GEOLOGICAL SURVEY OF CANADA

COMMISSION GEOLOGIQUE DU CANADA

OPEN FILE 1273

PROTEROZOIC, MACKENZIE CORRIDOR

G.K. Williams

April 1986

CONTENTS

Chapter 1

PROTEROZOIC

Preamble

The Proterozic map, Mackenzie Corridor, presents a graphic summary of Proterozoic strata of both surface and subsurface belts. Subsurface data are presented by abbreviated strip-logs showing depth, drilled thickness, lithology, any tests or cores, and the age of overlying sediments. These generalized strip-logs were compiled from several sources: my own logs which include most wells south of latitude 62°N, perhaps a third of the wells north of 62°; Meijer Drees, 1975, north to ~64°; and Canadian Stratigraphic Service or Company well reports north of 64°. Logs of the two deep tests in the Mackenzie Delta are from descriptions by A.F. Embry, I.S.P.G., Calgary.

The term 'Pre-identifiable Paleozoic' or PIP Rocks has been coined because, in some wells, there is considerable doubt as to the age of the bottom-hole sediments. I have included in the PIP category any strata that have been identified as Precambrian by any source even though this identification is, in my opinion, not correct.

Proterozoic rocks of the main outcrop belts, east of and west of the Mackenzie Corridor, are summarized in two correlation charts set into the map. The charts show nomenclature, gross lithology, thickness and correlation. These data are from reports on surface mapping as indicated on the index map.

The following brief text is intended partly to inform but mainly to direct the interested reader to the appropriate literature.

Shield

East of a north-south line running approximately along longitude 120°W, Paleozoic strata lie directly on igneous and metamorphic rocks of the Canadian Shield. Shield rocks are not dealt with on this map other than to present a worm's-eye view of overlying strata. This worm's-eye view depicts the configuration of the Tathlina Arch as it was in Middle Devonian time (the Ebbutt break is an unconformity at or near the Lower Middle Devonian boundary). For more data on the Shield rocks in the subsurface see Williams, 1981 (structure, wells with core, and some identification of rock types), Williams, 1977 (details on some Precambrian structures), and de Wit et al., 1973 or Law, 1971 (regional structure). Readers interested in the Hudsonian and older shield rocks should consult Hoffman, 1981; and Hoffman et al., 1970.

Coppermine Homocline

The homocline trends east-west and dips to the north. The western end of the homocline shows on the map, east of Great Bear Lake.

East of the map area the uppermost unit of the homoclinal sequence is the Coppermine Series, which includes ±3000 m of basalt. North of Dease Arm a thin remnant of these volcanics occurs; so far as is known, this is the westernmost occurrence. However, Davis and ~~Wilmont~~ Willott, 1978, on the basis of magnetic and seismic evidence, believe that the basalts are present in the subsurface of the Colville Hills area.

The sedimentary units of the Coppermine Homocline pertinent to the subsurface are the Dismal Lakes and Hornby Bay Group (eastern correlation chart). Each group is a northwesterly-thickening wedge of dominantly marine, shallow water sediments. The basal unit, or Hornby Bay Group, is dominantly clastics and minor dolomite and comprises: a basal nonmarine to marginal marine delta complex (conglomerate, mature sandstone, varicoloured shale); a middle unit of interbedded dolomite, sandstone and shale; and an upper unit of shale, sandstone and siltstone. The basal part of the Dismal Lakes Group is a mature fluvial sandstone, fining upward to green or black shale and minor dolomite. The upper ~ two thirds of the group consists mainly of dolomite, with textures indicating shallow water origin.

Brock Inlier

About 2000 m of unmetamorphosed, mostly marine Proterozoic sediments form this inlier. It is flanked on the west, east and south by Cambrian strata. There are five informal mappable divisions, P1 (oldest) to P5 - see eastern correlation chart. The sub-Cambrian unconformity cuts downsection from east to west; sub-Cambrian structure was, therefore, an east-dipping homocline. Post-Proterozoic vertical movements have raised the core of the inlier some 300 m structurally above the flanking areas. There is no stratigraphic evidence from the flanking Paleozoic sediments to suggest syndepositional arching. However, due to the nature of the outcrops, and lack of detailed studies, the tectonic history of the inlier is essentially unknown.

The oldest unit, P1, consists of 900 m + of green shale. The remainder of the section is mainly dolomite and sandstone. The dolomites are grey to maroon, fine to medium crystalline, commonly siliceous or cherty. The sandstones are quartzose, usually siliceous. The poorly exposed upper unit contains gypsum. See Young, 1977, 1981 for a more thorough treatment of these and related rocks.

Western Mountainous belt

The data on the map and in the western correlation chart are taken from the various maps listed on the index map. During and since publication of these maps, ideas on age, regional correlation, and on tectonic or depositional settings have evolved, and are still in a state of flux. Some of the pertinent reports are referred to below.

