
Calyptaulax? sp.
Lepidocyclus sp.
Paucicrura sp.
Platystrophia sp.
Strophomena? sp.
Thaerodonta sp.
undetermined brachiopods
AGE: late Middle or Late Ordovician, probably Caradoc, possibly Ashgill

162. C-087049 130.5 m MJO
Aphelognathus sp.
Belodina sp.
Drepanoistodus suberectus (Branson and Mehl)
D.? *venustus* (Stauffer)?
Oulodus? sp.
Ozarkodina n. sp. A
Panderodus sp.
Plectodina sp.
"*Pseudooneotodus*" *mitratus* (Moskalenko)
P. sp.
Staufferella lindstroemi (Ethington and Schumacher)
gastropods, ichthyoliths(?), bryozoans
others
CAI: 5
AGE: late Middle to Late Ordovician, late Caradoc-Ashgill

Section 32 (62°47.1′;128°28.4′)

163. C-087628 306 m MJO
Aphelognathus sp. indet.
Belodina sp.
Eocarniodus? sp.
Panderodus sp.
Walliserodus cf. *W. amplissimus* Serpagli
CAI: 5
AGE: late Middle to Late Ordovician, late Caradocian-Ashgill

164. C-087774 280 m BSN
echinoderm fragments
Helicelasma? sp.
Chaetetipora? sp.
AGE: probably Late Ordovician, possibly Early Silurian

165. C-087627 180 m MJO
Belodina sp.
Drepanoistodus? *venustus* (Stauffer)?
Panderodus sp.
cordylodiform element
CAI: 6
AGE: Middle to Late Ordovician

166. C-087626 175 m MJO
Phragmodus? sp.
CAI: 6-7
AGE: Middle to Late Ordovician

167. C-087771 168 m BSN
echinoderm fragments
sowerbyellid brachiopods
Paucicrura? sp.
Grewingkia? sp.
AGE: probably late Middle or Late Ordovician

168. C-087625 123 m MJO
Panderodus sp.
ramiform fragments
AGE: Ordovician to Early Devonian

169. C-087624 48 m MJO
Amorphognathus sp. indet.
Belodina sp.
Eocarniodus? sp.
Panderodus sp.
Periodon sp.
CAI: 5-6
AGE: Middle to Late Ordovician, probably Caradoc

Section 33 (62°34.8′;128°15.9′)

170. C-102579 885 m MJO
Leptochirognathus? sp.
Multioistodus sp.
CAI: 5
AGE: early Middle Ordovician, late Arenig-early Llanvirn

Section 35 (62°47.8′;128°7.8′)

171. C-081850 174 m BSN
Grewingkia sp.
Plaesiomys sp.
Lepidocyclus sp.
Paucicrura sp.
Thaerodonta sp.
AGE: latest Middle Ordovician, late Caradoc

172. C-081836 48 m BSN
Grewingkia sp.
Lepidocyclus sp.
Paucicrura sp.
Plaesiomys sp.
Thaerodonta sp.
AGE: latest Middle Ordovician, late Caradoc

Section 36 (62°46.8′;128°20.1′)

173. C-082655 357 m BSN
orthid brachiopod
undetermined tabulate and rugose corals (one of latter has dissepiments)
Catenipora sp.
Paleofavosites sp.
AGE: Silurian

Section 38 (62°57.8′;128°22.2′)

174. C-087643 646 m MJO
Aphelognathus sp.
Belodina sp.
Panderodus sp.
CAI: 5-6
AGE: late Middle to Late Ordovician

175. C-087642 644 m MJO
Belodina sp.
Oulodus? sp.
Panderodus? sp.
oistodiform element
CAI: 5-6
AGE: middle to Late Ordovician

176. C-087641 583 m MJO
Belodina sp.
Drepanoistodus cf. *D. suberectus* (Branson and Mehl)
D. cf. *D. venustus* (Stauffer)
Panderodus sp.
AGE: middle to Late Ordovician

Section 41 (62°31.9′;128°36.5′)

177. C-079640 1 m BSN
indeterminate solitary and heliolitid(?) corals
AGE: probably Silurian

Section 44 (62°57.2′;128°23.7′)

178. C-082693 275 m BSN
undetermined algae, stromatoporoids, bryozoans, echinoderm debris, brachiopods, trilobites, gastropods
Alispira? sp.
Auloporella? sp.
Catenipora sp.
favositid coral
solitary and colonial rugose corals (some with dissepiments)
AGE: Silurian, probably Llandovery

179. C-088013 275 m BSN
undetermined algae, bryozoan, echinoderm debris, brachiopods, gastropods, conulariid(?)
heliolitid, halysitid, and rugose corals
Catenipora sp.
Glyptograptus? sp.
Bumastus? sp.
Platylichas? sp.
Proetus (Lacuniporaspis?) sp.
AGE: Early Silurian, Llandovery

180. C-087634 243 m MJO
Aphelognathus sp.
Drepanoistodus sp.
Oulodus? sp.
Panderodus sp.
gastropods and ichthyoliths
AGE: late Middle to Late Ordovician

181. C-087633 160 m MJO
Panderodus? sp.
indeterminate fragments of *Aphelognathus*?
CAI: 5-6
AGE: Middle to Late Ordovician

182. C-088011 160 m BSN
Helicelasma? sp.
AGE: probably Late Ordovician, or possibly Early Silurian

183. C-087632 52 m MJO
Eoplacognathus sp.
"*Oneotodus*" sp.
Walliserodus sp.
oistodiform element
echinoderms, lots of phosphatic debris
inarticulate brachiopods
CAI: 4
AGE: Middle Ordovician, Llanvirn-early Caradoc

Section 49 (62°33.12′;128°17.37′)

184. C-081870 -1.5 m BSN
gastropod, bryozoan
undetermined solitary corals (with dissepiments)
Cateripora 2 spp.
Paleofavosites sp.
auloporinid and heliolitid corals
Skenidiodes sp.
indeterminate trilobite
AGE: Silurian or extremely Late Ordovician

Section 53 (62°33.2′;128°22.3′)

185. C-081888 -30 to 0 m BSN
indeterminate solitary coral
Favosites? sp.
Halysites sp.
AGE: Silurian

Section 54 (62°28.4′;127°59.1′)

186. C-087039 0 to -7 m MJO
Belodina sp.
Drepanoistodus sp.
Ozarkodina? sp.
Panderodus sp.
Periodon sp. indet.
Plectodina sp. indet.
phosphatic "conularid" fragments
CAI: 5
AGE: Middle to Late Ordovician

Section 55 (62°59.5′;128°19.7′)

187. C-087645 16.5 m MJO
Aphelognathus? sp. indet.
Belodina sp.
Dapsilodus sp.
Drepanoistodus? *venustus* (Stauffer)?
Panderodus sp.
inarticulate brachiopods, sponge spicules
CAI: 5-6
AGE: probably Late Ordovician

188. C-087644 15 m MJO
Panderodus sp.
ramiform element indet.
microgastropods
AGE: probably Ordovician

WHITTAKER FORMATION

189. C-087601 62°58.0′;127°55.0′ MJO
Ozarkodina confluens (Branson and Mehl) alpha and gamma
morphotypes (Klapper and Murphy, 1975)
CAI: 5
REMARKS: The gamma morphotype of *O. confluens* is recorded as early as the *siluricus* Zone but is most common

in the *index* fauna of Nevada (Klapper and Murphy, 1975, p. 16). The alpha morphotype occurs within the *Kockella* Stufe and higher in association within the gamma. Collected from top 0.2 m of Whittaker Formation immediately below locality C-087602 of the Delorme Formation.
AGE: Middle to Late Silurian, late Wenlock through early Pridolian

Section 57 (62°59.5′;127°56.0′)

190. C-087603 -3 m MJO
Ozarkodina? sp.
Panderodus? sp.
CAI: 5
AGE: probably Middle Silurian to Early Devonian

SAPPER FORMATION - limestone member

191. C-087615 62°58.0';128°40.0' MJO
Aphelognathus sp.
Drepanoistodus? *suberectus*
D.? *venustus* (Stauffer)?
Panderodus sp.
Phragmodus sp.
Walliserodus cf. *W. amplissimus* (Serpagli)
microgastropods
CAI: 5-6
AGE: late Middle to Late Ordovician, late Caradoc-Ashgill

192. C-074497 62°46.3';128°19.2' BSN
echinoderm fragments
small cephalopods, several species
small gastropods, several species
small bivalves, two species
small brachiopods, four or more genera
Ulrichostylus? sp.
solitary rugose coral
Climacograptus cf. *C. angustus* (Perner)
Glyptograptus sp.
Astroproetus sp.
Harpidella? sp.
Leonaspis jaanussoni Chatterton and Perry
REMARKS: Collection is from 12 m above base of the Sapper Formation. The fauna is very rich but most of the benthos are small specimens. In Canada, *Climacograptus* and *Glyptograptus* are not known from rocks younger than middle Llandovery. About a hundred specimens of graptolites were recovered by etching; none are monograptids, which would be expected to be common above the *acuminatus* Zone. *C. angustus* ranges from Ashgill to early Llandovery and the oldest known *Leonaspis* is from uppermost Ordovician rocks. *L. jaanussoni* was described from the Whittaker Formation near Avalanche Lake, Glacier Lake map area (about 18.3 m (60 miles) southeast of C-074497) from beds assigned to the *Distomodus kentuckyensis* conodont zone (early Llandovery) and perhaps somewhat younger).
AGE: Early Silurian, early Llandovery, probably *persculptus* Zone or *acuminatus* Zone

193. C-086328 62°53.9';128°16.1' MJO
Aspidognathus? sp.
Panderodus sp.
Pterospathodus celloni (Walliser)
Walliserodus? sp.
CAI: 5-6
AGE: late Early Silurian, late Llandovery, *celloni-amorphognathoides* zones

194. C-086327 62°55.8';128°25.0' MJO
Panderodus sp.
Pterospathodus pennatus (Walliser)
Walliserodus? sp.
CAI: 5
AGE: late Early-early Middle Silurian, late Llandovery-early Wenlock, *celloni-amorphognathoides* zones

195. C-087619 62°58.1';128°37.2' MJO
Protopanderodus? sp.
CAI: 7
AGE: Ordovician

196. C-082657 62°42.1';128°25.5' BSN
echinoderm columnals
bryozoan, brachiopods
gastropod, straight cephalopod
asaphid and cheirurid trilobites
Cryptolithus aff. *C. lorettensis* Foerste
AGE: late Middle Ordovician, late Caradoc, probably Barneveld

Section 32 (62°47.1′;128°28.4′)

197. C-087630 400 m MJO
Oulodus? sp.
Panderodus? sp.
Pterospathodus pennatus (Walliser)
Walliserodus sp.
AGE: late Early to early Middle Silurian, late Llandovery-early Wenlock, *celloni-amorphognathoides* zones

198. C-087629 309 m MJO
Belodella? sp.
Dapsilodus? sp.
Milaculum sp.
Panderodus sp.
Staufferella sp.
inarticulate brachiopods
phosphatic ("conularid") bar fragments
sponge spicules
CAI: 5
AGE: Middle to Late Ordovician

Section 36 (62°46.8′;128°20.1′)

199. C-074480 455 m BSN
Monograptus spp.
Retiolites sp.
AGE: Early or Middle Silurian, Llandovery or Wenlock

200. C-074482 364.5 m BSN
biserial graptolite
AGE: Early Ordovician to Middle Silurian, Arenig to Wenlock

Section 44 (62°57.2′;128°23.7′)

