9237-F9-1E

GEOLOGICAL MAPPING
of the
DOME LEASES
COLVILLE HILLS / ANDERSON PLAIN
District of Mackenzie
NORTHWEST TERRITORIES
N.T.S. 96/L,M,N
Lat. 66°40' to 67°50' North
Long. 125°30' to 127°45' East

prepared for
FORWARD RESOURCES LTD.
Calgary, Alberta

by
James W. Davis, M.Sc., P.Geol., F.GAC
Chief Geologist
TAIGA CONSULTANTS LTD.
Calgary, Alberta

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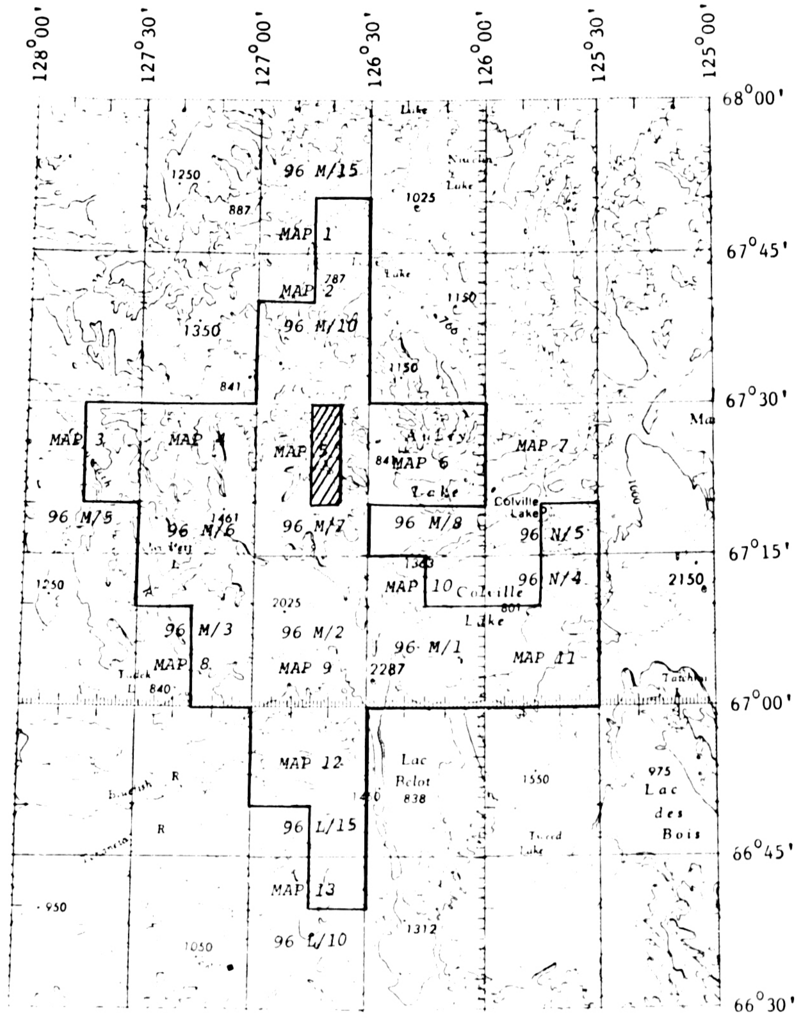
INTRODUCTION

At the request of Forward Resources Ltd., Taiga Consultants undertook a comprehensive field geological mapping program in the Colville Hills / Anderson Plain area of the Northwest Territories. The area explored is held under option to Forward Resources from Dome Petroleum Limited, and encompasses over 600,000 hectares within the District of Mackenzie. The area and extent of the project are illustrated in Figure 1.

The project area lies about 200 km north of the town of Norman Wells, which was used as the principal staging area for the program. The area is accessible via float-equipped aircraft or helicopter during the summer field season. Helicopter support for the program was provided by a Bell 206 Jet Ranger III leased to Forward Resources. Personnel supplied by Taiga Consultants included two senior geologists and two junior geologists. Field operations were carried out between July 19 and August 20 of this year.

The purpose of this exploration program was to map, as far as surface exposures would allow, the geology of the area as a guide to planned future seismic and drilling operations. Prior to the initiation of the field program, a photogeologic interpretation of the area was completed which outlined specific structures of interest to be further explored in detail by field techniques. All structural and stratigraphic observations made in the field were noted on 1:50,000 air photo mosaics prepared for the area. This information was evantually transferred to a series of 1:50,000 topographic base maps, which are used as the final geological maps. In addition, a composite 1:100,000 map of the entire project area was assembled to facilitate comparisons with seismic maps and to provide an overview of the Dome block geology.

Previous mapping of this region was carried out in 1968 by the Geological Survey of Canada as part of "Operation Norman", a regional helicopter supported geological reconnaissance. Bedrock and structural studies were the responsibility of D. G. Cook, J. D. Aitken, and M. E. Ayling. The results of this reconnaissance were summarized in GSC Paper 69-1A.



Scale 1 cm = 10 km

Property [box]

Figure 1

Property Location Map

Dome Petroleum / Forward Resources

A comprehensive description and map of the Colville Hills were produced by D. G. Cook and J. D. Aitken (1970) in G.S.C. Paper 70-12. Papers written by R. W. Macqueen (1969, 1970) and W. S. Mackenzie (1969, 1970) described the Paleozoic stratigraphy of the region. E. J. Tassonyi (1969) has reviewed the subsurface geology in areas adjacent to the Colville Hills. The glacial geology has been reported on by B. G. Craig (1960) and R. J. Fulton and R. W. Klassen (1969). A paper by J. W. Davis and R. Willott (1978) describes the structure of the Colville Hills based on field mapping and geophysical studies. A recent regional summary of the Cretaceous stratigraphy was completed by C. J. Yorath and D. G. Cook (1981).

PHYSIOGRAPHY

The Colville Hills are a series of linear ridges and rolling hills which interrupt the monotony of the Interior Plains north of the Franklin Mountains. These ridges, which have relief of up to 273 metres, bracket broad lowlands within which are found several large lakes including Lac Belot, Lac des Bois, Aubry Lake, and Colville Lake. Drainage in this region is sluggish and poorly integrated due to glaciation and in part to karst topography. This karst terrain, which is developed in a sequence of Cambrian to Devonian carbonates, is characterized by features such as sinkholes, caves, sinking streams, and springs. This karst surface apparently developed in pre-Cretaceous time and is presently undergoing active rejuvenation as evidenced by recent stream and lake disappearances.