Wernecke Supergroup

The oldest Proterozoic strata of the Mountainous belt occur only in the westernmost part of the map area. Under the Knorr Range column of the western correlation chart the Gillespie Lake and Quartet Groups are listed. These, along with an underlying Fairchild Lake Group, that occurs farther west, are now included in the Wernecke Supergroup. This Supergroup is no longer considered as old as Aphebian, see Young, 1977 and Delaney, 1981. This Supergroup consists of perhaps 14 km of fine clastics with subordinate dolomite, locally metamorphosed to slate, phyllite and schist. Rocks of this Supergroup probably occur beneath Paleozoic strata in the core of the southern Richardson Mountains.

Mackenzie Mountains Supergroup

Rocks of the Supergroup are shown in belts B and C on the map and, as they probably correlate with the Proterozoic strata of the Brock Inlier, will occur in the subsurface over most of the map area. This section, some 4 to 5 km thick, consists of mature platformal sediments: shale, siltstone, sandstone or quartzite, carbonates (mostly dolomite) and anhydrite (see Aitken, 1982, for an overview).

The two upper units, the Redstone River and Coppercap formations ("Copper Cycle") contain stratiform copper mineralization, see Ruelle, 1982. These units probably do not occur in the subsurface.

What appears to be the most interesting unit, from a petroleum assessment point of view, is the Little Dal Group; more on this unit later.

Windermere (=Ekwi) Supergroup

Windermere strata occur only west of the Mackenzie Arch (belt A on the map) and in the southernmost part of the Mountainous belt. The section, at least 5 km thick, consists of relatively immature clastics with minor carbonates. The Rapitan Group contains glacial deposits as well as sedimentary iron formations (see Eisbacher, 1981, or Yeo, 1981, for comprehensive descriptions). In the southernmost part of the map area the strata are dominantly fine grained clastics; there is some feldspathic coarse sandstone in the lower, or Grit unit. The upper part, or Argillite unit, is apparently of relatively deep water origin. There is no mappable break between Proterozoic and Cambrian strata in this area (Fritz, 1982).

Windermere strata are unlikely to be encountered in the subsurface within the map area, with the possible exception of the area south of 62°. Possibly their main relevance to petroleum geology will be the light these strata shed on tectonic evolution through latest Proterozoic time. In this regard, the papers by Eisbacher (1978a, b, 1981) are particularly relevant. The patterns of rifting, first established in Late Proterozoic time, probably exerted an influence into early Paleozoic time.

Small Proterozoic inliers

Beaver River (~60°20'N, 126°W)

This exposure is indicated on the east side of the Hyland-Liard Plateau column of the western correlation chart. Greenish grey argillites of uncertain age are unconformably overlain by an unfossiliferous quartzite and chert(?) boulder conglomerate. The exposure is associated with a body of syenite. Douglas and Norris (1959) indicate an intrusive relationship, but some pre-publication work diagrams by R.J.W. Douglas suggest that he was unsure of this interpretation.

Cap Mountain (~63°20'N, 123°W)

This 1800 m thick exposure is described in detail in Aitken et al. (1973, p. 148).

The upper 227 m, or Lone Land Formation, consists of grey to black shale with a basal, quartzose, fine to medium grained sandstone with pebbly layers. The remainder of the exposure, unnamed, is dominated by red, purple, and occasionally green, silty to sandy mudstone. There are interbeds, from laminae to several tens of metres thick, of sandstone and, in the lowest part, dolomite. The sandstones are mostly fine grained, occasionally coarser, with pebbles of quartz, chert and jasper. Analyses show an abundance of chlorite, illite and hematite in the sands; traces of malachite are common throughout the unnamed succession. Gypsum casts suggest the former presence of evaporites.

Aitken and Pugh (1984) contend that the Cap Mountain succession can be correlated on a unit-by-unit basis with part of the Dismal Lakes - Hornby Bay groups, as described by Kerans et al. (1981). If so, the position as indicated on the western correlation chart (southern Mackenzie Mountains) is too young.

Another Proterozoic inlier occurs some 75 km north of Cap Mountain, near Blackwater Lake. No description has been published.

Southern Richardson Mountains (~66°15'N, 135°30'W)

This exposure consists of black feldspathized phyllite. It is overlain by Lower Cambrian strata. It is tentatively correlated with the Quartet Group (Norris, 1974, Trail River sheet).

Campbell Uplift (~68°15'N, 133°30'W)

In the core of this uplift, near Inuvik, are scattered outcrops from which Dyke (1975) estimated a total exposure in the order of 600 m. The following lithologies occur (*ibid.*): grey, green, reddish to brown quartzite or sandstone; green, brown, to red argillite; orange, argillaceous to silty, microcrystalline dolomite. On the basis of paleomagnetism, Norris and Black (1964) estimated the age to be Late Precambrian ". . . possibly slightly older than the Purcell System . . .".