201 C-082697 570 m BSN
straight cephalopod
Monograptus sp.
M. ex gr. *M. priodon* (Bronn)
AGE: late Early or Middle Silurian, late Llandovery to Wenlock

202. C-082698 570 m BSN
straight cephalopod
indeterminate brachiopods
Monograptus spp.
AGE: Silurian

203. C-082699 548 m BSN
undetermined echinoderm debris, gastropods, cephalopod, solitary coral, brachiopods
Atrypa sp.
Atrypoidea? sp.
Kirkidium? sp.
AGE: Silurian, probably Ludlow, possibly late Wenlock

204. C-082696 525 m BSN
Monograptus ex gr. *M. Priodon* (Bronn)
AGE: late Early or Middle Silurian, late Llandovery to Wenlock

205. C-082694 507 m BSN
sponge spicules
indeterminate brachiopod
Monograptus ex gr. *M. priodon* (Bronn)
AGE: late Early or Middle Silurian, late Llandovery to Wenlock

206. C-082695 481 m BSN
Howellella? sp.
Monograptus ex gr. *M. priodon* (Bronn)
AGE: late Early or Middle Silurian, late Llandovery to Wenlock

207. C-082700 481 m BSN
echinoderm debris
indeterminate brachiopods
Howellella? sp.
Monograptus sp.
AGE: Silurian

208. C-087637 481 m MJO
Aspidognathus n. sp. B. aff.
A. tuberculatus Walliser
Belodella sp.
Carniodus carnulus Walliser
Oulodus cf. *O. fluegeli* (Walliser)
Panderodus sp.
Pterospathodus amorphognathoides Walliser
P. pennatus Walliser
Walliserodus sp.
CAI: 5
AGE: late Early to early Middle Silurian, latest Llandovery-early Wenlock, *amorphognathoides* Zone

209. C-087636 411 m MJO
Carniodus sp.
Oulodus cf. *O. fluegeli* (Walliser)
Panderodus sp.
Walliserodus sp.
scolecodonts
sponge spicules
AGE: Early to early Middle Silurian, Llandovery-early Wenlock

210. C-087635 315 m MJO
Oulodus sp.
Panderodus sp.
CAI: 3-4
AGE: probably Early Silurian, Llandovery

211. C-088012 275 m BSN
indeterminate brachiopod
Orthograptus? sp.
AGE: probably Middle or Late Ordovician

Section 48 (62°56.1′;128°25.2′)

212. C-086329 -5 m MJO
Aspidognathus sp.
Aulacognathus sp.
Carniodus carnulus (Walliser)
Oulodus fluegeli (Walliser)
Panderodus sp.
Pseudooneotodus tricornis Drygant
Pterospathodus pennatus procerus (Walliser)
P. cf. *P. amorphognathoides* Walliser
Walliserodus sp.
CAI: 5-6
AGE: late Early to early Late Silurian, latest Llandovery-early Wenlock, *amorphognathoides* Zone

Section 49 (62°33.0′;128°17.5′)

213. C-086326 0-1 m MJO
Astropentagnathus irregularis Mostler
Dapsilodus sp.
Oulodus fluegeli (Walliser)
Panderodus sp.
Pterospathodus celloni (Walliser)
Walliserodus sp.
inarticulate brachiopod
phosphatic fragments indet.
phosphatized ostracodes and gastropods
scolecodonts
CAI: 5
AGE: Early Silurian, late Llandovery, *celloni* Zone

Section 51 (62°42.2′;128°25.6′)

214. C-074486 75 m BSN
sponge spicules
indeterminate brachiopod
Climacograptus? sp.
Cyrtograptus? sp.
Monograptus ex gr. *M. spiralis* (Geinitz)
Retiolites sp.
AGE: late Early Silurian, latest Llandovery, *Monograptus spiralis* Zone

215. C-074484 69 m BSN
Orthograptus? sp.
AGE: Middle Ordovician to Early Silurian

216. C-087051 12 m MJO
Panderodus? sp.
phosphatic gastropods, crinoids(?), and indeterminate tubes
AGE: Ordovician-Silurian

Section 54 (62°28.4′;127°59.1′)

217. C-081809 5 m BSN
echinoderm columnals
bryozoan
Paucicrura? sp.
Strophomena? sp.
AGE: probably late Middle or Late Ordovician, Caradoc or Ashgill

Section 60 (62°44.8′;128°27.5′)

218. C-074499 48 m BSN
echinoderm columnals
atrypid brachiopod
undetermined brachiopod
Kirkidium (*Kirkidium*) sp.
AGE: Silurian, late Wenlock to early Pridoli

219. C-074483 13.5 m BSN
Monograptus sp.

AGE: Early Silurian to Early Devonian, Llandovery to Pragian

SAPPER FORMATION - silty limestone member

220. C-081838 62°55.5';128°13.7' AWN
favositids
Hexagonaria sp.
Spinatrypa sp. cf. *S. andersonensis* (Warren)
Leiorhynchus manetoe McLaren
very large echinoderm ossicle with single axial canal
REMARKS: Samples C-081887 and C-081820 (Grizzly Bear Formation), C-081832 and C-081833 (Funeral Formation), C-081838 (Sapper Formation), and C-082658 (Landry Formation)) contain a number of elements that suggest assignment to the "*Schuchertella*" *adoceta* Zone of Pedder (1975) and are dated as early Eifelian, early Middle Devonian. This zone occurs typically in the lower, but not lowermost part, of the Hume Formation in the Norman Wells area. *Leiorhynchus manetoe* McLaren (1962) present in samples C-081887 and C-081820 (Grizzly Bear Formation), C-081838 (Sapper Formation), and C-082658 (Landry Formation) is a common element in the Headless Formation and equivalent rocks in the North and South Nahanni rivers region. Associated fossils suggest assignment to the *adoceta* Zone.
AGE: probably *adoceta* Zone, early Eifelian, early Middle Devonian

221. C-086408 62°33.2';128°22.3' MJO
Polygnathus linguiformis linguiformis Hinde
P. parawebbi Chatterton
P. sp. indet.
Tortuodus kockelianus australis (Jackson)
CAI: 5
AGE: Middle Devonian, Eifelian, *australis* Zone

222. C-086407 62°33.1';128°17.6' MJO
Belodella sp.
Oulodus? sp.
Panderodus sp.
Pandorinellina? aff. n. sp. B.Chatterton
Polygnathus costatus Klapper
P. linguiformis linguiformis Hinde
P. parawebbi Chatterton
P. robusticostatus Bischoff and Ziegler group
P. sp. A
Tortuodus? sp.
ostracodes, sponge spicules
CAI: 5
AGE: Middle Devonian, Eifelian, *australis* Zone

223. C-087573 62°58.0';128°42.0' MJO
Belodella sp.
Icriodus sp. indet.
Polygnathus costatus partitus Klapper, Ziegler, and Mashkova
ramiform fragments
CAI: 5
AGE: Middle Devonian, Eifelian, *partitus-C. costatus* zones

224. C-087609 62°58.1';128°45.8' MJO
Belodella sp.
ramiform fragments indet.
CAI: 5
AGE: Silurian-early Late Devonian

225. C-086406 62°50.8';128°6.3' MJO
Belodella sp.
Polygnathus linguiformis linguiformis Hinde
P. parawebbi Chatterton
P. cf. *P. kluepfeli* Wittekindt
P. robusticostatus Bischoff and Ziegler group
ichthyoliths
CAI: 5
AGE: Middle Devonian, probably Eifelian, *australis-kockelianus* zones

226. C-088039 62°58.0';128°42.0' AWN
orthoconic cephalopod
cf. *Anetoceras* sp.
Styliolina sp.
REMARKS: Impressions suggestive of *Anetoceras* sp. in sample C-088039, if correctly determined, would indicate a late Zlichovian, Early Devonian age for the containing beds (Chlupac, 1976).
AGE: late Zlichovian, Early Devonian

227. C-074492 62°46.4';128°29.0' AWN
Nowakia sp. cf. *N. maueri holynensis* Boucek
Styliolina sp. *S. glabra* Lardeux
AGE: late Emsian of late Early Devonian to earliest Eifelian of early Middle Devonian

228. C-088035 62°58.0';128°42.0' AWN
Nowakia sp. cf. *N. elegans* (Barrande)
Paranowakia sp. cf. *P. obuti* Boucek
Styliolina sp. cf. *S. elongata* Peneau
AGE: late Lochkovian and Pragian, Early Devonian

229. C-087815 62°58.0';128°42.0' AWN
cf. *Ogilviella* sp.
Spinatrypa sp.
bryozoan
echinoderm ossicle with single axial canal
Nowakia sp. cf. *N. barrandei* Boucek and Prantl
cf. *Cheirurus* sp.
REMARKS: The form suggestive of *Nowakia barrandei* Boucek and Prantl occurs typically in beds of middle and late Zlichovian, Early Devonian age in western Europe (Lutke, 1979).
AGE: middle and late Zlichovian, Early Devonian

230. C-087574 62°58.0';128°42.0 MJO
Icriodus sp. indet.
Pandorinellina? sp. indet.
Polygnathus cf. *P. dehiscens* Philip and Jackson
CAI: 5
AGE: Early Devonian, late Pragian-Zlichovian, *dehiscens-gronbergi* zones

231. C-088048 62°58.0';128°42.0' BSN
brachiopods
Monograptus yukonensis Jackson and Lenz
AGE: Early Devonian, Pragian, *M. yukonensis* Zone

232. C-087814 60°58.0';128°42.0' BSN
dacryoconarid
cephalopod fragment
Dictyomena sp.
Monograptus sp.
AGE: Early Devonian

233. C-088017 62°57.1';128°17.0' AWN
cf. *Phragmostrophia mucronata* Lenz
Cyrtina sp.
echinoderm ossicle with single axial canal
gastropod
trilobite fragment
REMARKS: The form suggestive of *Phragmostrophis mucronata* Lenz (1977a) occurs typically in beds of late

Lochkovian to Pragian, Early Devonian age, in the Royal Creek area of the Yukon Territory.
AGE: late Lochkovian to Pragian, Early Devonian

234. C-087582 62°57.3';128°15.5' MJO
Belodella sp.
Panderodus sp.
Pandorinellina n. sp. O sensu Klapper and Johnson
P. steinhornensis Ziegler group
Pelekysgnathus? sp. indet. (cones)
ramiform fragments
CAI: 5
AGE: Early Devonian, Zlichovian, *gronbergi*(?) Zone

235. C-088016 62°57.2';128°16.4' AWN
coral fragment
Gypidula sp. 1 of Lenz (1977a)
douvillinid fragment
Ambocoelia sp.
Howellella sp.
Cryptatrypa sp. 1 of Lenz (1977b)
planispiral gastropod
small costate pelecypod
echinoderm ossicle with single axial canal
AGE: late Lochkovian to Pragian, early Early Devonian

236. C-087581 62°56.7';128°17.5' MJO
Belodella sp.
Eognathodus cf. *E. sulcatus* Philip
Panderodus sp.
Pandorinellina sp. indet.
CAI: 5
AGE: Early Devonian, latest Lochkovian-Pragian, sulcatus-kindlei zones