The Anderson Plain extends west from the Colville Hills and consists of a gently undulating plain of moderate relief of 60 metres. Abundant small lakes are present in the area along with numerous karst features.

The karst topography is developed in the Bear Rock Formation, the Mount Kindle Formation, and the Franklin Mountain Formation. Drilling operations in the Colville Hills have on several occasions been severely hampered by the presence of karst features in the subsurface.

Pleistocene glaciation affected the entire region. The most prominent depositional features are a series of drumlinoid ridges, which extend north and west from Smith Arm of Great Bear Lake and swing westward across Belot Ridge. The remainder of the Dome land is mantled by glacial till which is generally less than 10 metres thick, except along the western margin of the area where thick glacio-fluvial and morainal deposits are recognized.

Bedrock is only intermittently exposed through this glacial cover. Exposures are best adjacent to streams and along ridges. Glacial erosion has resulted in scouring of topographically high areas. Permafrost is intermittent throughout the area as indicated by the development of karst features.

The most extraordinary feature about the topography of the area is how closely the present morphology reflects the structure of the region. Linear ridges such as Colville Ridge and Belot Ridge are all faulted anticlines while the large lakes occupy broad structural depressions. Likewise, the low rolling hills within the lowlands correspond to broad low-amplitude anticlines. Linear sets of small lakes are the surface expression of fault traces. This positive correlation between topography and structure, which was first inferred from a photogeologic interpretation of the area, was subsequently confirmed by field work. This fact allowed a rapid inventory of the structures to be made.

REGIONAL STRATIGRAPHY

The composition of the Precambrian crystalline basement underlying the area is unknown, but is probably the extension of the Bear Province beneath the Interior Plains. Overlying these basement rocks is the Hornby Bay Group which consists of sandstone, quartzite, and dolomite first described by Kidd (1932) from exposures along the east shore of Hornby Bay on Great Bear Lake. The Hornby Bay Group attains a maximum thickness of about 2,400 metres and has been dated between 1,765 m.y. and 1,155 m.y. (Helikian or Latest Aphebian).

The overling Coppermine River Series (Sandberg, 1913) is recognized to extend beneath the area on the basis of regional magnetic data and the strong seismic response produced by the basaltic flow units within this sequence. This series consists of up to 3,300 metres of amygdaloidal basalt flows which are thought to be genetically related to the Muskox intrusion. The most probable age for the Coppermine Basalts is 1,065 m.y. to 1,400 m.y. (Helikian).

The Hornby Bay Group and the Coppermine River Series are both cut by a series of diabase dykes. The dykes (which have been dated at 1,315 m.y.) trend predominantly in a northwest or northeast direction or parallel to major fault directions in the Colville Hills. In some cases, these dykes mark the locations of subsequently reactivated fault zones.

Following the emplacement of the Coppermine River Series, the region was uplifted and eroded before the succeeding sedimentary sequence was laid down. The original Coppermine River Series included an upper succession composed of up to 9,000 metres of interlayered sandstone, shale, dolomite, and gypsum; however, these units are now correlated with the Shaler Group which is exposed along the Hornaday River northeast of the project area. The upper 300 metres of the Shaler Group have been penetrated by various wells drilled in and adjacent to the Colville Hills. The Shaler Group is locally cut by a late series of gabbroic dykes and sills which aid in differentiating these unmetamorphosed late Proterozoic sediments from the overlying Cambrian rocks.

Unconformably overlying this Upper Proterozoic succession is the Lower Cambrian Old Fort Island Formation. This formation consists of mature, fine- to coarse-grained quartzose sandstone with minor interbedded pebble conglomerate with an aggregate thickness of up to 100 metres in exposures along the Hornaday River. This porous, cross-bedded transgressive sandstone unit is the principal potential hydrocarbon reservoir in this region. Sedimentary structures within this formation are indicative of a shallow water marine depositional environment. The maximum thickness of the Old Fort Island Formation encountered in the subsurface is about 80 metres in the Good Hope well north of Smith Arm of Great Bear Lake. The thinnest section of this unit was found in the Tedji gas well where only about 5 metres of this sandstone was drilled.

The Old Fort Island sandstone is succeeded by the fine clastics and carbonates of the Middle Cambrian Mount Cap Formation. This unit is a shallow water sequence which is transitional between the mature clastics of the Old Fort Island Formation and the shales and evaporites of the overlying Saline River Formation. The lowermost units of the Mount Cap often contain sandstones quite similar to those of the Old Fort Island, but these sandstones are usually more highly variated and interbedded with siltstone and shale. The bulk of this formation consists of silty shale with several interbedded dolomite units present near the top of the formation. The Mount Cap Formation reaches a maximum thickness of about 82 metres.

Conformably overlying the Mount Cap Formation is the Saline River Formation consisting of evaporites, shale, and minor interbedded dolomite. This formation, which is also Middle Cambrian in age, can be grossly divided into two units: a lower interbedded shale, dolomite, salt, and anhydrite unit; and an upper red to green shale unit. The maximum thickness of the Saline River Formation is approximately 260 metres in the Good Hope well.

The overlying carbonate sequence, which was once referred to as the Ronning, is now divided into the Franklin Mountain Formation and the Mount Kindle Formation. This subdivision was necessary when a regional unconformity was recognized within the Ronning at the base of the Mount Kindle Formation.

The Franklin Mountain Formation, on the basis of field studies, has been subdivided into three units: the cyclic, the rhythmic, and the cherty. The basal cyclic unit is transitional between the underlying shale and evaporites of the Saline River Formation and the overlying carbonate sequence. This unit is characterized by cyclic repetitions of dolomite with green dolomitic shale with a total thickness of up to 50 metres. The middle rhythmic unit is composed of dolomite which exhibits a subtle banded appearance due to alternating colours and resistance of the strata. Although readily distinguishable from the underlying unit in surface exposures, it is difficult to discriminate on a consistent basis from the overlying cherty unit in the subsurface. The rhythmic unit ranges from 150 to 260 metres thick in this region. The upper cherty unit of the Franklin Mountain Formation is a dolomite unit distinguished by vugs lined with varicoloured drusy quartz and bands of light grey to white chert. This resistant unit is up to 730 metres thick beneath the Colville Hills.