These rocks are unconformably overlain by Ordovician dolomite. Sub-Ordovician dip, deduced from Figure 1 of Dyke (1975) may have been northerly.

Igneous rocks

Coppermine Homocline

The Dismal Lake and Hornby Bay groups are both cut by diabase dykes. Dismal Lakes sediments were succeeded by lavas of the Coppermine Series. Both dykes and lavas are attributed to a tensional event dated about 1200 m.y. (Kerans et al., 1981, p. 178).

Brock inlier

Proterozoic strata are cut by many diabase dykes and sills. Dykes trend northwesterly, are nearly vertical, and are up to 120 m thick. Sills are up to 30 m thick. These intrusions have yielded dates (K-Ar) between 705 and 770 m.y. (Balkwill and Yorath, 1970).

Beaver River (~60°20'N, 126°W)

The syenite body that Douglas and Norris (1959) considered to intrude Proterozoic argillite has yielded a K-Ar date of 312 m.y. (Baadsgaard et al., 1961).

Hyland-Liard Plateau

Unit 3 of Gabrielse and Blusson (1969), which is of questionable age - late Proterozoic and/or Early Cambrian, consists of green and purple volcanic flows and breccia, with minor dolomite.

Mackenzie Mountains

In the southern mountains, Gabrielse et al. (1973) reported a mafic flow in the Keele Formation; gabbro in the Redstone River Formation; basalt in the upper Little Dal; and a mafic sill, flow and diorite dyke in the lower Little Dal Group. Aitken (1982, p. 158), mentions the following igneous rocks: up to five basaltic flows at the top of the Little Dal; widespread gabbro dykes and sills (the sills are no higher than the Tsezotene/Katherine contact, and one dyke cuts through the entire Mackenzie

Mountains Supergroup but most terminate in the Little Dal Group); chloritic diatremes, some as young as Ordovician. Two sills have been dated about 770 Ma by the rubidium - strontium method. See Morris and Park (1981), for paleomagnetic data on these intrusions.

Subsurface

Igneous rocks are present in several wells in the southern part of the map area, west of the Tathlina Arch, in association with PIP strata. The granite below PIP sandstone in F-72 (≈63°10'N, 120°40'W) is probably part of the Shield. The same may be the case in G-69 (≈62°N, 122°45'W). Some igneous rocks are intrusives: the diabase in Liard no. 2 (≈61°15'N, 122°50'W), the granodiorite in Arrowhead no. 1 (≈60°50'N, 122°W) and I-49 (≈61°N, 122°W). These intrusions are associated with a distinctive, green, siliceous mudrock (tuff?) that sometimes resembles a chert (siliceous shale on the strip logs). These intrusions provide strong, but not conclusive evidence for a Proterozoic age. Age determinations (K/A method), on the Liard no. 2 rocks range from 300 m.y. to 1100 m.y. (Baadsgaard et al., 1961; Lowden, 1961).

In several wells, what appear to be thin granitic sills occur within PIP sandstones (Meijer Drees, 1975): G-32 and O-27A (≈62°15'N, 121°W), J-66 (≈62°N, 122°W) and J-32 (≈61°N, 121°20'W). In all cases the rock is so weathered that a positive identification is impossible. Could these be arkosic sands or conglomerates, such as occur in outcropping Lower Cambrian clastics west of Liard River (Unit 4 of Gabrielse and Blusson, 1969).

On the south side of the Liard River, near the Liard No. 2 well, are a number of siliceous, carbonate-rich dykes. These dykes occur in Upper Devonian Fort Simpson shale. Roed (1969) believes that they were emplaced with cataclysmic force. Could there be any connection between these dykes and the nearby subsurface igneous intrusions?

The igneous rocks encountered in PIP strata in Mackenzie Delta wells are volcanics or volcaniclastics.

Proterozoic-Cambrian contact

In the early years of petroleum exploration, somewhere north of Great Bear Lake, two geological field crews set out to find the Proterozoic-Cambrian contact. One crew started in the east, where they were quite sure they were on Precambrian strata, and worked westwards. The other crew started in the west, in fossiliferous strata, and worked eastward. The two crews met, and passed, each confident that they had not yet seen the contact. This story is probably apocryphal, yet it contains a valid warning: criteria for differentiating Paleozoic from Proterozoic strata are not yet satisfactory, especially in the subsurface.

The Proterozoic-Cambrian contact is not mappable in the Hyland-Liard Plateau area; the boundary is thought to lie within a unit of fine clastics, presumably of fairly deep water origin (Gabrielse and Blusson, 1969). The same may be true farther north, in the Selwyn Basin (Fritz, 1982). Over most of the mountain area, however, the contact is an erosion surface, although commonly paraconformable (see Aitken, 1982, p. 159). Over the crest of the Mackenzie Arch, estimating from the rate of truncation at the unconformity, maximum dip divergence between Cambrian and Proterozoic strata may be in the order of 80 m/km, or 5°.