237. C-081847 62°55.6';128°13.5' AWN
favositid coral
cup coral
Dalejina sp. 1 of Lenz (1977a)
Sieberella sp.
cf. *Spinatrypa* sp.
Spirigerina sp. cf. *S. supramarginalis* (Khalfin)
echinoderm ossicle with single axial canal
five-sided echinoderm ossicle with single axial canal
REMARKS: The most diagnostic element is *Spirigerina* sp. cf. *S. supramarginalis* (Khalfin). This species where known elsewhere appears to be restricted to beds of late Lochkovian, Early Devonian age (Lenz, 1977b).
AGE: late Lochkovian, early Early Devonian

238. C-088010 62°56.9';128°17.2' AWN
megastrophiid
Leptagonia sp.
Gypidula sp.
Atrypa nieczlawiensis Kozlowski
REMARKS: *Atrypa nieczlawiensis* Kozlowski is the main constituent of a coquina in sample C-088010. This form occurs abundantly in beds of the "Delorme" Formation on Cathedral Mountain, near Virginia Falls on the South Nahanni River. There, it is associated with fossils characteristic of the brachiopod *Gypidula pelagica* Zone, and conodonts of the *woschmidti* (= *hesperius*) and possibly also the *post-woschmidti* (*eurekaensis*) zones of the early Lochkovian, Early Devonian (Norris and Uyeno, 1981).
AGE: early Lochkovian, early Early Devonian

239. C-087577 62°57.4';128°45.5' MJO
Ancyrodelloides asymmetricus (Bischoff and Sannemann)
A. delta Klapper and Murphy
Belodella sp.
Ozarkodina stygia (Flajs)
Panderodus sp.
ramiforms
CAI: 5
AGE: Early Devonian, middle Lochkovian, *delta* Zone

240. C-086404 62°46.4';128°20.0' MJO
Ancyrodelloides eleanorae Lane and Ormiston
O. cf. *O. excavata* (Branson and Mehl)
Panderodus sp.
Pseudooneotodus sp.
CAI: 5
AGE: Early Devonian, middle Lochkovian, *delta* Zone

241. C-082654 62°46.4';128°20.0' AWN
bryozoan fragments
cf. *Leptaena* sp.
cf. *Gracianella* sp.
Cortezorthis sp.
Spinatrypa sp.
Ancillotoechia sp.
Plicosplasia sp.
Cyrtina? sp.
undet. brachiopod fragments
echinoderm ossicle with single axial canal
REMARKS: Both the *Cortezorthis* and *Plicoplasia* suggest a range in age of late Lochkovian through the Pragian into the Zlichovian of the Early Devonian.
AGE: Early Devonian

242. C-087578 62°57.3';128°15.5' MJO
Amydrotaxis? sp.
Ancyrodelloides delta Klapper and Murphy
Belodella sp.
Oulodus? cf. *O. walliseri* (Ziegler)
Ozarkodina stygia (Flajs)
Panderodus sp.
ichthyoliths
CAI: 5
AGE: Early Devonian, middle Lochkovian, delta Zone

243. C-087783 62°58.2';128°36.9' AWN
Alveolites sp.
cf. *Coenites rectilineatus* (Simpson)
atrypid? impression
echinoderm ossicle
AGE: Late Silurian or Early Devonian

244. C-079643 62°32.9';128°42.6' BSN
Monograptus sp.
M. cf. *M. bohemicus* (Barrande)
AGE: Silurian, Ludlow

245. C-081807 62°35.0';128°26.1' BSN
Bohemograptus aff. *B. bohemicus* (Barrande)
Lobograptus? sp.
Monograptus spp.
Pristiograptus sp.
AGE: Late Silurian, Ludlow

246. C-081822 62°34.4';128°24.8' BSN
sponge spicules
Bohemograptus aff. *B. bohemicus* (Barrande)
Monograptus sp.
AGE: Late Silurian, Ludlow

247. C-081819 62°39.8';128°07.2' BSN
Monograptus sp.
M. ex gr. *M. spiralis* (Geinitz)
Retiolites? sp.
AGE: Early Silurian, late Llandovery, *Monograptus spiralis* Zone

248. C-081881 62°33.1';128°22.3' BSN
Monograptus sp.
M. ex gr. *M. spiralis* (Geinitz)
AGE: Early Silurian, late Llandovery, *Monograptus spiralis* Zone

249. C-087780 62°58.1';128°37.1' BSN
Monograptus sp.
M. ex gr. *M. spiralis* (Geinitz)
AGE: Early Silurian, late Llandovery, *M. spiralis* Zone

250. C-083033 62°18.5';128°10.0' BSN
Dicellograptus complanatus ornatus Elles and Wood
Orthograptus sp.
REMARKS: 1 m above base of Sapper Formation.
AGE: Late Ordovician, Ashgill, *Dicellograptus complanatus ornatus* Zone

251. C-087047 62°20.2';128°13.7' MJO
Amorphognathus sp. indet.
Belodina sp.
Drepanoistodus suberectus (Branson and Mehl)
D.? venustus (Stauffer)?
Panderodus sp.
Protopanderodus sp. indet.
Scabbardella sp.
coniform elements indet.
CAI: 5
REMARKS: From stratigraphic position similar to preceeding collection (C-083033).
AGE: probably Late Ordovician

252. C-080503 62°17.2';128°7.4' TTU
Belodella spp.
Ozarkodina cf. *O. excavata inflata* (Walliser)
Panderodus sp.
sagittodontiform (S?) element of possibly *Pedavis* sp.
AGE: Late Silurian-Early Devonian, with Late Silurian as more probable

253. C-080504 62°17.2';128°7.4' BSN
solitary coral
REMARKS: Same locality as C-080503 above.
AGE: late Middle Ordovician to Permian

254. C-088047 62°58.0';128°42.0' AWN
cf. *Cassidirostrum pedderi* McLaren
Distriatostylus sp.
AGE: Eifelian, early Middle Devonian

Section 16 (62°41.2';129°38.5')

255. C-087622 155 m MJO
carminate element indet.
sagittodontan? element
AGE: Middle Ordovician-Early Devonian

Section 29 (62°32.5';128°5.5')

256. C-086548 1888-1898 m AWN
Distriatostylus? sp.
Styliolina sp.
Viriatella sp.
REMARKS: Most of the specimens are fragmentary and most show little or no fine ornamentation so that determinations below the generic level are not attempted. The ranges of the three dacryoconarid genera present in the sample would suggest a possible age within the interval from the base of the Zlichovian of the Early Devonian to the top of the Eifelian of the early Middle Devonian (see Lardeux, 1966, Table 3).
AGE: within Zlichovian of late Early Devonian to Eifelian of early Middle Devonian

257. C-086548 1888-1898 m TTU
Eognathodus sulcatus kindlei Lane and Ormiston
Icriodus cf. *I. steinachensis* Al-Rawi (a single small I element)
Pandorinellina exigua philipi (Klapper)
P. steinhornensis miae Bultynck
Pedavis sp. (fragmented I elements)
Polygnathus dehiscens Philip and Jackson
P. pireneae Boersma
CAI: 5
AGE: middle Early Devonian, Pragian *kindlei* Zone

258. C-092561 1767-1768 m BSN
dacryonarids
**Monograptus yukonensis* Jackson and Lenz
REMARKS: *Indicates placement in reference collection.
AGE: Early Devonian, Pragian, *M. yukonensis* zone

259. C-092561 1767-1768 m AWN
Nowakia acuaria (Richter)
Styliolina sp.
AGE: late Lochkovian and Pragian, early Early Devonian

Section 34 (62°47.8';128°10.4')

260. C-092573860.0-860.4 mAWN
Coenites rectilineatus (Simpson)
undet. cup coral
cf. *Gypidula thorsteinssoni* Johnson
cf. *Reticulatrypa norrisi* Lenz
Ancillotoechia sp. cf. *A. infelix* (Barrande)
Thliborhynchia pedderi (Lenz)
Plicoplasia acutiplicata Lenz
AGE: late Lochkovian, early Early Devonian

261. C-092573 860.0-860.4 m TTU
Pandorinellina optima (oskalenko)
CAI: 5
AGE: Early Devonian, mid-Lochkovian to mid-Pragian (stratigraphic position above C-092572, suggests *pesavis* to *kindlei* zones).

262. C-092572 760-761 m AWN
Coenites rectilineatus (Simpson)
Favosites sp.
cf. *Stylopleura* sp.
Cortezorthis norfordi Lenz
Schizophoria sp.
Reticulatrypa norrisi Lenz
Atrypa aspiformis Lenz
Thliborhynchia pedderi (Lenz)
Plicoplasia acutiplicata Lenz
undet. uncoiled gastropod
echinoderm ossicle with single axial canal
AGE: late Lochkovian, early Early Devonian

263. C-092572 760-761 m TTU
Amydrotaxis johnsoni (Klapper), beta morphotype
Ozarkodina stygia (Flajs)
Pandorinellina optima (Moskalenko)
Pedavis pesavis pesavis (Bischoff and Sannemann)
Pseudooneotodus beckmanni (Bischoff and Sannemann)
CAI: 5
AGE: Early Devonian, late Lochkovian (*pesavis* Zone)

264. C-092571 720.0-720.8 m AWN
Coenites rectilineatus (Simpson)
undet. small cup coral
cf. *Atrypa nieczlawiensis* Kozlowski

Ambocoelia sp.
Ancillotoechia sp.
echinoderm ossicle with single axial canal
REMARKS: The most diagnostic element is a form suggestive of *Atrypa nieczlawiensis* Kozlowski which occurs abundantly in lower Lochkovian beds on Cathedral Mountain, Virginia Falls (NTS 95F) map area, southwestern District of Mackenzie (see Norris and Uyeno, 1981).
AGE: early Lochkovian, early Early Devonian

265. C-092571 720.0-720.8 m TTU
indet. spathognathodontan element
"*Ozarkodina*" *denckmanni* Ziegler
Pseudooneotodus beckmanni (Bischoff and Sannemann)
CAI: 4.5-5
AGE: Late Silurian to Early Devonian

Section 35 (62°47.7′;128°07.8′)

266. C-086338 963 m MJO
hindeodelliform element
ostracodes
CAI: 5
AGE: Middle Devonian, bracketed as Eifelian

267. C-086337 874.5 m MJO
Belodella sp.
Polygnathus costatus costatus Klapper
CAI: 5
AGE: Middle Devonian, late Eifelian, *c. coststus-australis* zones

268. C-081834 764 m AWN
Nowakia sp. cf. *N. zlichovensis* Boucek
Styliolina sp.
AGE: early Zlichovian of late Early Devonian

269. C-086336 763 5 m MJO
Belodella sp.
Eognathodus sulcatus juliae Lane and Ormiston
Ozarkodina selfi Lane and Ormiston
Panderodus sp.
Pelekysgnathus? sp. indet. (coniform elements)
Pseudooneotodus sp.
scolecodonts
CAI:5
AGE: Early Devonian, Pragian, *sulcatus-kindlei* zones

270. C-081839 694.5 m AWN
cf. *Styliolina* sp.
Nowakia? sp.
AGE: Pragian of Early Devonian to Frasnian of early Late Devonian

271. C-086335 687 m MJO
Belodella sp.
Eognathodus sulcatus? *kindlei* Lane and Ormiston
Panderodus sp.
scolecodonts
CAI: 5
AGE: Early Devonian, Pragian, *sulcatus-kindlei* zones