The ages of the three units of the Franklin Mountain Formation are still somewhat in doubt. An Upper Cambrian age has been tentatively assigned to the cyclic unit. The Cambrian-Ordovician boundary is placed somewhere within the upper part of the rhythmic unit, and the cherty unit is presently considered Ordovician in age. All three units appear to be of shallow water marine origin. The Franklin Mountain Formation is most commonly exposed along folds of high structural relief within the Colville Hills and adjacent areas.

Unconformably overlying the Franklin Mountain Formation is the Mount Kindle Formation. This resistant unit is composed of dolomite with a characteristic silicified fossil assemblage of Ordovician and Silurian age. The Mount Kindle Formation reaches a maximum thickness of 130 metres in the southern part of the Colville Hills. Differential erosion has resulted in the development of a strip surface at the top of the Mount Kindle which is basically responsible for the positive correlation between structure and topography previously mentioned.

The Middle Devonian Bear Rock Formation unconformably overlies the Mount Kindle Formation. This generally recessive formation is composed of dolomite, limestone, and rarely-exposed white gypsum. Probably only the lower 200 metres of the Bear Rock are present in the central and northern parts of the Colville Hills, west of the project area. Good exposures of the Bear Rock Formation occur in the southern part of the project area. Elsewhere the characteristic hummocky topography produced by solution collapse of the Bear Rock allows it to be recognized on aerial photographs.

Conformably overlying the Bear Rock is the Middle Devonian Hume Formation. The Hume consists of very fossiliferous, brown, dense, thin- and medium-bedded limestone that is typically rubbly in outcrop. Beds and partings of shale occur in the middle and lower part of this formation, but are seldom exposed. The thickness of the Hume Formation is 107 to 137 metres.

A major regional unconformity separates the Paleozoic carbonates from the overlying Cretaceous sandstone and shale. Preserved in a fault block on the west flank of Belot Ridge is an excellent exposure of tar sand about 50 metres thick. This sandstone unit may be correlative with the Sans Sault Formation. Along the west and south shores of Lac des Bois are additional exposures of interbedded Cretaceous sandstone and shale. These Cretaceous exposures are typically preserved in lowland areas.

From a structural viewpoint, the Phanerozoic formations which underlie the Colville Hills can be divided into two groups: the lower shale, sandstone, and evaporite packet; and the upper carbonate packet. The break between these two packets is at the base of the Franklin Mountain Formation. Coincidentally, the base of the carbonates is the strongest seismic reflection mappable in this region.

REGIONAL STRUCTURAL GEOLOGY

The Colville Hills form a northward extension of the Franklin Mountains into the Interior Plains. The style of the Colville Hills is similar to that of the Franklin Mountains, but different in the degree of deformation and orientation of the strucures present. Tunago Ridge, as noted by Cook and Aitken (1971), actually forms a physical link between the two structural provinces.

The Mackenzie Mountains, the Franklin Mountains, the Colville Hills, and the Anderson Plain, although differing in the intensity of deformation, are thought to be the tectonic expression of the same easterly-directed compressional stresses, which systematically decreased toward the north and east. The fundamental control for these four tectonic elements is believed to be rejuvenation of basement fault systems along which large vertical and horizontal adjustments have occurred. This interpretation is in essential agreement with that proposed by Goodman (1954) and Jeletzky (1961).

In the Franklin Mountains, this deformation took the form of a series of linear fault-controlled ranges and ridges composed largely of resistant Lower Paleozoic carbonates. The structures present are predominantly oriented in east-west and northwest-southeast directions. Faulting results either in scarps or sharply asymmetric folds which are characterized by rapid reversals of throw along strike, producing the so-called 'flip-flop' structures of the Franklin Mountains.

Although thrust faulting is involved in at least one structure at the extreme northwestern end of the Franklin Mountains, as demonstrated convincingly by Cook and Aitken (1976), it is not considered to be the pervasive mode of deformation. Rather, the structure of the Franklin Mountains appears to be controlled by a regional system of basement faults which divide the area into a series of orthogonal blocks of tesserae. These blocks, when subjected to horizontal compression, have responded by rotating in a counter-clockwise fashion accompanied by tilting, uplift, and horizontal fault movements. The result of this rotation was the development of a series of right-lateral strike-slip faults within and at the margins of the Franklin Mountains.

This interpretation is based on the geometry of the structures present and their similarities with the structures in the Colville Hills. Structures in the Franklin Mountains typically trend toward the northwest or northeast and are marked by regionally continuous faults. These faults are expressed either by a fault scarp or as highly asymmetric faulted folds. An asymmetric faulted fold characteristically plunges towards the next fold in the series which exhibits the opposite asymmetry. These 'flip-flop' structures are interpreted as the surface expression of rapid reversals of throw along strike of the controlling basement faults. This scissor faulting is a common phenomenon associated with strike-slip faults.

Another characteristic structural feature of strike-slip faulting is the drag fold. These are usually found as a right-hand en echelon series of low-amplitude folds diverging from a fault zone at about 30°. While these faults and their associated drag folds are neither the most prominent structures nor the most numerous type present, they are quite instructive as to the basic nature of the faulting.