The Proterozoic-Cambrian contact in the east is also paraconformable. Along the south end of the Brock Inlier some 850 m of sediments are truncated over a distance of about 85 km for a net divergence in the order of 10 m/km; locally the angularity is up to 5°, or 85 m/km. Along the truncated east end of the Coppermine Homocline the divergence is in the order of 20 m/km.

Picking the Cambrian-Proterozoic contact in the subsurface is no easy task. Within the confines of the Cambrian salt basin north of Great Bear Lake there is no problem because of a well developed basal Cambrian sandstone, commonly burrowed and glauconitic. Beyond the salt limits there is a problem; Cambrian strata consist of mixed and interbedded fine clastics and carbonates, and a well developed basal Cambrian sandstone is not usually present. Colour, grain size or crystallinity do not seem to provide diagnostic criteria. Even the presence of glauconite is suspect, it is reported from rocks thought to be Proterozoic. Possibly the best criterion is the degree of silicification - higher in Proterozoic strata, including the dolomites.

In the south (belt IV of the worm's-eye view) the problem is not in picking the top of the PIP rocks (usually a carbonate-sandstone contact) but is a question of the age of these sandstones. Here, the wells penetrate recognizable Devonian to Cambrian sediments and bottom in quartzose sandstone, commonly siliceous but never metaquartzite. To the petroleum geologist, the age of these sands is of little consequence. To the historical geologist, however, the age may be significant. To note but one possiblity - some of these sandstones may be remnants of an Early Cambrian distributary system centered on an area that later became the locus of the Tathlina Arch.

In several wells, the top of the Proterozoic has, in my opinion, been incorrectly identified; these are noted on the map. Probably the most important are Caribou N-25 (~66°15'N, 135°W) and Old Fort Point E-30. The silty shale of N-25 resembles the description of the Middle Cambrian Slats Creek Formation, which outcrops only 25 km to the west of the well; these strata do not in any way resemble the outcrop of Precambrian phyllites in the same area. The identification here is important to structural as well as historical interpretations. The E-30 well, in my opinion, drilled through a fault and bottomed in limestone of the Franklin Mountain Formation (Late Cambrian-Ordovician). Analyses of a core show total organic carbon of 0.58%, thermally undermature. A correct identification here is pertinent to an evaluation of the petroleum prospects of Proterozoic sediments.

Pre-Paleozoic topographic relief

For the most part, this phenomenon will be discussed in connection with various maps of Paleozoic of the Mackenzie Corridor.

Numerous basement hills protrude through Cambrian to Ordovician strata along the North Arm of Great Slave Lake and north to about 64°. These hills and ridges had a relief of up to 240 m (Douglas and Norris, 1960, p. 4). Several basement hills on the Shield can be documented farther south, onlapped by Devonian strata (Williams, 1981); most of these hills are metaquartzite, not igneous rocks.

Along the eastern margin of the PIP rocks (belt IV, worm's-eye view) there appears to be considerable relief on the top of the PIP sandstone. At the southern end, in the Celibeta area, sub-Devonian topographic relief was about 100 m or more (Williams, 1977, 1981). Farther north is the Bulmer Lake Arch of Meijer Drees (1975) (between 62°N and 64°N) where early Paleozoic strata are thin or missing. This phenomenon can be interpreted as a basement ridge, rather than tectonic arching. At the northern end of the line is Leith Ridge, interpreted by Balkwill (1971) as a paleoridge with a relief of about 300 m, which was onlapped by early Paleozoic seas.

Over the remainder of the map area there is not sufficient subsurface control to delineate any topographic relief, no doubt some did exist.

Correlation, surface to subsurface

Correlation between outcrop belts has been discussed by Young (1977, 1981), Young et al. (1979), and Aitken et al. (1978). There is agreement, in general if not in detail, that the Shaler Group of the Brock Inlier correlates with units H1 to the Little Dal Group of the Mackenzie Mountains Supergroup. It is logical to suppose that the same strata will occur in the intervening area. Pugh (1983), and Aitken and Pugh (1984) have produced tentative subcrop maps, identifying several formations or units.

Hornby Bay and Dismal Lakes strata, which outcrop east of Great Bear Lake, undoubtedly extend eastward in the subsurface, as suggested by Meijer Drees (1975). Aitken and Pugh (1984), are confident that such rocks can be recognized in several wells south and east of Great Bear Lake. As a consequence of this correlation, these authors deduce a profound northeast trending fault zone (Fort Norman Structure) in the subsurface.