272. C-081840 651 m AWN
favositid coral
cup coral
pelecypod
bryozoan
Salopina sp.
cf. *Plicoplasia acutiplicata* Lenz
Atrypa sp.
Spinatrypa sp.
cf. *Ancillotoechia* sp.
echinoderm ossicle with single axial canal
REMARKS: The presence of *Plicoplasia acutiplicata* Lenz suggests a late Lochkovian to Pragian, Early Devonian age for the containing beds (Lenz, 1977b, p. 17). This form has been recorded also by Perry (1974) from the Delorme Formation.
AGE: late Lochkovian to Pragian

273. C-081835 552 m AWN
Gypidula sp. 1 of Lenz (1977a)
Plicoplasia acutiplicata Lenz
Atrypa sp.
Desquamatia filistriata Lenz
Spinatrypa sp.
Ambocoelia sp.
small finely costate pelecypod
gastropod
cephalopod
echinoderm ossicle with single axial canal
REMARKS: *Desquamatia filistriata* Lenz (1977b) is a form that is restricted to beds of Pragian, Early Devonian age, in the Royal Creek area of the Yukon Territory. The presence of *Plicoplasia acutiplicata* Lenz in sample C-081835 suggests a late Lochkovian to Pragian, Early Devonian age for the containing beds (Lenz, 1977b, p. 17). This form has been recorded also by Perry (1974) from the Delorme Formation.
AGE: late Lochkovian to Pragian, Early Devonian

274. C-086334 532.5 m MJO
Ozarkodina remscheidensis remscheidensis (Ziegler)
CAI: 5
AGE: latest Silurian-Early Devonian, late Pridolian-mid-Lochkovian

275. C-086333 498 m MJO
Dapsilodus sp.
Ozarkodina cf. *O. confluens* (Branson and Mehl)
O. cf. *O. fundamentata* (Walliser)
Panderodus sp.
scolecodonts, ostracodes, microgastropods, inarticulate brachiopods, pellets, ichthyoliths
CAI: 5
AGE: probably Late Silurian, ?Ludlow

276. C-081837 498 m BSN
unstudied fossils
Monograptus sp.
Cheirurus? sp.
Encrinurus sp.
AGE: Silurian, probably Middle or Late

277. C-081845 468 m BSN
Bohemograptus aff. *B. bohemicus* (Barrande)
Monograptus sp.
AGE: Late Silurian, Ludlow

278. C-086332 426 m MJO
Panderodus sp.
dolobrate element
CAI: 5
AGE: probably Silurian

279. C-081848 364.5 m BSN
ostracodes, brachiopods, gastropods
echinoderm and fish fragments
Astroproetus? sp.
Encrinurus sp.
Cheirurus? sp.
Coenites sp.
AGE: Silurian, probably Middle or Late

280. C-086331 258 m MJO
Oulodus sp.
Panderodus spp.
Pseudooneotodus sp.
Pterospathodus pennatus (Walliser)
ichthyoliths, gastropods
CAI: 5
AGE: late Early to early Middle Silurian, late Llandovery to early Wenlock, *celloni-amorphognathoides* zones

Section 36 (62°46.9′;128°20′)

281. C-074481 580.5 m BSN
Monograptus sp.
AGE: Late Silurian to Early Devonian, Pridoli to Pragian

282. C-086330 456 m MJO
Aspidognathus n. sp. aff.
A. tuberculatus (Walliser)
Aulacognathus n. sp. aff. *A. bullatus* Nicoll and Rexroad
Carniodus carnulus (Walliser)
Distomodus staurognathoides Walliser
Oulodus cf. *O. fluegeli* (Walliser)
Panderodus sp.
Pseudooneotodus tricornis Drygant
P. pennatus procerus (Walliser)
CAI: 5
AGE: late Early to early Middle Silurian, late Llandovery-early Wenlock(?), *amorphognathoides* Zone

Section 37 (62°33.2′;128°13.2′)

283. C-102574 732 m MJO
Eognathodus sulcatus Philip
Icriodus cf. *I. claudiae* Klapper and Johnson
I. cf. *I. steinachensis* Al-Rawi
Pandorinellina exigua (Philip)
Polygnathus pireneae Boersma
CAI: 5
AGE: Early Devonian, Pragian, *kindlei* Zone

Section 41 (62°31.9′;128°36.5′)

284. C-079642 34 m BSN
retiolitid graptolite
Monograptus spp.
M. ex gr. *M. priodon* (Bronn)
M. sp. or *Cyrtograptus* sp.
AGE: Silurian, Llandovery to Wenlock, probably late Llandovery or Wenlock

285. C-103695 25-33 m MJO
Kockelella? sp. aff. "*Spathognathodus*" *abruptus* Aldridge
Pterospathodus celloni (Walliser)
CAI: 5
AGE: Silurian, probably later Llandovery

Section 45 (62°8.0′;130°1.5′)

286. C-102585 16.5 m MJO
Panderodus sp.
Pandorinellina cf. *P.* n. sp. O Klapper and Johnson
Pelekysgnathus? sp. (coniform elements)
Polygnathus dehiscens Philip and Jackson
P. aff. *P. perbonus* (Philip)?
CAI: 5
AGE: Early Devonian, latest Pragian-Zlichovian, *dehiscens* or *gronbergi* zones

Section 46 (62°42.0′;128°26.0′)

287. C-087539(a) -3.2 m MJO
Belodella sp.
ramiform fragment
REMARKS: 3.2 m below Grizzly Bear Formation.
AGE: Ordovician-Late Devonian

Section 47 (62°59.2′;129°49.2′)

288. C-087607 413 m MJO
Panderodus sp. indet.
ramiform fragment
CAI: 6-7
AGE: Ordovician-Early Devonian

Section 48 (62°56.1′);128°25.2′)

289. C-086411 325.5 m MJO
Belodella sp.
Panderodus sp.
Pandorinellina expansa Uyeno and Mason
Polygnathus inversus Klapper and Johnson
P. serotinus Telford
Steptotaxis glenisteri (Klapper)
sponge spicules
CAI: 5
AGE: Early Devonian, Dalejan, *serotinus* Zone

290. C-074491 318-324 m AWN
siliceous sponge spicules
goniatite impressions
Coleolus sp.
Nowakia sp.
Styliolina sp.
Gasterocoma? *bicaula* Johnson and Lane
echinoderm ossicle with single axial canal
REMARKS: The "two-holer" echinoderm ossicle referred to as *Gasterocoma*? *bicaula* is widely distributed in North America and elsewhere. This form ranges from about mid-Emsian of the Early Devonian to earliest Eifelian of the early Middle Devonian, but appears to be most abundant in beds of late Emsian age where dated by associated conodonts.
AGE: mid-Emsian of Early Devonian to earliest Eifelian of early Middle Devonian

291. C-074490 145 m AWN
Nowakia acuaria (Richter)
AGE: late Lochkovian to early Zlichovian of the Early Devonian

Section 49 (62°33.0′;128°17.5′)

292. C-081802 150 m TTU
Polygnathus cf. *P. parawebbi* Chatterton (2 juvenile Pa elements)
CAI: 4.5
AGE: *australis* Zone to Lower *varcus* Subzone (middle Eifelian to early Givetian, Middle Devonian)

293. C-086414 124.5 m MJO
Polygnathus sp. indet.
sponge spicules
CAI: 5
AGE: late Early Devonian through Mississippian

294. C-081801 124.5 m TTU
?*Polygnathus beckmanni* Bischoff and Ziegler (single fragmentary Pa element)
Polygnathus linguiformis Hinde, epsilon morphotype of Ziegler and Klapper (in Ziegler et al., 1976)

P. parawebbi Chatterton
CAI: 5
AGE: Lower *varcus* Subzone (early Givetian, early Middle Devonian)

Section 50 (62°19.1′;128°0.2′)

295. C-081863 70 m BSN
Monograptus sp.
AGE: probably Late Silurian or Early Devonian

Section 51 (62°42.2′;128°25.6′)

296. C-086350 360 m MJO
Eognathodus sulcatus kindlei Lane and Ormiston
"*Ozarkodina*" *selfi* Lane and Ormiston
Pelekysgnathus cf. *P. serratus* Jentzsch
Polygnathus pireneae Boersma
Pseudooneotodus sp.
dacryoconarids
CAI: 5
AGE: Early Devonian, Pragian, *kindlei* Zone

297. C-074489 360 m AWN
Styliolina sp.
Nowakia sp. cf. *Nowakia acuaria* (Richter) s.l.
AGE: late Lochkovian to Pragian of the Early Devonian

298. C-074495 358.5 m AWN
Orbiculoidea sp.
Nowakia sp.
Styliolina sp.
AGE: Pragian of Early Devonian to Frasnian of early Late Devonian

299. C-074488 277 m BSN
Monograptus aff. *M. aequabilis* (Pribyl)
M. aff. *M. praehercynicus* Jaeger
AGE: Early Devonian, probably Lochkovian

300. C-074485 189 m BSN
**Cyrtograptus* cf. *C. radians* Tornquist
Monograptus sp.
M. cf. *M. testis* (Barrande)
REMARKS: *Indicates placed in reference collection.
AGE: Middle Silurian, late Wenlock

301. C-074487 150 m BSN
Cyrtograptus sp.
C. aff. *C. canadensis* Jackson and Etherington
Monograptus sp.
M. ex gr. *M. priodon* (Bronn)
M. ex gr. *M. spiralis* (Geinitz)
Retiolites sp.
AGE: late Early Silurian, latest Llandovery, late *Monograptus spiralis* zone

Section 52 (62°47.5′;128°9.1′)

302 C-092570 75.5-76.5 m BSN
indeterminate trilobite and brachiopod
ostracode
retiolitid graptolite
Cyrtograptus sp.
Monograptus spp.
**M. firmus nahanniensis* Lentz
REMARKS: *Indicates placement in reference collection.
AGE: Middle Silurian, Wenlock

303. C-087729 71.5 m MJO
Oulodus? sp.
Ozarkodina confluens (Branson and Mehl)
O. cf. *O. excavata* (Branson and Mehl)
ichthyoliths
CAI: 5
AGE: Middle-Late Silurian

304. C-092569 68.0-68.05 m BSN
Monograptus sp.
M. ex gr. *M. priodon* (Bronn)
AGE: late Early or Middle Silurian, late Llandovery to Wenlock

305. C-092568 48.00-48.25 m BSN
Dictyonema? sp.
Cyrtograptus sp.
Monograptus sp.
AGE: Middle Silurian, Wenlock

306. C-092567 44.00-44.05 m BSN
Monograptus sp.
Retiolites sp.
AGE: Early or Middle Silurian, Llandovery to Wenlock

307. C-087750 43 m MJO
Aspidognathus n. sp.C
Carniodus carnulus Walliser
Oulodus cf. *O. fluegeli* (Walliser)
Panderodus sp.
Pterospathodus pennatus (Walliser)
P. aff. *P. amorphognathoides* Walliser
CAI: 5
AGE: late Early to early Middle Silurian, latest Llandovery-early Wenlock *amorphognathoides* Zone

308. C-092566 30.50-36.55 m BSN
Monograptus sp.
AGE: Silurian

309. C-092565 10.5-10.6m BSN
Monograptus sp.
AGE:Silurian

310. C-092564 0 m BSN
Monograptus ex gr. *M. spiralis* (Geinitz)
AGE: late Early Silurian, late Llandovery, *M. spiralis* Zone