STRUCTURE OF THE COLVILLE HILLS

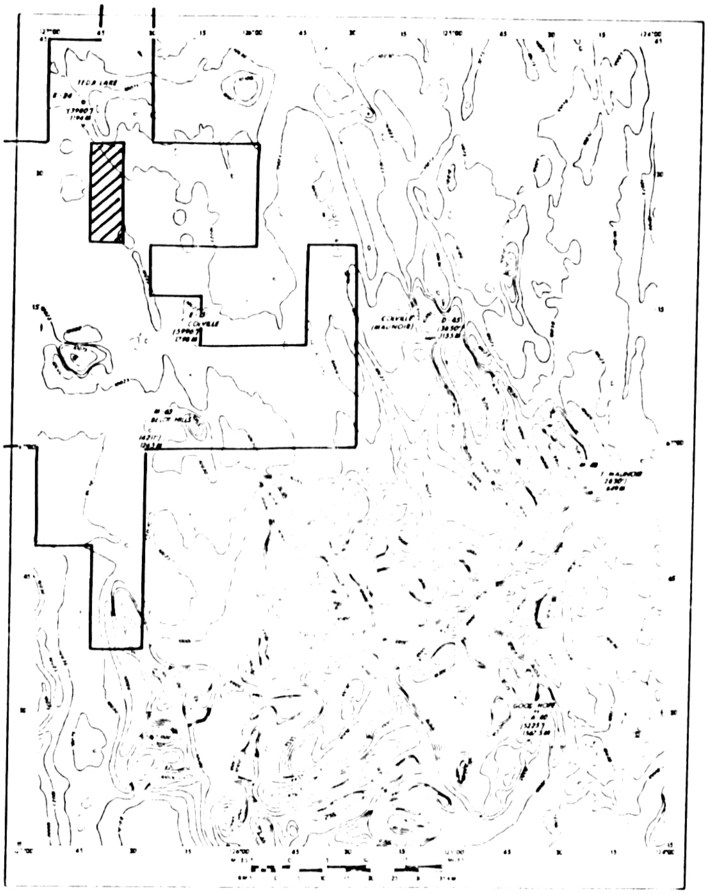
Geophysical Data

A substantial amount of geophysical data has been acquired in the project area. This includes thousands of kilometres of aeromagnetic coverage, and hundreds of kilometres of seismic.

Magnetics (Figure 2)

Close to 64,000 kilometres of airborne geomagnetic survey have been flown in the Colville Hills / Anderson Plain. In the Dome block, the magnetic signature is dominated by the basaltic flows of the Coppermine River Series and the intrusions that occurred later, probably in Hadrynian time.

The Pelot Ridge and the Colville Ridge are believed to be underlain by extensive regional flood basalts. It is important to note that a flood basalt does not necessarily give rise to a magnetic anomaly; there must be a lateral change in magnetic susceptibility (a fault or fold is a simple way to achieve this change). The strong magnetic response which is seen in this area and particularly over such a structure as the Maunoir Ridge, could only be caused by extensive folding and particularly faulting that involved these strongly magnetic bodies. Using the Colville Ridge as an example, faulting must extend at least as far into the section as the Coppermine River basalts in order to provide such a strong magnetic anomaly. A weak argument could be made that what is involved here is the intrusion of basic dykes along lines of weakness, i.e., faults or joints. This undoubtedly happened further to the northeast and particularly in the Great Bear Plain east of Lac Maunoir. However, the magnetic anomalies associated with these dykes are very elongate and narrow, whereas the Colville Ridge feature is much broader.



after Davis and Willott (1978)

FIGURE 2

REGIONAL MAGNETIC MAP

Seismic

There is about 1,000 km of regional seismic coverage on the Dome block. Seismic profiles obtained in the area are generally of quite poor quality with the exception of the more recent data. This is due to the presence of discontinuous permafrost and karsted carbonates which combine to produce a great deal of seismic noise.

Geometry of Structures

The geological composite map of the area which accompanies this report locates the principal faults and folds present. Basically, there are four types of flexures identified: (1) narrow faulted anticlinal ridges; (2) large faulted asymmetric folds; (3) fault-related drag folds; and (4) domes.

A structure such as the Belot Ridge Anticline belongs to the first class. These narrow faulted anticlines are formed by the uplift of elongate basement fault blocks. Either one or both limes of these folds are faulted and cross-faults are common. The continuity and extent of these faulted fold structures are interpreted as the surface expression of a regional fault system. Within the fault zone, narrow basement fault blocks have been uplifted as horsts which die out upwards into the observed asymmetric folds.

Large asymmetric faulted folds such as the Good Hope Ridge Anticline and the Maunoir Ridge Anticline belong to the second class of structures. These two folds have the same 'flip-flop' relationship typical of folds in the Franklin Mountains. The Good Hope Ridge structure is a large, asymmetric anticline with a steep, faulted east limb. This fault trends northward where it becomes a simple east-dipping fault block. These folds are clearly the result of large basement fault blocks uplifted along a regional fault zone. These faults are characterized by rapid reversals of throw along strike producing the opposite asymmetry of these folds.

The ductile shale and evaporites of the Saline River Formation appear to thin somewhat along the axial region of these folds indicating that flowage has taken place. However, this is considered to be the response to rather than the cause of the deformation.

Drag folds related to the regional fault system constitute the third class of flexures present in the region. These folds vary from parallel to about 30° to the controlling fault zone. The orientation of the axes of these folds to the regional faults can best be explained by assuming a right-lateral strike-slip movement. A consistent right-lateral horizontal movement can be inferred from drag fold orientations for all major faults in the Colville Hills. None of these drag folds has the amount of structural relief as do the other two types of folds. They are typically broad, low-amplitude symmetrical folds. It is significant that faulting of the drag folds themselves is generally minor. An example of this type of structure would be the "Spring" Anticline.

One advantage of describing the geometry of these folds in terms of fault-related drag folds is that it can easily account for observed rapid changes of fold direction. Various sets of en echelon folds vary by as much as 90° to one another. Where such rapid changes in fold orientations occur, invariably one of the regional faults is present.

Two examples of the fourth and final type of flexure present in the Colville Hills have been recognized thus far, the Tedji Dome and the "East Tedji" Dome. Extensive seismic was shot over both the domes and from these records it can be seen that these domes are faulted flexures of moderately high structural relief. On the Tedji Dome, the rapid thinning of the Old Fort Island sandstone along the crest of this structure indicates that either a paleotopographic high was present in Cambrian time or there was a post-Old Fort / pre-Mount Cap structure developed in this area, which was subsequently reactivated during the late Cretaceous Laramide Orogeny.

GEOLOGICAL MAPPING RESULTS

MAP 1 96 M/15

The southeastern corner of this map-sheet is included within the Dome farm-out area. No bedrock exposures were detected in this area; however, the area has been interpreted as underlain by the Devonian Bear Rock Formation based on the characteristic hummocky topography present.

Structurally, a synclinal axis has been inferred to be located in the western part of the mapped area. This syncline would be the structural low adjacent to the Tedji Dome located towards the southwest. The only other indications of structures mapped within the area are series of northeast and northwest trending lineaments. These lineaments have been interpreted based on photogeologic and geomorphic criteria and are thought to be the surface expression of subsurface fault trends.

Due to the lack of suitable structures, no seismic is proposed for this area.

MAP 2 96 M/10

With the exception of the northwestern corner of this map-sheet in the vicinity of the Tedji Dome, this map-area lies completed within the Dome Leases optioned to Forward Resources.