None of the above interpretations are shown on the Mackenzie Corridor Proterozoic map. While these correlations are tenable, they are not convincing. As stated elsewhere, it is often difficult to distinguish Proterozoic from Paleozoic strata in outcrops, let alone in wells; recognition of Proterozoic formations or groups from a few metres of drilled section is even more difficult.

Mega structures

Mackenzie Arch

As depicted, the various belts reflect the outline of the arch in early Paleozoic time. The development of the arch is discussed in Aitken et al. (1973, p. 37). Its origin is thought to have been fairly late, approximately coincident with the sub-Rapitan erosional event. At this stage, these authors suggest it was a hinge line rather than an arch. Probably by Early, certainly by Late Cambrian time the feature behaved as an arch. Maps of progressively younger horizons will show that the locus of maximum arching shifted westward through time. By Devonian time the crest lay some 75 km west of the center of belt C.

Aklavik Arch or Eskimo Lakes Arch

This feature is not outlined on the map, its presence is indicated by the several wells in the vicinity of the Mackenzie Delta that drilled into PIP sediments and volcanics. The Aklavik Arch is a complex, composite feature that extended south-westward from the delta to Alaska. For a review, see Norris, 1974. Some Proterozoic movement can be deduced from some elements of the Arch west of the map area; nothing can be said regarding its Proterozoic history within the map area.

Richardson Mountains

This feature is not depicted on the map. At present an anticlinorium formed during the Laramide orogeny, this feature was a narrow north-south trough throughout most of Paleozoic time. Norris (1974) has documented some Proterozoic tectonism at the south end of the feature; see also Norris and Hopkins (1977, p. 13). The northward bulge of preserved Rapitan aged sediments in the southern core of the anticlinorium (belt A, ~65°30'N, 134°W) suggests that a trough may have been in existence in at least Late Proterozoic time.

Leith Line

This line (~66°N, 118°W) is taken from Figure 9-2b in Kerans et al. (1981). These authors deduce that it marks a hinge line, with faster subsidence on the west, throughout Hornby Bay - Dismal Lakes deposition. Post-depositional deformation occurred along the line. McGrath and Henderson (1984) found strong evidence of a fault, down on the west by at least 2 km, extending under Leith Peninsula. This fault marks the eastern limit of thick Proterozoic rocks at the surface.

Aitken and Pugh (1984) showed the Leith Fault trending southwest from Leith Ridge, intersecting the 60th parallel in the vicinity of 127°W. They attribute to this structure the major offset or northeastward jog of the Cordillera and other structural and stratigraphic phenomena (*ibid.*, p. 143 and Fig. 5). However, it would seem almost irresistible to deduce a genetic relationship between the contact of shield and Proterozoic sediments on Leith Ridge and the shield and PIP contact in the subsurface, as did Meijer Drees, 1975. If the PIP sandstones of belt IV are Proterozoic, or even only in part Proterozoic in age, then the Leith Line or Leith Fault is a nearly north-south structural zone linking such subsurface features as the Bulmer Lake Arch (Meijer Drees, 1975), the basement hills in the Celibeta area (Williams, 1977) and, perhaps, the Fort Nelson High in British Columbia. Maps of several Paleozoic units show that these features, like Leith Ridge, were topographic highs in Paleozoic seaways, rather than arches. In other words there was very little, if any, movement along the line through Paleozoic time.

Fort Norman structure

Aitken and Pugh (1984) deduced a major basement fault zone, down on the northwest, trending northeast through Fort Norman (~65°N, 125°W). Their evidence is derived mainly from their recognition of Hornby Bay - Dismal Lakes Group sediments in some wells east of Keith Arm of Great Bear Lake. There is compelling evidence for a zone of weakness transecting Laramide trends in the Fort Norman area affecting thickness and facies of Paleozoic units (Williams, 1975) as well as Laramide structure (Cecile et al., 1982). This Fort Norman structure, not shown on the Proterozoic map, is apparent on maps of several Paleozoic horizons.

Petroleum potential

Proterozoic strata, with the exception of the core of the Richardson Mountains, are unmetamorphosed. Descriptions from outcrops reveal sand bodies that should constitute reservoirs, Aitken (1982) has seen pyrobitumen in the Mackenzie Mountains in rocks of unit H1 and of the Little Dal Group (*ibid.*, p. 150, 154). Organic material has also been noted in cores. There has been considerable interest lately in the petroleum potential of Proterozoic strata of the Mackenzie Corridor. From core and sample descriptions, however, it is difficult to sustain optimism. Carbonates are commonly aphanitic and siliceous; sandstones, where sorted, are cemented by silica. L.R. Snowdon (I.S.P.G. Calgary) has a study in progress on organic material in selected cores; to date results have been discouraging. As mentioned earlier, limestone with 0.58% organic carbon has been reported from Old Fort Island E-30, but this is probably Paleozoic, not Proterozoic limestone.