311. C-087749 0 m MJO
"*Oulodus*" cf. "*O.*" *fluegeli* (Walliser)
Panderodus? sp.
Pterospathodus celloni Walliser
scolecodonts
shell fragments
sponge spicules
CAI: 5
AGE: Early Silurian, late Llandovery, *celloni-amorphognathoides* zones

Section 53 (62°33.2′;128°22.3′)

312. C-081889 0-30 BSN
Bohemograptus aff.*B. bohemicus* (Barrande)
Monograptus sp.
AGE: Late Silurian, Ludlow

Section 54 (62°28.4′;127°59.1′)

313. C-086405 301-306 m MJO
Icriodus taimyricus Kuzmin
I. sp. indet.
Pandorinellina sp. indet.
Polygnathus cf. *P. dehiscens* Philip and Jackson
CAI: 5

AGE: Early Devonian, late Pragian-early Zlichovian, *dehiscens* Zone

314. C-081812 301-306 m AWN
undet. pelecypod
Styliolina sp.
Nowakia acuaria (Richter) s.l.
Monograptus sp.
AGE: late Lochkovian to Pragian of the Early Devonian

315. C-081810 122-125 m BSN
sponge spicules
Bohemograptus aff. *B. bohemicus* (Barrande)
Linograptus sp.
Monograptus sp.
AGE: Late Silurian, Ludlow

Section 55 (62°59.3′;128°19.4′)

316. C-087820 825 m BSN
dacryoconarid
rhynchonellid and other brachiopods
AGE: Devonian

317. C-087835 820 m AWN
favositid coral
Atrypa sp. cf. *A. nieczlawiensis* Kozlowski
Spinatrypa sp.
bryozoan fragments
cf. *Platyceras* sp.
Styliolina sp.
small echinoderm ossicle with single axial canal
very large echinoderm ossicle with large star-shaped axial canal
REMARKS: The presence of *Styliolina* sp. suggests a Pragian or younger age (Lardeux, 1966). See remarks for collection at 706 m (AWN).
AGE: probably Pragian, Early Devonian

318. C-087648 766 m MJO
Panderodus? sp.
Pseudooneotodus sp. indet.
ramiform fragments
scolecodont
CAI: 5
AGE: Silurian-Devonian (L)

319. C-087647 764 m MJO
Ozarkodina? sp. indet.
Panderodus sp.
CAI: 6
AGE: Silurian-Early Devonian

320. C-087829 706 m AWN
douvillinid
Pragmostrophia mucronata Lenz
Gypidula sp. l. of Lenz (1977a)
Katunia? *postmodica* (Scupin)
Atrypa sp. cf. *A. nieczlawiensis* Kozlowski
REMARKS and AGE: Part of sample C-087829 was etched with acid by B.S. Norford, and conodonts in the residue of this sample were examined and dated by T.T. Uyeno as mid-Lochkovian, Early Devonian age. Brachiopods in samples C-087835, C-087829, C-087830, C-087828 (this section), and C-088016 and C-087733 (Sapper Formation-isolated outcrops) are suggestive of a single fauna that collectively range in age from Lochkovian to Pragian of the Early Devonian. Comparison is made with the detailed brachiopod sequence established by Lenz (1977a,b) in the Royal Creek area of the Yukon Territory and with the Cathedral Mountain section in the southwestern District of Mackenzie by Norris and Uyeno (1981).

321. C-087829 706 m TTU
Ozarkodina stygia (Flajs)
O. remscheidensis remscheidensis (Ziegler)
Pandorinellina optima (Moskalenko)
CAI: 5
AGE: Early Devonian, middle Lochkovian (*eurekaensis* to *delta* zones)

322. C-087830 670 m AWN
favositid coral
Latonotoechia ludvigseni Lenz
Thiborhhynchia kerri Johnson
orthoconic cephalopod
echinoderm ossicle with single axial canal
REMARKS: See remarks for collection at 706 m (AWN).
AGE: Lochkovian to Pragian, Early Devonian

323. C-087828 521 m AWN
cup coral showing peripheral budding
cf. *Stylopleura* sp.
Coenites rectilineatus (Simpson)
undetermined colonial coral
Atrypa aspiformis Lenz
echinoderm ossicle with single axial canal
REMARKS: See remarks for collection at 706 m (AWN).
AGE: Lochkovian to Pragian, Early Devonian

324. C-087836 460 m AWN
Coenites rectilineatus (Simpson)
douvillinid
Muriferella sp.
Howellella sp. aff. *H. laeviplicata* (Kozlowski)
small echinoderm ossicle with single axial canal
large echinoderm ossicle with star-shaped axial canal
AGE: late Pridolian, late Late Silurian

325. C-087646 412 m MJO
Ozarkodina excavata (Walliser)
Panderodus sp.
Polygnathoides siluricus Branson and Mehl
ichthyoliths
CAI: 5-6
AGE: Late Silurian, Ludlow

326. C-087827 410 m AWN
Orbiculoidea sp.
Conchidium sp.
heterostracid fish plate fragment (examined by Dr. R. Thorsteinsson)
AGE: Pridolian, Late Silurian

327. C-087821 174 m BSN
graptolite fragments
AGE: Ordovician or Silurian

GRIZZLY BEAR FORMATION

328. C-081820 62°40.0′;128°7.4′ AWN
favositid
Lekanophyllum sp.
Strophodontid
douvillinid
"*Schuchertella*" *adoceta* Crickmay
Desquamatia aperanta (Crickmay)
Warrenella sp.
Leiorhynchus manetoe McLaren
pelecypod with sharp pointed beak
Paracyclas sp.
echinoderm ossicle with single axial canal

REMARKS: Samples C-081887 and C-081820 (Grizzly Bear Formation), C-081832 and C-081833 (Funeral Formation), C-081838 (Sapper Formation), and C-082658 (Landry Formation) contain a number of elements that suggest assignment to the "*Schuchertella*" *adoceta* Zone of Pedder (1975) and are dated as early Eifelian, early Middle Devonian. This zone occurs typically in the lower, but not lowermost part, of the Hume Formation in the Norman Wells area. *Leiorhynchus manetoe* McLaren (1962) present in samples C-081887 and C-081820 (Grizzly Bear Formation), C-081838 (Sapper Formation), and C-082658 (Landry Formation) is a common element in the Headless Formation and equivalent rocks in the North and South Nahanni rivers region. Associated fossils suggest assignment to the *adoceta* Zone.
AGE: *adoceta* Zone, early Eifelian, early Middle Devonian

329. C-081887 62°37.4';128°21.0' AWN
favositid
colonial coral
cup coral
"*Schuchertella*" *adoceta* Crickmay
Desquamatia aperanta (Crickmay)
Spinatrypa andersonensis (Warren)
Leiorhynchus manetoe McLaren
bryozoan
echinoderm ossicle with single axial canal
Dechenella (*D.*) sp. cf. *D.* (*D.*) *mclareni* Ormiston
REMARKS: See C-081820 (Grizzly Bear Formation).
AGE: *adoceta* Zone, early Eifelian, early Middle Devonian

330. C-086344 62°37.4';128°21.0' MJO
Belodella sp.
Ozarkodina aff. *O. brevis* (Bischoff and Ziegler)
Panderodus sp.
Pandorinellina cf. *P. expansa* Uyeno and Mason
Polygnathus robusticostatus Bischoff and Ziegler group
P. serotinus Telford
P. aff. *P.* n. sp. B Klapper
ramiform elements
scolecodonts, dacryoconarids
CAI: 5-6
AGE: Middle Devonian, early Eifelian, *c. costatus* Zone

331. C-079644 62°28.0';128°28.5' AEHP
stromatoporoids, massive bulbous
coenostia, not studied
Squameofavosites sp. indet.
Briantia sp. nov.
Exilifrons exilis Crickmay
REMARKS: Same locality as below.
AGE: Early Devonian, late Zlichovian

332. C-103697 62°28.0';128°28.5' MJO
Belodella sp.
Panderodus sp.
Pandorinellina cf. *P. exigua* (Philip)
CAI: 5-6
REMARKS: Same locality as above.
AGE: Early Devonian, Pragian-Dalejan

333. C-086412 62°22.2';128°23.7' MJO
Panderodus sp.
Polygnathus cf. *P. inversus* Klapper and Johnson
Steptotaxis sp.
CAI: 5
AGE: Early Devonian, late Zlichovian-Dalejan, *inversus-serotinus* zones

334. C-086349 62°19.8';128°18.5' MJO
Belodella sp.
Panderodus sp.
Pandorinellina? sp. indet.
Polygnathus cf. P. *inversus* Klapper and Johnson
P. sp. indet.
Steptotaxis glenisteri Klapper
CAI: 5-6
AGE: Early Devonian, late Zlichovian-Dalejan,, *inversus-serotinus* zones

335. C-086348 62°30.6';128°37.0' MJO
Belodella spp.
Icriodus? sp. indet.
Panderodus spp.
Pandorinellina exigua exigua Philip
P. cf. *P.* n. sp. O Klapper and Johnson
Polygnathus inversus Klapper and Johnson
P. inversus-P. serotinus Telford
P. laticostatus Klapper and Johnson
Steptotaxis glenisteri Klapper
CAI: 5
AGE: Early Devonian, late Zlichovian-early Dalejan, *inversus* Zone

336. C-086343 62°18.8';127°56.0' MJO
Belodella sp.
Icriodus sp.
Ozarkodina aff. *O. brevis* (Bischoff and Ziegler)
Panderodus sp.
Pandorinellina cf. *P. expansa* Uyeno and Mason
P. cf. *P. steinhornensis* (Ziegler)
Polygnathus benderi Weddige
P. costatus costatus Klapper
P. c. aff. n. subsp. A.Chatterton
P. linguiformis linguiformis Hinde
P. parawebbi Chatterton
P. cf. *P. pseudofoliatus*
P. robusticostatus Bischoff and Ziegler group
P. spp. indet.
Tortuodus intermedius (Bultynck)
ramiform elements: M, Pb, Sc-b, Sa
sponge spicules
CAI: 5
AGE: Middle Devonian, Eifelian, *australis* Zone

Section 37 (62°33.2';128°13.2')

337. C-102575 735 m MJO
Belodella sp.
Icriodus sp.
Panderodus sp.
Pandorinellina cf. *P. expansa* Uyeno and Mason
Pelekysgnathus sp.
Polygnathus cf. *P. cooperi* Klapper
P. cf. *P. linguiformis bultyncki* Weddige
P. robusticostatus Bischoff and Ziegler group
P. serotinus Telford
Steptotaxis glenisteri (Klapper)
S.? n. sp.
CAI: 5
AGE: Early Devonian, Dalejan, *serotinus* Zone

Section 43 (62°33.2';128°43.3')

338. C-103698 0 m MJO
Belodella sp.
Pandorinellina sp. indet.
Polygnathus costatus Klapper
P. linguiformis bultyncki Weddige
P. cf. *P. serotinus* Telford
CAI: 5
AGE: Middle Devonian, Eifelian, probably *c. costatus* Zone

Section 46 (62°42.0′;128°26.0′)

339. C-087539 MJO
24 samples (labelled b to y) were collected from the Grizzly Bear Formation at this section. Apart from the top (y) and basal (b and c) samples, which are listed separately, the faunules are similar and are summarized below.