Bedrock exposures were not observed within this map-sheet; however, a number of exposures were mapped immediately east of the "East Tedji" Dome on the adjacent map-sheet. These exposures, which were of Devonian Bear Rock carbonates, helped to define the east flank of the "East Tedji" Dome and the north-south trending fault zone along this flank. Throughout the remainder of the area, the distribution of the Bear Rock and Cretaceous sediments was inferred based on morphology and airphoto examination.

Within the area under option, three significant structures were delineated. These are, in order of importance, the "East Tedji" Dome, the "South Tedji" Dome, and the north-plunging segment of the "Oris" Anticline.

The "East Tedji" Dome has been mapped with a fair degree of confidence based on its topographic and airphoto expression and bedrock structural control obtained from the adjacent map-sheet to the east. The "South Tedji" Dome has been identified using geomorphic and airphoto interpretative techniques. Since there were no bedrock exposures to support this interpretation, a lower degree of confidence would be ascribed to this structure. In the southwestern corner of the map-sheet is located the north-plunging "Oris" Anticline. The continuation of the "Oris" Anticline is poorly defined within the area by either photogeologic or geomorphic criteria and as such is considered highly interpretative.

A considerable amount of seismic has already been shot over the "East Tedji" Dome and thus, since sufficient control already exists, no additional seismic is recommended. On the "South Tedji" Dome, several additional seismic lines are necessary to define the existence and subsurface configuration of this structure. Since only a small part of the "Oris" Anticline is present within the project area, no seismic program is recommended until seismic has been shot across the fold structure further north.

MAP 3 96 M/5

The northwestern part of this map-sheet is within the project area. Exposures of both the Devonian Hume Formation and Cretaceous sediments were found along the incised channel of Carnwath River. With the exception of the limestone belonging to the Hume Formation exposed in the lower reaches of the Carnwath River channel, the remainder of the area appears to be underlain by gently dipping Cretaceous sedimentary rock units mantled by thin glacial outwash deposits.

Structurally, no fold axes could be defined within the area. The single east dip obtained from the Hume exposure indicates that an anticline may be located immediately west of the property. This is inferred due to the fact that the regional dip is toward the west and any east dip measured would indicate local reversal of dip which usually indicates the presence of an anticline. A number of strong topographic and airphoto linears were identified as a guide to possible subsurface fault trends in this map-area.

Since additional structures may exist beneath the Cretaceous unconformity within the area, at least one reconnaissance seismic line should be shot with a northeast-southwest orientation to evaluate this map-area further.

MAP 4 96 M/6

This entire map-sheet lies within the Dome / Forward farm-out area. Three rock units were mapped within the area: the Bear Rock Formation, the Hume Formation, and undifferentiated Cretaceous sandstone and shale. Of these units, only the Hume was identified at two localities from a surface exposure in the area. The contacts and distributions of the units were inferred over the remainder of this map-sheet based on an air-photo interpretation and by the distributions of the units on the adjacent map-sheet.

The only structures identified within the area were the Belot Ridge Anticline and adjacent synclinal lows. The Belot Ridge structure consists of two en echelon asymmetric anticlines which form the northernmost extension of the complex Belot Ridge anticlinal trend. Two separate closures along this trend have been mapped. These two anticlines are separated by a fault and have opposite asymmetries with the southernmost anticline having a steeper east flank, and the more northerly anticline having a steeper west flank. As mentioned previously, this is the typical 'flip-flop' configuration common to anticlines in both the Franklin Mountains and the Colville Hills structural provinces.

It is proposed that a number of seismic lines be laid out across the Belot Ridge Anticline in order to confirm and quantify the closures indicated by surface mapping. These lines would be arranged with a northeast-southwest orientation perpendicular to the axial trend of the Belot Ridge Anticline.

MAP 5 96 M/7

With the exception of half a grid unit in the north-central part of the area, the entire map-sheet lies within the Dome block. Although no bedrock exposures were mapped, the distributions of the Devonian Bear Rock Formation and Cretaceous sediments were inferred based on geomorphic and airphoto criteria and from the composition of glacial deposits.

A number of small anticlines and one small dome have been inferred to exist based on geomorphic and airphoto interpretation completed for the area.

Three anticlines of potential interest as hydrocarbon traps have been designated the "Oris", the "Ptard", and the "West Aubry" anticlines. These three anticlines occur in close proximity in the northern part of the map-sheet. Two of these, the "Oris" and the "West Aubry" anticlines, are oriented in an en echelon pattern trending northwesterly. The fault-bounded "Ptard" Anticline is located between the other two anticlines and is oriented northeast-southwest. The rapid reversal of the direction of fold axes is only possible if faulting is involved. The "Ptard" may be a younger fault block related to cross structures developed subsequent to the other two anticlines. In addition to the three named anticlines, several small unnamed anticlines were mapped within the area. These smaller anticlines are highly interpretative and too small to be of further interest as exploration targets.

The "Aubry" Dome is located in the southeastern part of this map-area and is fairly well defined by geomorphic and photogeologic techniques. While relatively small be comparison to the Tedji Dome, it is still sufficiently sufficiently large to justify further seismic evaluation.

Seismic surveying of the "Oris" Anticline, the "West Aubry" Anticline, and the "Aubry" Dome is recommended. Seismic is precluded on the "Ptard" Anticline as most of this structure lies within the area excluded from the Dome / Forward farm-out area.

MAP 6 96 M/8

Only the southeastern part of this map-sheet is excluded from the Dome / Forward farm-out area. No bedrock exposures were located within the area. The inferred contact between the Devonian Bear Rock Formation and undifferentiated Cretaceous sediment was based on geomorphic and photogeologic interpretation. Thus, the distribution of these units within this map-area is generalized.

A total of six anticlines were mapped in this area. In the northern part of the area, three north-south trending anticlines were mapped and designated the "East Aubry", the "Middle Ridge", and the "Petrock" anticlines. Toward the south are the "Crosswise", the "Aubry", and the Colville Ridge anticlines which have an essentially east-west orientation. This abrupt change in the orientation of these folds is marked by a major strike-slip fault zone.

With the exception of the Colville Ridge Anticline, which has been drilled previously, the remaining five anticlines should be detailed by a seismic survey shot perpendicular to the axial trends of these folds.