From a petroleum explorationist's point of view, the most interesting Proterozoic strata are part of the Little Dal Group. Reading about these rocks is somewhat reminiscent of the Devonian of Alberta: sharp carbonate fronts, basinal shaly fill-deposits, reefs, evaporites . . . , see Aitken, 1981. Little Dal sediments may be present in the subsurface of the Norman Wells - Fort Norman area (belt B, ~64°N to 65°N, 126°W; see also figs. 3-14, p. 59 in Aitken, 1981). One of several tenable explanations for salt below Middle Cambrian shale in the Keele L-04 well (~64°30'N, 125°W) is that it is Little Dal salt.

References

Aitken, J.D.
1981: Stratigraphy and sedimentology of the Upper Proterozoic Little Dal Group, Mackenzie Mountains, Northwest Territories; in Proterozoic Basins of Canada, F.H.A. Campbell (ed.); Geological Survey of Canada, Paper 81-10, p. 47-71.

1982: Precambrian of the Mackenzie Fold Belt - a stratigraphic and tectonic overview; in Precambrian Sulphide Deposits, R.W. Hutchinson, C.D. Spence and J.M. Franklin (eds.); Geological Association of Canada, Special Paper 25, p. 150-161.

Aitken, J.D. and Cook, D.G.
1974: Caracajou Canyon Map-Area (96D), District of Mackenzie, Northwest Territories; Geological Survey of Canada, Paper 74-13.

Aitken, J.D., Cook, D.G., and Yorath, C.J.
1982: Upper Ramparts River and Sans Sault Rapids map-areas (106G, H), District of Mackenzie; Geological Survey of Canada, Memoir 388, with maps 1452A and 1453A.

Aitken, J.D., Long, D.G.F., and Semikhatov, M.A.
1978: Correlation of Helikian strata, Mackenzie Mountains - Brock Inlier - Victoria Island; in Current Research, Part A; Geological Survey of Canada, Paper 78-1A, p. 485-486.

Aitken, J.D., Macqueen, R.W., and Usher, J.L.
1973: Reconnaissance studies of Proterozoic and Cambrian stratigraphy, lower Mackenzie River area (Operation Norman), District of Mackenzie; Geological Survey of Canada, Paper 73-9, 178 p.

Aitken, J.D. and Pugh, D.C.
1984: The Fort Norman and Leith Ridge structures: Major buried Precambrian features underlying Franklin Mountains and Great Bear and Mackenzie Plains; Bulletin of Canadian Petroleum Geology, v. 32, no. 2, p. 139-146.

Baadsgaard, H., Campbell, F.A., Cummings, G.L., Evans, T., Kanasewich, E., Krouse, R.H., and Robertson, D.K.
1965: Isotopic data from the Cordillera and Liard Basin in relation to the genesis of the Pine Point lead-zinc deposits; (unpublished), Department of Geology, University of Alberta, Edmonton.

Baadsgaard, H., Folinsbee, R.E., and Lipson, J.
1961: Caledonian or Acadian granites of the northern Yukon Territory; in Geology of the Arctic, v. 1; Toronto, University Toronto Press, p. 458-465.

Balkwill, H.R.
1971: Reconnaissance geology, southern Great Bear Plain, District of Mackenzie; Geological Survey of Canada, Paper 71-11, 47 p.

Balkwill, H.R. and Yorath, C.J.
1970: Brock River map-area, District of Mackenzie; Geological Survey of Canada, Paper 70-32, 25 p.

Baragar, W.R.A.
1972: Coppermine River basalts: geological setting and interpretation; in Rubidium-Strontium Isochron age studies, Report 1, R.K. Wanless and W.D. Loveridge (eds.); Geological Survey of Canada, Paper 72-23, p. 21-24.

Barager, W.R.A. and Donaldson, J.A.
1973: Coppermine and Dismal Lakes map-areas; Geological Survey of Canada, Paper 71-39.

Cecile, M.P.
1982: The Lower Paleozoic Misty Creek Embayment, Selwyn Basin, Yukon and Northwest Territories; Geological Survey of Canada, Bulletin 335.

Cecile, M.P., Cook, D.G., and Snowdon, L.R.
1982: Plateau overthrust and its hydrocarbon potential, Mackenzie Mountains, Northwest Territories; in Current Research, Part A; Geological Survey of Canada, Paper 82-1A, p. 89-94.

Cook, D.G. and Aitken, J.D.
1969: Erly Lake, District of Mackenzie (97A); Geological Survey of Canada, Map 5-1969.

1971: Geology, Colville Lake map-area and part of Coppermine map-area, Northwest Territories (96 NW and NE; part of 86 NW); Geological Survey of Canada, Paper 70-12.

Davis, J.W. and Willott, R.
1978: Structural geology of the Colville Hills; Bulletin of Canadian Petroleum Geology, v. 26, p. 105-122.