C-087539(y) 200.5 m
Belodella sp.
Pandorinellina? sp.
Polygnathus costatus Klapper
P. linguiformis Hinde group
P. robusticostatus Bischoff and Ziegler group
CAI: 5-6
AGE: Middle Devonian, Eifelian, probably *c. costatus-australis* Zone

(x)-(d) Collections at 189, 177, 165, 153, 141, 129, 117, 105, 93, 81, 75, 69, 63, 57, 51, 45, 39, 33, 27, 25, and 11 m respectively.
Belodella sp.
Panderodus sp.
Pandorinellina exigua exigua (Philip)
Steptotaxis glenisteri (Klapper)

These species are joined from 11 m (d) to 141 m (t) by:
Polynathus inverses Klapper and Johnson
P. inversus-P. serotinus Telford

At 39 m (p) the following species occurs:
P. cf. *P. laticostatus* Klapper and Johnson

At 93 m (p) the following species ocurs:
P. linguiformi bultyncki Weddige

At 153 m (u) and 165 m (v) the following species occurs:
P. cf. *P. cooperi* Klapper

At 177 m (w) the following species occurs:
P. serotinus Telford

CAI: 5-6
AGE: Early Devonian, late Zlichovian through Dalejan, *inversus* (11-81 m) and *serotinus* (93-189 m) zones

C-087539(c) 0.2 m
Belodella sp.
Icriodus sp.
Panderodus sp(p).
Pandorinellina exigua (Philip)
P. n. sp. O Klapper and Johnson
Polygnathus gronbergi Klapper and Johnson
P. cf. *P. inversus* Klapper and Johnson
P. aff. *P. perbonus* Klapper and Johnson
Steptotaxis? n. sp. Uyeno and Klapper
CAI: 5
AGE: Early Devonian, Zlichovian, late *gronbergi*-early *inversus* zones

C-087539(b) 0 m
Belodella sp.
Panderodus spp.
Pandorinellina steinhornensis (Ziegler)
P. n. sp. O Klapper and Johnson
Pelekysgnathus? *furnishi* Klapper?
Polygnathus gronbergi Klapper and Johnson
P. cf. *P. dehiscens* Philip and Johnson
P. aff. *P. perbonus* (Philip)?
CAI: 5
AGE: Early Devonian, Zlichovian, *gronbergi* Zone

Section 51 (62°42.2′;128°25.6′)

340. C-082660 534 m AWN
stromatoporoid
alveolitid
favositid
Thamnopora sp.
cup coral
Devonoproductus? sp.
Carinatrypa dysmorphostrota (Crickmay)
Nucleospira sp.
Dechenella (*D.*) sp. cf. *D.* (*D.*) *maclareni* Ormiston
echinoderm ossicle with single axial canal
REMARKS: Sample C-082660 containing *Nucleospira* sp. and *Carinatrypa dysmorphostrota* is assigned to the *dysmorphostrota* Zone of Pedder (1975) and is dated as late Eifelian, early Middle Devonian. This zone occurs typically in the upper part of the Hume Formation in the Norman Wells-Anderson River area. Elements of this zone are recognized also in several formations in the northern Yukon Territory.
AGE: *dysmorphostrota* Zone, late Eifelian, early Middle Devonian

341. C-086403 534 m MJO
Belodella sp.
Icriodus sp. indet.
Pandorinellina cf. *P. expansa* Uyeno and Mason
Polynathus costatus costatus Klapper
P. cf. *P. linguiformis* Hinde
P. sp. A
CAI: 5-6
AGE: Middle Devonian, Eifelian, *c. costatus-?australis* zones

342. C-086402 384 m MJO
Belodella sp.
Panderodus sp.
Pandorinellina exigua exigua (Philip)
Polygnathus inversus Klapper and Johnson
CAI: 5+
AGE: Early Devonian, late Zlichovian-Dalejan, *inversus-serotinus* zones

343. C-086401 363 m MJO
Belodella sp.
Panderodus sp.
Pandorinellina exigua exigua Philip
P. n. sp. O Klapper and Johnson
Polygnathus inversus Klapper and Johnson
P. inversus-P. serotinus Telford
P. aff. *P. perbonus* Klapper and Johnson
P. cf. *P. laticostatus* Klapper and Johnson
P. n. sp. aff. ("*P. cooperi secus*") Klapper, Ziegler and Mashkova
Pseudooneotodus sp.
Steptotaxis glenisteri (Klapper)
ostracodes, gastropods, dacryoconarids, bryozoans
CAI: 5
AGE: Early Devonian, late Zlichovian-early Dalejan, *inversus* Zone

FUNERAL FORMATION

344. C-087575 62°58.5′;128°47.4′ MJO
Polygnathus parawebbi Chatterton
CAI: 5
REMARKS: Single polygnathid is of early Middle Devonian aspect.
AGE: Middle Devonian, Eifelian *australis* Zone through early Givetian

345. C-087580 62°48.2';128°28.0' MJO
Polygnathus sp(p). indet.
CAI: 5
AGE: probably Middle Devonian

346. C-087608 62°57.4';128°45.5' MJO
acodiniform element
CAI: 5
REMARKS: this collection reassigned to Sapper Formation
AGE: probably Devonian

347. C-086347 62°43.0';128°30.4' MJO
Belodella sp.
Polygnathus cf. *P. linguiformis* Hinde
P. cf. *P. parawebbi* Chatterton
CAI: 5
AGE: Middle Devonian, probably Eifelian

348. C-081883 62°43.0';128°30.4' BSN
undetermined brachiopods, gastropod, bryozoan, algal, and echinoderm fragments
Dechenella (*Dechenella*) sp.
AGE: Middle Devonian, Eifelian or Givetian

Section 35 (62°47.7′;128°07.8′)

349. C-086341 1707 m MJO
Belodella sp.
Icriodus sp. indet.
Ozarkodina aff. *O. brevis* (Bischoff and Ziegler)
CAI: 5
AGE: Middle Devonian, Eifelian, *c. costatus* Zone

350. C-081833 1659 m AWN
Alveolites sp.
Coenites sp.
Favositid
Productella sp.
Emanuella sp.
Desquamatia aperanta (Crickmay)
Spinatrypa andersonensis (Warren)
Plectospirifer sp.
bryozoan fragments
Cypricardenia sp.
Dechenella (*D.*) sp. cf. *D.* (*D.*) *neotesca* Ormiston
REMARKS: Samples C-081887 and C-081820 (Grizzly Bear Formation), C-081832 and C-081833 (Funeral Formation), C-081838 (Sapper Formation), and C-082658 (Landry Formation) contain a number of elements that suggest assignment to the "*Schuchertella*" *adoceta* Zone of Pedder (1975) and are dated as early Eifelian, early Middle Devonian. This zone occurs typically in the lower, but not lowermost part, of the Hume Formation in the Norman Wells area.
AGE: *adoceta* Zone, early Eifelian, early Middle Devonian

351. C-081844 1557 m AWN
favositid coral
Desquamatia sp.
Carinatrypa sp.
Spinatrypa sp.
Warrenella sp.
pelecypod
echinoderm ossicle with single axial canal
Dechenella (*Dechenella*) sp.
Tentaculites sp.
AGE: probably Eifelian, early Middle Devonian

352. C-081843 1506 m AWN
Dechenella (*Dechenella*) n. sp.
AGE: probably Eifelian, early Middle Devonian

353. C-086340 1440 m MJO
Belodella sp.
AGE: presumably Middle Devonian, Eifelian (fauna is bracketed)

354. C-086339 1284 m MJO
Belodella sp.
Polygnathus costatus costatus Klapper
Tortuodus cf. *T. intermedius* (Bultynck)
sponge spicules, ostracodes, dacryoconarids
CAI: 5
AGE: Middle Devonian, Eifelian, *c. costatus-australis* zones

355. C-081842 1143 m AWN
Schizophoria sp.
Desquamatia sp. cf. *D. aperanta* Crickmay
Spinatrypa sp.
Carinatrypa sp. cf. *C. dysmorphostrota* Crickmay
cf. *Warrenella* sp.
echinoderm ossicle with single axial canal
Dechenella (*Dechenella*) sp.
Schizoproetoides sp.
REMARKS: Samples C-081844, C-081843, and C-081842 of this section contain a number of fossil elements in common with the Funeral, Headless, and Nahanni formations of the southern Mackenzie Mountains which suggest an Eifelian, early Middle Devonian age. Detchenellid trilobites, most of which appear to be new species, are common in all four of the samples.
AGE: Eifelian, early Middle Devonian

Section 37 (62°33.2′;128°13.2′)

356 C-102577 775 m MJO
Polygnathus aff. *P. costatus* Klapper
CAI: 5
AGE: Middle Devonian, probably Eifelian

DELORME FORMATION

357. C-087602 62°58.0';127°55.0' MJO
Ozarkodina cf. *O. remscheidensis remscheidensis* (Ziegler)
CAI: 4-5
REMARKS: Collected from basal 0.2 m of Delorme Formation immediately above locality C-087601.
AGE: Late Silurian, Pridolian-Early Devonian, mid-Lochkovian

Section 57 (62°59.8′;128°56.0′)

358. C-087604 6 m MJO
Ozarkodina remscheidensis Ziegler
icthyolith
CAI: 4-5
AGE: Late Silurian, Pridolian-Early Devonian, mid-Lochkovian

SOMBRE FORMATION

Section 55 (62°59.5′;128°19.7′)

359. C-087583 877 m MJO
Eognathodus sulcatus cf. *kindlei* Lane and Ormiston
Icriodus? sp. (coniform element)
CAI: 6
AGE: Early Devonian, Pragian, *sulcatus-kindlei* zones

Section 56 (62°56.7′;128°0.2′)

360. C-087525 -5 to 0 m MJO
Panderodus sp.
Pandorinellina sp. indet.
Polygnathus sp. indet. (posterior fragment with inverted cavity)
Steptotaxis glenisteri Klapper
crinoid ossicles
tentaculitid
CAI: 5
AGE: Early Devonian, late Zlichovian-early Dalejan, *inversus* Zone

361. C-087524 approx. -70 m MJO
Belodella sp.
Panderodus sp.
Pandorinellina sp. indet.
Pelekysgnathus furnishi Klapper
Polygnathus dehiscens Philip and Jackson
crinoid ossicles
CAI: ?6-7 (?superficial)
REMARKS: Collected from middle black dolostone member of Sombre Formation.
AGE: Early Devonian, late Pragian-Zlichovian, *dehiscens-gronbergi* zones

ARNICA FORMATION

Section 56 (62°56.7′;128°0.2′)

362. C-087527 42 m MJO
Belodella sp.
Panderodus sp.
Pandorinellina steinhornensis steinhornensis (Ziegler)
P. n. sp. O Klapper and Johnson?
Polygnathus crascens Klapper, Ziegler and Mashkova?
P. inversus Klapper and Johnson
P. cf. *P. laticostatus* Klapper and Johnson
Pseudooneotodus spp.
Stepanovites glenisteri Klapper
CAI: 5
AGE: Early Devonian, late Zlichovian-Dalejan, *inversus* or possibly *serotinus* Zone

363. C-087526 18 m MJO
Belodella sp.
Panderodus sp.
Pandorinellina exigua exigua (Philip)
P. n. sp. O Klapper and Johnson
Polygnathus inversus Klapper and Johnson
P. cf. *P. laticostatus* Klapper and Johnson
P. aff. *P. perbonus* (Philip)
gastropods
ichthyoliths
CAI: 5
AGE: Early Devonian, late Zlichovian-early Dalejan, *inversus* Zone