MAP 7 96 N/5

Only the southeastern part of this map-sheet lies within the farm-out area. No bedrock exposures were found during the reconnaissance of the area. Undifferentiated Cretaceous sandstone and shale are inferred to underlie the area based on the topographic expression of these clastic sediments. Glacial deposits in the form of outwash and drumlinoid ridges were noted in the area. From these drumlinoid ridges, a northwest direction of glacial movement can be interpreted.

Only one prominent lineament trend was mapped in this area. This lineament, which offsets the Colville Ridge Anticline toward the north, is considered the surface expression of a significant fault in the subsurface.

No seismic surveying of this area can be recommended.

MAP 8 96 M/3

The eastern and northern portions of this map-sheet lie within the project area. No exposures were delineated within the area, but the Bear Rock Formation and the Hume Formation and Cretaceous rock units are interpreted as occurring beneath this area. This interpretation is based on morphology and exposures on adjacent map-areas toward the north and east.

The only fold structure identified within the area is a segment of the Belot Ridge Anticline located in the northeastern corner of the map-sheet. This anticline is fairly broad and appears to have a separate culmination or closure in this area. The anticline is slightly asymmetric with a steeper east limb indicating this limb is faulted in the subsurface. Additional faults are indicated by a number of lineaments present in this area.

Although several seismic lines have been shot along and across this structure, two additional cross lines would be required to fully detail this anticline. It appears possible, with this additional seismic coverage, to establish a separate closed anticline structure along this section of the Belot Ridge Anticline.

MAP 9 96 M/2

This entire map-sheet lies within the project area. Along the crests of both the Belot Ridge and the Colville Ridge, exposures of the cherty unit of the Franklin Mountain, the Mount Kindle, and the Bear Rock formations and Cretaceous rock units are relatively abundant.

Good dip control allows the intricate details of both of these major anticlinal structures to be deciphered. The Belot Ridge Anticline is a compound anticline with a number of independent closures located along the trend. These northwest trending folds are fundamentally related as drag folds related to a right-lateral strike-slip fault which parallels the overall anticlinal trend. The constituent anticlines typically have the reverse asymmetries characteristic of the 'flip-flop' structures described elsewhere in the Franklin Mountains and the Colville Hills.

The Colville Ridge Anticline is essentially a faulted sharply asymmetric anticline related to the Belot Ridge anticlinal trend. At the juncture of these two structures, the fault controlling the Belot Ridge structure bifurcates. One fault swings toward the northwest and controls the folding of the Belot Ridge structure, while the second branch swings toward the northeast and forms the Colville Ridge structure. Along the northeast nose of the Colville Ridge Anticline, bedrock exposures allow observation of structural detail not commonly visible elsewhere in this region. At this locality, the plunging anticline is expressed as a series of W-folds terminating against a vertical fault with right-lateral horizontally aligned slickensides. This one series of exposures is concrete proof that the structural model proposed by Davis and Willott (1978) is correct.

A small anticline with low structural relief has been inferred to the southwest of the Belot Ridge. This unnamed anticline was interpreted based on geomorphic expression alone, but if valid, would appear to have closure. In addition to the main strike-slip faults which parallel both the Belot Ridge and the Colville Ridge, a number of lineaments have been mapped in this area as indications of the locations and orientations of subsurface faults.

Detailed seismic is required to establish separate fault or fold closures along both the Belot Ridge anticlinal trend and the Colville Ridge Anticline. Although both structures have been drilled at one location each, a number of independent closures exist along both trends to allow further drill testing to be carried out. Several seismic lines could be shot to establish the geometry and closure on the small anticline to the southwest of the Belot Ridge and to determine whether additional structures could be present in this area.

MAP 10 96 M/1

All but the northeastern section of this map-sheet is included within the Dome / Forward option. Bedrock exposures within the area are confined to the southwestern corner of the map-sheet along the crest of the Belot

Ridge structure. In this area, excellent exposures of the cherty unit of the Franklin Mountain Formation were mapped, along with exposures of the Mount Kindle and the Bear Rock formations. Contacts between these formations could be mapped directly over short distances and inferred with great accuracy in hte remainder of the area. Direct observation of a major fault zone in the area was also possible. Elsewhere in the area, the contacts had to be inferred, based on topography and photogeology.

Three anticlinal structures and the north plunge of a major dome were mapped in this area. The anticlinal trends include portions of the Belot Ridge and the Colville Ridge structures and a small unnamed anticline southeast of Colville Lake. The Belot Ridge Anticline is a complexly folded and faulted anticlinal trend. Within this area, this north-south trending structure bifurcates, with the main trend diverging toward the northwest, and a subsidiary fold plunging toward the north. The major right-lateral strike-slip fault, which controls the geometry of the structure, likewise splits with the main fault continuing northwest and a secondary fault continuing northward. The prominent hill which is the high point of the entire ridge occurs at the intersection of these two trends. This point also represents the highest structural relief of any structure within the Dome block. A minimum of 1,000 metres of structural relief is required to bring the cherty unit of the Franklin Mountain Formation to the top of this prominent topographic high.

The main fault zone can be field observed at several locations along the east flank of the Belot Ridge. At one location, south-southeast of the ridge crest near the contact of the cherty unit and the Mount Kindle Formation, a vertical fault zone with nearly horizontal slickensides can be seen. The sense of movement inferred from these slickensides indicates the fault is a right-lateral strike-slip. This type of faulting was predicted based on the structural model of the Colville Hills proposed by Davis and Willott (1978). At a second location further north along the same fault zone just east of the crest of Belot Ridge, this fault zone is expressed as a narrow silicified breccia zone which locally stands out in relief.

A section of the Colville Ridge structure is mapped in the northwestern part of the map-sheet. In this area, the Colville Ridge structure consists of two anticlines which plunge towards each other with opposite asymmetries and are separated by a fault zone. The western anticline is faulted along the north flank of the anticline with the steep limb on this flank. The anticline plunges towards the east-northeast. The eastern anticline has a steeper south limb and plunges towards the west-southwest. The overall pattern is the familiar 'flip-flop' pattern previously described. The anticlines are essentially tilted fault blocks in the subsurface along a major regional fault zone with the blocks tilted in opposite directions passing upward into the observed asymmetric folds.