Delaney, G.D.
1981: The mid-Proterozoic Wernecke Supergroup, Wernecke Mountains, Yukon Territory; in Proterozoic Basins of Canada, F.H.A. Campbell (ed.); Geological Survey of Canada, Paper 81-10, p. 1-24.

de Wit, R., Gronberg, E.C., Richards, W.B., and Richmond, W.O.
1973: Tathlina Area, District of Mackenzie; in The Future Petroleum Provinces of Canada, R.G. McCrossan (ed.); Canadian Society of Petroleum Geologists, Memoir 1, p. 187-212.

Dixon, J.
1979: Comments on the Proterozoic stratigraphy of Victoria Island and the Coppermine area, Northwest Territories; in Current Research, Part B; Geological Survey of Canada, Paper 79-1B, p. 263-267.

Douglas, R.J.W. (editor)
1970: Geology and economic minerals Canada; Geological Survey of Canada, Economic Geology Report no. 1.

Douglas, R.J.W. and Norris, A.W.
1960: Horn River Map-area, Northwest Territories; Geological Survey of Canada, Paper 59-11.

Douglas, R.J.W. and Norris, D.K.
1959: Fort Liard and La Biche Map-areas, Northwest Territories and Yukon; Geological Survey of Canada, Paper 59-6.

1961: Camsell Bend and Root River map-areas, District of Mackenzie, Northwest Territories; Geological Survey of Canada, Paper 61-13.

1963: Dahadinni and Wrigley map-areas, District of Mackenzie, Northwest Territories; Geological Survey of Canada, Paper 62-33.

Douglas, R.J.W. et al.
1973: Map 1370A, Great Slave, and 1372A, Horn River; Geological Survey of Canada.

Dyke, L.D.
1975: Structural investigations in Campbell uplift, District of Mackenzie; Geological Survey of Canada, Paper 75-1A, p. 143-532.

Eisbacher, G.H.
1978a: Re-definition and subdivision of the Rapitan Group, Mackenzie Mountains; Geological Survey of Canada, Paper 77-35, 21 p.

1978b: Two major Proterozoic unconformities, northern Cordillera; in Current Research, Part A, Geological Survey of Canada, Paper 78-1A, p. 53-58.

1981: Sedimentary tectonics and glacial record in the Windermere supergroup, Mackenzie Mountains, northwest Canada; Geological Survey of Canada, Paper 80-27.

Fraser, J.A., Donaldson, J.A., Fahrig, W.F., and Tremblay, L.P.
1970: Helikian Basins and Geosynclines of the northwestern Canadian Shield; in Basins and Geosynclines of the Canadian Shield, A.J. Baer (ed.); Geological Survey of Canada, Paper 70-40, p. 213-238.

Fritz, W.H.
1982: Vampire Formation, A new Upper Precambrian(?)/Lower Cambrian Formation, Mackenzie Mountains, Yukon and Northwest Territories; Geological Survey of Canada, Paper 82-1B, p. 83-92.

Gabrielse, H. and Blusson, S.L.
1969: Geology of Coal River Map-area, Yukon Territory and District of Mackenzie; Geological Survey of Canada, Paper 68-38.

Gabrielse, H., Blusson, S.L., and Roddick, J.A.
1973: Geology of Flat River, Glacier Lake and Wrigley Lake map-areas, District of Mackenzie and Yukon Territory; Geological Survey of Canada, Memoir 366, Pts. I and II.

Green, L.G.
1972: Geology of Nash Creek, Larsen Creek and Dawson map-areas, Yukon Territory; Geological Survey of Canada, Memoir 364.

Hildebrand, R.S., Annesley, I.R., Bardoux, M.V., Davis, W.J., Heon, D., Reichenbach, I.G., and Van Nostrand, T.
1984: Geology of the early Proterozoic rocks of parts of the Leith Peninsula map area, District of Mackenzie; in Current Research, Part A, Geological Survey of Canada, Paper 84-1A, Report 31.

Hoffman, P.F.
1981: Autopsy of Athapuscow Aulacogen: a failed arm affected by three collisions; in Proterozoic Basins of Canada, F.H.A. Campbell (ed.); Geological Survey of Canada, Paper 81-10, p. 97-102.

Hoffman, P.F., Fraser, J.A., and McGlynn, J.C.
1970: The Coronaton Geosyncline of Aphebian age, District of Mackenzie; in Basins and Geosynclines of the Canadian Shield, A.J. Baer (ed.); Geological Survey of Canada, Paper 70-40, p. 201-212.

Kerans, C., Ross, G.M., Donaldson, J.A., and Geldsetzer, H.J.
1981: Tectonism and depositional history of the Helikian Hornby Bay and Dismal Lakes Groups, District of Mackenzie; in Proterozoic Basins of Canada, F.H.A. Campbell (ed.); Geological Survey of Canada, Paper 81-10, p. 157-182.