NATLA FORMATION

364. C-088022 62°56.9';128°18.7' AWN
orthoconic cephalopod
Styliolina sp.
Stylionowakia sp. cf. *S. ligeriensis* Lardeux
REMARKS: The presence of *Stylionowakia* sp. cf. *S. ligeriensis* Lardeux (1969) suggests a late Emsian, Early Devonian age. This species occurs typically in the Armoricain area of France.
AGE: late Emsian, Early Devonian

365. C-082656 62°53.4';127°59.5' AWN
favositid
Thamnopora sp.
cup corals
Spinatrypa sp. – impression of shell fragment
Warrenella sp.
orthoconic cephalopod fragments
Dechenella (*D.*) sp. cf. *D.* (*D.*) *maclareni* Ormiston
very large echinoderm ossicle with single axial canal
echinoderm ossicle with small axial canal
REMARKS: One sample (C-082656) is dated as Eifelian, early Middle Devonian, based mainly on the presence of the widespread trilobite suggestive of *Dechenella* (*D.*) *maclareni* Ormiston (1967).
AGE: Eifelian, early Middle Devonian

366. C-074494 62°53.4';127°59.5' AWN
Styliolina sp.
Stylionowakia sp.
cf. *Gurichina* sp.
Nowakia sp. cf. *N. zlichovensis* Boucek
AGE: early Zlichovian of late Early Devonian

367. C-074493 62°53.5';127°59.2' AWN
Nowakia sp.
Styliolina sp.
cf. *Viriatella* sp.
AGE: Zlichovian of late Early Devonian to about mid-Frasnian of the early Late Devonian

368. C-086346 62°53.5';127°59.2' MJO
Belodella spp.
"Coelocerodontus" klapperi Chatterton
Panderodus sp.
Polygnathus cooperi cooperi Klapper
P. inversus Klapper and Johnson
P. cf. *P. linguiformis bultyncki* Weddige
P. serotinus Telford
Steptotaxis glenisteri (Klapper)
inarticulate brachiopods
CAI: 5
AGE: Early Devonian, Dalejan, *serotinus* Zone

Section 55 (62°59.5′;128°19.7′)

369. C-087585 1825 m MJO
Belodella sp.
Polygnathus costatus costatus Klapper
P. robusticostatus Bischoff and Ziegler group
CAI: 5
AGE: Middle Devonian, Eifelian, *c. costatus-australis* zones

370. C-087846 1825 m AWN
Styliolina sp.
Nowakia? sp.
REMARKS: Poor preservation of the forms suggestive of *Styliolina* and *Nowakia* in sample C-087846 precludes a more precise age determination. Species of the two genera range throughout the Pragian to Frasnian of the Devonian (Lardeux, 1966).
AGE: Pragian to Frasnian of the Devonian

371. C-087584 1502 m MJO
Belodella sp.
Panderodus sp.
Pandorinellina exigua exigua Philip
P. steinhornensis (Ziegler)
Polygnathus inversus Klapper and Johnson
P. inversus-P. serotinus Telford
P. cf. *P. cooperi* Klapper

Pseudooneotodus sp.
CAI: 5
AGE: Early Devonian, late Zlichovian-early Dalejan, *inversus-serotinus* zones

Section 56 (62°56.7′;128°0.2′)

372. C-087532 490-500 m MJO
Belodella sp.
Icriodus sp.
Polygnathus costatus Klapper group
silicified ostracodes, tentaculitids, sponge spicules
CAI: 5
AGE: Middle Devonian, Eifelian to early Givetian

373. C-087531 498 m MJO
Belodella sp.
Polygnathus costatus costatus Klapper
P. cf. *P. parawebbi* Chatterton
P. robusticostatus Bischoff and Ziegler group
ostracodes, tentaculitids, spicules, ichthyoliths
CAI: 5
AGE: Middle Devonian, Eifelian, probably *australis* Zone

374. C-092575 496 m MJO
Belodella sp.
Icriodus sp. indet.
sponge spicules (hexaradial), ostracodes
tentaculitids, phosphatic spheres, bryozoans
AGE: Middle Devonian

375. C-087529 198-200 m MJO
Belodella sp.
Icriodus expansus Branson and Mehl
Panderodus sp.
Pandorinellina n. sp. A Uyleno and Mason
Pelekysgnathus sp.
Polygnathus linguiformis bultynki Weddige?
P. robusticostatus Bischoff and Ziegler group
ostracodes, ichthyoliths
CAI: 5
AGE: Middle Devonian, Eifelian, *patulus-c. costatus* zones

376. C-092574 71.5-72.0 m AWN
Nowakia sp. cf. *N. cancellata* (Richter)
Styliolina sp.
Variatella sp. cf. *V. procera* (Maurer)
undet. pentamerid brachiopod
undet. rhynchonellid brachiopod
REMARKS: Both *Nowakia* sp. cf. *N. cancellata* (Richter) and *Variatella* sp. cf. *V. procera* (Maurer) in sample C-092574 are closely related but not identical to forms that occur typically in the lower and upper parts, respectively, of the Dalejan and equivalent rocks. This range is from upper Lower Devonian to lowermost Middle Devonian if the Lower-Middle Devonian boundary is drawn at the base of the conodont Upper *patulus* Subzone which marks the base of the Eifelian (Lutke, 1979).
AGE: Dalejan, late Early and earliest Middle Devonian

377. C-092574 30.0-71.5 m MJO
Belodella sp.
Panderodus sp.
Polygnathus inversus Klapper and Johnson
P. inversus-P. serotinus Telford
P. aff. *P. linguiformis bultyncki* Weddige
Pseudooneotodus sp.
scolecodonts, inarticulate brachipods
CAI: 5
AGE: Early Devonian, late Zlichovian-Dalejan, *inversus-serotinus* zones

LANDRY FORMATION

378. C-086410 62°53.4';127°59.6' MJO
Belodella sp.
Pandorinellina n. sp. B. Chatterton
Polygnathus pseudofoliatus Wittenkindt
ostracods, crioconarids, trilobites, bryozoans
CAI: 5
REMARKS: An exceptionally well-preserved silicified microfauna, with a particularly rich ostracode fauna. Collection from same location as collection C-82658 below.
AGE: Middle Devonian, middle Eifelian-(?)early Givetian, *australis-ensensis* zones

379. C-082658 62°53.4′;127°59.6′ AWN
Desquamatia aperanta (Crickmay)
Warrenella sp. cf. *W. quadrata* Ludvigsen and Perry
Leiorhynchus manetoe McLaren
bryozoan fragments
large coarsely costate pelecypod
orthoconic cephalopod
large echinoderm ossicle with single axial canal
Dechenella (D.) sp.
REMARKS: See C-081820 (Grizzly Bear Formation). Collection from same location as collection C-086410 above.
AGE: *adoceta* Zone, early Eifelian, early Middle Devonian

380. C-087572 62°56.8';128°18.1' MJO
Polygnathus costatus Klapper group
ramiform fragments
CAI: 6-7
AGE: Middle Devonian, probably Eifelian

Section 55 (62°59.5′;128°19.4′)

381. C-087587 2042 m MJO
Pelekysgnathus? sp. indet. (coniform elements)
Polygnathus costatus costatus Klapper
Po. sp.
CAI: 5+
AGE: Middle Devonian, Eifelian, *c. costatus-australis* zones

382. C-087586 1971 m MJO
Belodella sp.
Icriodus sp. indet.
Milaculum sp.
Polygnathus robusticostatus Bischoff and Ziegler group
Tortuodus? sp.
CAI: 5
AGE: Middle Devonian, Eifelian, *c. costatus-australis* zones

Section 56 (62°57.0′;128°0.0′)

383. C-087536 895 m
Icriodus sp. indet.
Panderodus sp.
ramiform elements indet.
scolecodonts
AGE: Middle Devonian

384. C-087535 773 m MJO
Belodella sp.
Icriodus sp.
Polygnathus parawebbi Chatterton
CAI: 5
AGE: Middle Devonian, Eifelian-Givetian, *australis*-Lower *varcus* zones

HEADLESS FORMATION

Section 56 (62°56.7′;128°0.2′)

385. C-087537 30-900 m MJO
Belodella sp.
Icriodus sp.
Panderodus sp.
Polygnathus robusticostatus Bischoff and Ziegler group?
CAI: 5
AGE: Middle Devonian

Section 59 (62°55.4′;128°4.0′)

386. C-102587 -0.5 to 0 m MJO
Belodella sp.
Icriodus sp.
agglutinated forams
CAI: 5
AGE: Middle Devonian

NAHANNI FORMATION

387. C-087579 62°48.2′;128°28.1′ MJO
Neopanderodus sp.
Polygnathus costatus Klapper group
P. parawebbi Chatterton
P. cf. *P. linguiformis linguiformis* Hinde
CAI: 5
AGE: Middle Devonian, Eifelian

Section 35 (62°47.7′;128°07.8′)

388. C-086342 1795.5 m MJO
Belodella sp.
Icriodus sp.
Neopanderodus sp.
Polygnathus sp. indet.
ostracodes, bryozoans
CAI: 5
AGE: Middle Devonian, probably middle to late Eifelian

389. C-081849 1795.5 m AWN
Desquamatia sp.
Dechenella (*Dechenella*) sp.
REMARKS: Samples C-081842, C-081843, C-081844 (see under Funeral Formation), and C-081849 contain a a number of fossil elements in common with the Funeral, Headless, and Nahanni formations of the southern Mackenzie Mountains which suggest an Eifelian, early Middle Devonian age. Dechenellid trilobites, most of which appear to be new species, are common in all of the four samples.
AGE: probably Eifelian, early Middle Devonian

390. C-081832 1728 m AWN
cymostrophid? sp.
Schizophoria sp. cf. *S. macfarlani* (Meek)
"*Schuchertella*" *adoceta* Crickmay
Desquamatia aperanta (Crickmay)
bryozoan
Paracyclas sp.
Platyceras sp.
Dechenella (*D.*) sp.
REMARKS: Samples C-081887 and C-081820 (Grizzly Bear Formation), C-081832 and C-081833 (Funeral Formation), C-081838 (Sapper Formation), and C-082658 (Landry Formation) contain a number of elements that suggest assignment to the "*Schuchertella*" *adoceta* Zone of Pedder (1975) and are dated as early Eifelian, early Middle Devonian. This zone occurs typically in the lower, but not lowermost part, of the Hume Formation in the Norman Wells area.
AGE: *adoceta* Zone, early Eifelian, early Middle Devonian

Section 36 (62°46.8′;128°20.1′)

391. C-086409 795 m MJO
Belodella? sp.
Neopanderodus sp.
Polygnathus linguiformis linguiformis Hinde
P. parawebbi Chatterton
Tortuodus? cf. *T. intermedius* (Bultynck)

Section 60 (62°55.4′;128°4.0′)

392. C-102588 26.6 m MJO
"*Coelocerodontus*" cf. *C. klapperi* Chatterton
Icriodus sp. indet.
Polygnathus costatus costatus Klapper
P. cf. *P. linguiformis* Hinde
P. robusticostatus Bischoff and Ziegler group
CAI: 5
AGE: Middle Devonian, probably Eifelian, *australis* zone and younger

PORTRAIT LAKE FORMATION

393. C-087588 62°29.0′;129°21.4 MJO
Palmatolepis cf. *P. perlobata grossi* Ziegler
P. perlobata schindewolfi Muller
CAI: 5
AGE: Late Devonian, Famennian, probably *marginfera-velifera* zones

394. C-087589 62°29.6′;129°23.5′ MJO
Palmatolepis glabra lepta Ziegler and Huddle
P. glabra prima Zeigler and Huddle
P. cf. *P. glabra pectinata* Ziegler
P. cf. P. gracilis Branson and Mehl
P. cf. *P. marginifera* Helms
AGE: Late Devonian, Famennian, *marginifera* Zone

395. C-086285 62°25.8′;129°18.0′ MJO
Palmatolepis glabra lepta Zeigler and Huddle
Polygnathus sp.
CAI: 5
AGE: Late Devonian, Famennian, probably *marginifera-velifera* zones

396. C-086286 62°27.6′;129°19.0′ MJO
Palmatolepis glabra Ulrich and Bassler subsp. indet.
Polygnathus spp.
"*Spathognathodus*" sp.
CAI: 5
AGE: Late Devonian, Famennian, *crepida-velifera* zones

397. 62°24′;128°30′ MJO
The following faunas, collected by K.M. Dawson are within 0 to 15 m beneath bedded barite locality (see Dawson and Orchard, 1982)

C-087543
Mesotaxis asymmetricus asymmetricus (Bischoff and Ziegler)

C-087542
Polygnathus cf. *P. dubius* Hinde
P. cf. *P. dengleri* Bischoff and Ziegler

?*P. varcus* Stauffer group
Icriodus sp. indet.
"*Spathognathodus*" sp.