A small unnamed anticline is interpreted to exist adjacent to the southeastern corner of Colville Lake. This structure is interpreted on the basis of geomorphic criteria and airphoto studies. It appears to be a symmetrical anticline with low structural relief.

In the southeastern corner of this map-sheet is the north-plunging termination of the "Nili" Dome. While this dome is probably the best untested structure in the Colville Hills, too little of the structure extends onto the Dome acreage to warrant further evaluation.

Several additional seismic lines should be shot in order to evaluate the Belot Ridge, the Colville Ridge, and the unnamed structure. These seismic lines would detail separate closures on the Belot Ridge and the Colville structure within the area, and confirm closure on the small unnamed anticline southeast of Colville Lake. No seismic program is warranted on the "Nili" Dome since only the northern extremity of this structure occurs on the Dome land.

MAP 11 96 N/4

With the exception of the northeastern corner of this map-sheet, which lies entirely within Colivlle Lake, the area lies within the Dome / Forward farm-out area. No bedrock exposures were delineated during reconnaissance of this area. Most of the area appears to be underlain by undifferentiated

Cretaceous sandstone and shale with the exception of the extreme southeastern part of the area on the flanks of the "Nili" Dome where the Mount Kindle and the Bear Rock formations are interpreted to subcrop. Glacial deposits in the form of drumlinoid ridges and outwash mantle most of the eastern part of the area. From the orientation of these drumlinoid ridges, the direction of the last ice advance in the area was towards the northwest.

The only significant structure identified within the area is the northernmost extremity of the "Nili" Dome. Like the adjacent map-sheet to the west, so little of this structure occurs within the Dome / Forward farm-out area that it is of little interest.

No seismic is recommended on the "Nili" Dome. A single reconnaissance seismic line oriented north-northeast across the eastern part of the area could be completed in order to evaluate the possibility that structures could exist beneath the Cretaceous cover in this area that do not have a surface expression.

MAP 12 96 L/15

This map-area, with the exclusion of the southwestern corner, is included in the Dome farm-out area. Bedrock exposures are fairly abundant in the southeastern part of the area while in the northern half of the map-sheet, none was observed. Outcrops of the Mount Kindle and the Bear Rock formations occur along with several good exposures of Cretaceous sandstone. Good exposures are noted in the extreme southeastern part of the map-sheet along a fault scarp where the Bear Rock Formation juxtaposes against the Mount Kindle Formation across this fault. Elsewhere several small glacial pavements are developed on the Bear Rock and outcrops were delineated along the rims of sinkholes developed in the Bear Rock. Several extensive exposures of Cretaceous sandstone were mapped in the east-central part of the area. A number of sandy drumlinoid ridges are developed in the northern part of the area indicating a westward direction for ice advance over the area.

Two anticlines were mapped based on good dip control in the south-eastern part of the area. The "Cuesta" Anticline is a north-south oriented symmetrical anticline with low structural relief. A possible closure on this anticline was mapped in the southeastern corner of the map-sheet. This small fold appears to be a first-order drag fold related to the fault located immediately to the southeast. The anticline appears to be symmetrical with a possible closure within this area. A number of well developed lineament trends were mapped in this area, indicating faulting in the subsurface.

At the northern end of this unnamed anticline, a dead oil seep was discovered. The seep has an area of perhaps 100 m^2 and consists of plastic, water-saturated carbon black on which no vegetation grows. An attempt was made to obtain samples below the surface, but the rapid inflow of this plastic material precluded such penetration. It is thought that the dead seep was formed by the surface combustion of a live seep as a result of a forest fire. Burning of the live seep would continue until the seep was sealed off and carbon residue remained.

Three short seismic lines should be shot across the "Cuesta" Anticline in order to detail this structure and to prove closure. There is room to shoot one east-west line across the smaller unnamed anticline to the south-west. It would be prudent to establish several reconnaissance seismic lines in the northern part of this map-sheet to identify possible structures not visible at the surface.

MAP 13 96 L/10

Only the northeastern corner of this map-sheet falls within the project area. Bedrock exposures are scattered throughout the area and consist exclusively of the Middle Devonian Bear Rock Formation. Subcrops of Mount Kindle and Cretaceous sediments are projected to occur in the northern part of the area. Outcrops of the Bear Rock Formation typically occur along the rims of numerous collapsed sinkholes which dot the area. While individual dip and strike readings may be suspect, a consistent overall structural pattern did emerge.

Only two anticlines were mapped within this area. The first was the northeast-plunging "Spring" Anticline. This well defined open symmetrical fold does not appear to have closure within the Dome lands. The small unnamed anticline noted to the north, plunges southeastward into the northern border of the map-sheet.

Since neither of these structures appears to be closed within that part of the map-sheet which falls within the Dome / Forward farm-out area, no seismic is proposed.

Composite Geology Map

The individual 1:50,000 geological maps were reduced to a scale of 1:100,000 to facilitate comparison with available seismic maps and to provide a regional perspective of the geology of the area. This map scale allows the size and extent of the various structures to be viewed and directly compared in a regional context. Based on such observations, the ten more important structures have been priority-rated in the following order:

1. The "East Tedji" Dome.
   This broad domal structure should be the first priority for any drilling in the area. This recommendation is based on the proximity with and the similarity to the Tedji Dome gas discovery. The target horizon would be the Old Fort Island sandstone from which gas flowed from the Tedji well.

2. The "Aubry" Dome
   This geomorphically defined dome, once confirmed by seismic, should be tested by exploratory drilling. The primary target would be the Cambrian Old Fort Island sandstone with secondary consideration given to evaluating the maturation of the Proterozoic Shaler Group. If a hydrocarbon potential can be demonstrated in these Upper Proterozoic sedimentary rocks, deep drilling could be considered.

3. The Belot Ridge Anticline
The complexly folded and faulted anticlinal structure should receive a fairly high priority for future drilling in this area. A number of individual closures have been identified along this trend, which once detailed by seismic, would be suitable drill targets. The fact that a major fault is associated with this structure indicates that periodic rejuvenation probably occurred along this fault through geologic time. Vertical movements along this fault during Cambrian time could have a direct effect on distribution and sedimentation trends with the Old Fort Island sandstone which is the primary drilling target in this region.

4. The "South Tedji" Dome
This dome, if seismic confirmation can be obtained for the geomorphically defined structure, should be given a fairly high priority. The priority would be changed significantly depending on the results of drilling on the "East Tedji" Dome. The Cambrian Old Fort Island Formation would be the principal reservoir to be tested beneath the "South Tedji" Dome.