Law, J.
1971: Regional Devonian geology and oil and gas possibilities upper Mackenzie River area; Bulletin of Canadian Petroleum Geology, v. 19, no. 2, p. 437-486.

Lowden, J.A.
1961: Age determinations by the Geological Survey of Canada, Report 2 -Isotopic Ages; Geological Survey of Canada, Paper 61-17.

McGlynn, J.C. and Henderson, J.B.
1970: Archean volcanism and sedimentation in the Slave structural province; in Basins and Geosynclines of the Canadian Shield, A.J. Baer (ed.); Geological Survey of Canada, Paper 70-40, p. 31-44.

McGrath, P.H. and Hildebrand, R.S.
1984: An estimate, based on magnetic interpretation, of the minimum thickness of the Hornby Bay Group, Leith Peninsula, District of Mackenzie; in Current Research, Part A, Geological Survey of Canada, Paper 84-1A, p. 223-228.

Meijer Drees, N.C.
1975: Geology of the Lower Paleozoic formations in the subsurface of the Fort Simpson Area, District of Mackenzie, Northwest Territories; Geological Survey of Canada, Paper 74-40.

Morris, W.A. and Park, J-K.
1981: Correlation of upper Proterozoic strata in the Cordillera: paleomagnetism of the Tsezotene sills and the Little Dal lavas; in Proterozoic Basins of Canada, F.H.A. Campbell (ed.); Geological Survey of Canada, Paper 81-10, p. 73-78.

Norris, D.K.
1974: Structural geometry and geological history of the northern Canadian Cordillera; in Proceedings of the 1973 National Convention, A.E. Wren and R.B. Cruz (eds.); Canadian Society of Exploration Geophysicists, p. 18-45.

1974, 1975, 1979: Geological maps of Operation Porcupine area, northern Yukon Territory and northwestern District of Mackenzie; Geological Survey of Canada, Maps 1514A-1530A.

Norris, D.K. and Black, R.F.
1964: Paleomagnetic age of the pre-Ordovician rocks near Inuvik, Northwest Territories; Geological Survey of Canada, Paper 64-2, p. 47-51.

Norris, D.K. and Hopkins, W.S.
1977: The geology of the Bonnet Plume Basin, Yukon Territory; Geological Survey of Canada, Paper 76-8.

Pugh, D.C.
1983: Pre-Mesozoic geology in the subsurface of Peel River map-area, Yukon Territory and District of Mackenzie; Geological Survey of Canada, Memoir 401.

Roed, M.A.
1969: An occurrence of chalcopyrite, Liard River, Northwest Territories; Bulletin of Canadian Petroleum Geology, v. 17, no. 3, p. 347-353.

Ruelle, J.C.L.
1982: Depositional environments and genesis of stratiform copper deposits of the Redstone Copper Belt, Mackenzie Mountains, Northwest Territories, Canada; in Precambrian Sulphide Deposits (Robinson Volume), Geological Association of Canada, Special Paper 25, p. 701-738.

Skall, H.
1975: The paleoenvironment of the Pine Point lead-zinc district; Economic Geology, v. 70, no. 1, p. 22-45.

Wanless, R.K., Stevens, R.D., Lachance, G.R., and Rimsaite, R.Y.H.
1965: Age determinations and geological studies, Part 1 - Isotopic ages, Report 5; Geological Survey of Canada, Paper 64-17.

Williams, G.K.
1975: Arnica Platform Dolomite (NTS 85, 95, 96, 105, 106), District of Mackenzie; Geological Survey of Canada, Paper 75-1C, p. 31-35.

1977: The Celibeta structure compared with other basement structures on the flanks of the Tathlina High, District of Mackenzie; Geological Survey of Canada, Paper 77-1B, p. 301-310.

1981: Middle Devonian carbonate, barrier-complex of western Canada; Geological Survey of Canada, Open File 761.

Yeo, G.M.
1981: The late Proterozoic Rapitan Glaciation in the northern Cordillera; in Proterozoic Basins of Canada, F.H.A. Campbell (ed.); Geological Survey of Canada, Paper 81-10, p. 25-46.

Young, G.M.
1977: Stratigraphic correlations of Upper Proterozoic rocks of northwestern Canada; Canadian Journal of Earth Sciences, v. 14, p. 1771-1787.

1981: The Amundsen Embayment, Northwest Territories; relevance to the upper Proterozoic evolution of North America; in Proterozoic Basins of Canada, F.H.A. Campbell (ed.); Geological Survey of Canada, Paper 81-10, p. 203-218.

Young, G.M., Jefferson, C.W., Delaney, G.D., and Yeo, G.M.
1979: Middle and late Proterozoic evolution of the northern Canadian Cordillera and Shield; Geology, v. 7, p. 125-128.