C-087696
Mesotaxis asymmetricus (Bischoff and Ziegler)
Polygnathus sp.

C-087697
Polygnathus dubius Hinde
Mesotaxis asymmetricus (Bischoff and Ziegler)
Polygnathus sp.

C-101979
Ancyrodella cf. *A. curvata* (Branson and Mehl)

C-101978
Palmatolepis cf. *P. transitans* Muller
Mesotaxis asymmetricus (Bischoff and Ziegler)
Polygnathus cf. *P. dubius* Hinde

CAI: 5
AGE: Late Devonian, early Frasnian; in total, these collections date from the *asymmetricus* Zone

398. C-087552 62°27.7';129°27.2' MJO
?*Tortuodus kockelianus* (Bischoff and Ziegler)
AGE: middle or late Eifelian

399. C-087881 62°29.8';129°28.5' BSN
Monograptus yukonensis Jackson and Lenz
AGE: Early Devonian, Pragian, *M. yukonensis* Zone

400. C-088046 62°18.6';129°27.9' BSN
Monograptus cf. *M. thomasi* Jaeger
REMARKS: Collected at a date subsequent to measurement of Section 14, on same line of section estimated not more than 20 m(?) above top of SteelFormation. Four graptolite zones currently are recognized in the lower Devonian of western Canada: in ascending order the *uniformis,hercynicus, thomasi,* and *yukonensis* zones. Although the preservation in C-088046 is very poor, sufficient numbers of specimens are present to rule out the *yukonensis* Zone in that no "J-shaped" rhabdosomes are present.
AGE: Early Devonian, Pragian, probably *M. thomasi* Zone

401. C-086288 62°29.5';129°13.6' MJO
Belodella sp.
Pandorinellina? sp. indet.
Polygnathus inversus Klapper and Johnson
P. aff. *P. perbonus* Klapper and Johnson
hexactinellid sponge spicules
AGE: Early Devonian, late Zlichovian-early Dalejan, *inversus* Zone

402. C-076623 62°29.5';129°13.6' TTU
Pandorinellina exigua exigua (Philip)
P. steinhornensis steinhornensis (Ziegler)
Polygnathus gronbergi Klapper and Johnson
P. aff. *P. perbonus* (Philip)
AGE: Early Devonian, *P. gronbergi* Zone of Klapper and Johnson (1977)

403. C-086287 62°28.0';129°10.5' MJO
Belodella sp.
Pandorinellina sp. indet.
Pelekysgnathus? sp. (coniform element)
Polygnathus pireneae Boersma
AGE: Early Devonian, late Pragian-early Zlichovian, *kindlei-dehiscens* zones

Section 19 (63°38.4';130°02.8')

404. C-087562 75 m MJO
Palmatolepis glabra lepta Ziegler and Huddle
P. glabra pectinata Ziegler morphotype 1 Sandberg and Ziegler
P. minuta Branson and Mehl
P. cf. *P. regularis* Cooper
P. cf. *P. tenuipunctata* Sannemann
P. quadrantinodosalobata Sannemann morphotype 1 Sandberg and Ziegler
P. subperlobata Branson and Mehl
Polygnathus nodocostatus Branson and Mehl group
CAI: 3-4
AGE: Late Devonian, Famennian, Upper *crepida* Zone

405. C-087561 0 m MJO
Palmatolepis tenuipunctata Sannemann
Pelekysgnathus sp.
Polygnathus sp.
P. cf. *P. minuta* Branson and Mehl
P. subperlobata Branson and Mehl
CAI: 4
AGE: Late Devonian, Famennian, upper *P. triangularis-crepida* zones

Section 45 (63°8.0';130°1.5')

406. C-087560, C-102586 893 m MJO
Ancyrognathus sp. indet.
Palmatolepis gigas Miller and Youngquist
P. hassi Muller and Muller?
P. subrecta Miller and Youngquist
Polygnathus sp.
REMARKS: 2 collections made from same bed in different years.
AGE: Late Devonian,Frasnian, *gigas* Zone (lower?)

PREVOST FORMATION

407. C-086413, 62°25.7';129°15.8' MJO
Palmatolepis cf. *P. delicatula* Branson and Mehl
P. cf. *P. triangularis* Sannemann
Polygnathus sp. indet.
CAI: 5
REMARKS: Limestone lens(?) or block(?) within Prevost Formation shale
AGE: Late Devonian, late Frasnian-early Famennian

408. C-086345, 62°17.0';128°08.4' MJO
Belodella? sp.
Polygnathus costatus costatus Klapper
P. cf. *P. linguiformis linguiformis* Hinde
P. cf. *P. parawebbi* Chatterton
P. robusticostatus Bischoff and Zeigler group
CAI: 6
REMARKS: Limestone clast within Prevost Formation shale
AGE: Middle Devonian, Eifelian, probably *australis* Zone

Section 19 (63°38.4';130°02.8')

409. C-087564, 431 MJO
Bispathodus cf. *B. bispathodus* Zeigler, Sandberg, Austin
Siphonodella? or *Polygnathus?*
sp. indet.
CAI: 3-4
AGE: Late Devonian, Late Famennian-Early Mississippian, Tournaisian

MOUNT CHRISTIE FORMATION

410. C-087592 (62°48.7′;129°42.0′) MJO
Neogondolella sp. indet.
Neostreptognathodus cf. *N. pequopensis* Behnken
CAI: 5
REMARKS: Collected at an early date on same line of section as Section 20, within the Mount Christie Formation.
AGE: Early Permian, late Wolfcampian-early Leonardian

Section 17 (62°52.6′;129°49.7′)

411. C-102654 541.5 m MJO
"*Gondolella*" n. sp. aff.
G. postdenuda von Bitter and Merrill
N. gen. et sp.
Streptognathodus elongatus Gunnell
CAI: 4-5
AGE: Late Pennsylvanian, Virgilian-Early Permian, Wolfcampian

412. C-102656 354 m MJO
Gnathodus cf. *G. bilineatus*
Paragnathodus? sp.
ramiform elements
CAI: 4-5
AGE: probably Late Mississippian

Section 20b (62°48.3′;129°42.4′)

413. C-087590 696 m MJO
Neogondolella bisselli Clark and Behnken s.l.
Sweetognathus sp.
ichthyoliths
CAI: 4-5
AGE: Early Permian, probably late Wolfcampian

TSICHU FORMATION

Section 18 (63°17.1′;130°55.3′)

414. C-087569 119 m MJO
Gnathodus bilineatus (Roundy)
G. defectus Dunn?
G. girtyi Hass
Idioprioniodus? sp.
Rhachistognathus muricatus (Dunn)
R. cf. *R.* sp. B Tynan
CAI: 5
AGE: Late Mississippian, Chester = probably early Namurian

415. C-087568 229 m MJO
Gnathodus bilineatus (Roundy)
G. g. cf. *collinsoni* Rhodes, Austin, and Druce
G. girtyi simplex Dunn
Idioprioniodus? sp.
Paragnathodus cf. *P. commutatus* (Branson and Mehl)
Polygnathus? sp. indet. (reworked?)
Rhachistognathus muricatus (Dunn)
R. sp. B Tynan
CAI: 5-6
AGE: Late Mississippian, Chester = probably early Namurian

416. C-087567 368 m MJO
Cavusgnathus sp.
Gnathodus bilineatus (Roundy)
G. girtyi collinsoni Rhodes, Austin, and Druce
G. texanus Roundy
Palmatolepis? sp. (reworked?)
"*Spathognathodus*" sp.
CAI: 5
AGE: Early Carboniferous, probably late Visean

417. C-087566 561 m MJO
Gnathodus girtyi collinsoni Rhodes, Austin, and Druce
G. g. cf. *girtyi* Hass
Paragnathodus aff. *P. commutatus* (Branson and Mehl)
"*Spathognathodus*" cf. "*S.*" *campbelli* Rexroad
"S." sp.
CAI: 4-5
AGE: Early Carboniferous, late Visean

Section 19 (63°38.4′;130°02.8′)

418. C-087565 828 m MJO
Gnathodus girtyi collinsoni Rhodes, Austin, and Druce
G. cf. *G. bilineatus* (Roundy)
G. cf. *G. texanus* Roundy
Idioprioniodus sp.
Paragnathodus cf. *P. commutatus* (Branson and Mehl)
ichthyoliths, bryozoans, spicules
CAI: 4
AGE: Early Carboniferous, late Visean

419. C-087570 1134 m MJO
Declinognathodus noduliferus (Ellison and Graves?)
Gnathodus cf. *G. bilineatus* (Roundy)
G? n. sp.
Idiognathoides attenuatus Harris and Hollingsworth
I. sinuatus Harris and Hollingsworth
Idioprioniodus sp.
Paragnathodus cf. *P. commutatus* (Branson and Mehl)
Rhachistognathodus muricatus (Dunn)
R. primus Dunn
ichthyoliths
CAI: 3
AGE: Early Pennsylvanian, Morrowan = late Namurian

JONES LAKE FORMATION

420. C-087593 62°27.2′;128°33.3′ MJO
Neogondolella sp. indet.
CAI: 5
AGE: Permian or Triassic, probably Triassic

Section 20b (62°48.3′;129°42.4′)

421. C-087591 1181 m MJO
Gnathodus girtyi Hass?
Neogondolella bisselli Clark and Behnsen s.l.?
N. crenulata Mosher
N. milleri (Muller)
N. nevadensis (Clark)
Neospathodus pakistanensis Sweet
N. waageni Sweet
CAI: 4
REMARKS: The presence of possible early Permian gondolellids (*G. bisselli*) and even late Mississippian gnathodids (*G. girtyi*) suggests this fauna includes reworked elements.
AGE: Early Triassic, Smithian