5. The "Aubry" Anticline
This broad anticlinal trend, once detailed by seismic, would constitute an attractive drilling location. While indirectly related to the Colville Ridge Anticline / fault structure as a large first-order drag fold, the "Aubry" Anticline has not been intensely faulted and thus probably the Old Fort Island reservoir has not been breached. The size and simplicity of this structure makes it highly attractive.

6. The "Cuesta" Anticline
This doubly plunging anticline, which is well defined by surface dip measurements, appears to have surface closure. Once detailed by seismic, this anticline would provide an exploration drilling target in a relatively untested area. As throughout the area, the Old Fort Island would be the primary exploration target in the subsurface.

7. The Colville Ridge Anticline

This compound anticlinal structure, like the Belot Ridge structure, consists of a number of separate anticlines with closure. These anticlines are located along a major fault structure and their asymmetric character is probably due to the fact that they form a series of tilted fault blocks in the subsurface. Although this structure was tested on one of these component anticlines, other close anticlines along this trend may be more suitable as hydrocarbon traps. With sufficient seismic detail on these anticlines, a preferred structure could be defined. Such an anticline would provide suitable closure of the Old Fort Island Formation with a minimum of fault disruption.

8. The "Oris" Anticline

This relatively low relief anticline is located with of the Tedji Dome and for this reason is given priority over other similar structures in the area. Once a seismic survey is completed on this structure and closure is confirmed, exploration drilling should be initiated to evaluate the hydrocarbon potential of the underlying Old Fort Island Formation.

9. The "East Aubry" Anticline

This elongated symmetrical anticline is defined on the basis of geomorphic and airphoto interpretations of the Dome block. Once seismic confirmation of the geometry and closure on this structure is available, an evaluation of the hydrocarbon potential of the Old Fort Island Formation beneath this area could be undertaken. The priority of this anticline could be elevated based on the results of a test of the "East Tedji" Dome area toward the northwest.

10. The "Middle Ridge" Anticline

The elongated anticline is located east of the "East Aubry" Anticline and parallels this structure. Once seismic data are available to substantiate closure on this structure, exploration drilling to test the Old Fort Island Formation can be considered.

CONCLUSIONS

As part of the evaluation of the Dome farm-out area, Taiga Consultants Ltd. has carried out on behalf of Forward Resources Ltd. a detailed field geological mapping program in the Colville Hills and adjacent parts of the Anderson Plain. The results of this field mapping program, combined with a previously completed photogeologic mapping program, have led to the identification of numerous structures capable of providing suitable hydrocarbon traps within the area. Maps which provide geological and stratigraphic details of these structures were prepared at a scale of 1:50,000 from which a composite map was constructed at a scale of 1:100,000.

Various structures within the Dome block were evaluated as to the need for additional seismic and priority-rated as to exploration drilling targets. These structures in order of priority are: the "East Tedji" Dome, the "Aubry" Dome, the Belot Ridge Anticline, the "South Tedji" Dome, the "Aubry" Anticline, the "Cuesta" Anticline, the Colville Ridge Anticline, the "Oris" Anticline, the "East Aubry" Anticline, and the "Middle Ridge" Anticline. Additional structures exist within the project area but either are too small to be of interest or occur only partly within the Dome / Forward farm-out area.

The results of this geologic mapping program, combined with the analysis of seismic and other geophysical data from the area, should be compared prior to final selection of exploration well locations.

Respectfully submitted,

J. W. Davis, M.Sc., P.Geol., F.GAC
TAIGA CONSULTANTS LTD.

PROFESSIONAL GEOLOGIST
JAMES W DAVIS
ALBERTA

THE ASSOCIATION OF
PROFESSIONAL ENGINEERS,
GEOLOGISTS and GEOPHYSICISTS
OF ALBERTA
PERMIT NUMBER
P 2399
TAIGA CONSULTANTS LTD.

J. W. DAVIS

SELECTED REFERENCES

Aitken, J.D. et al. (1969): Operation Normam, District of Mackenzie; Geol. Surv.Canada, Paper 69-1A, pp.223-229

Cook, D.G. (1975): The Keele Arch - A Pre-Devonian and Pre-Late Cretaceous Paleo-Upland in the Northern Franklin Mountains and Colville Hills; Geol.Surv.Canada, Paper 75-1C, pp.243-246

Cook, D.G. and Aitken, J.D. (1971): Geology, Colville Lake Map-Area and Part of Coppermine Map-Area, Northwest Territories; Geol.Surv. Canada, Paper 70-12

―――――― (1976): Two Cross-Sections Across Selected Franklin Mountain Structures and Their Implications for Hydrocarbon Exploration; Geol.Surv.Canada, Paper 76-1B, pp.315-322

Craig, B.G. (1960): Surficial Geology of North-Central District of Mackenzie, Northwest Territories; Geol.Surv.Canada, Paper 60-18

Davis, J.W. and Willott, D. (1978): Structural Geology of the Colville Hills; Bull.of Cdn.Petr.Geol., Vol.26-1978, pp.105-120

Fulton, R.J. and Klassen, R.W. (1969): Quaternary Geology, Northwest District of Mackenzie; Geol.Surv.Canada, Paper 69-1A, p.193

Goodman, A.J. (1954): Tectonics of East Side of Cordillera in Western Canada; Western Canada Sedimentary Basin (Tulsa: Amer.Assn.Petr. Geol.), pp.341-345

Jeletzky, J.A. (1961): Eastern Slope, Richardson Mountains, Cretaceous and Tertiary Structural History and Regional Significance; Geology of the Arctic, Vol.I (Toronto: Univ.of Tor.Press), pp.532-583

Kidd, D.F. (1932): Great Bear Lake Area, Northwest Territories; Geol.Surv. Canada, Summary Report Part C, pp.1C-36C

Mackenzie, W.S. (1969): Lower Mackenzie River, District of Mackenzie; Geol. Surv.Canada, Paper 69-1A, pp.236-238

―――――― (1970): Devonian Stratigraphy, District of Mackenzie; Geol. Surv.Canada, Paper 70-1A, pp.224-225

Macqueen, R.W. (1969): Lower Paleozoic Stratigraphy, Operation Norman; Geol.Surv.Canada, Paper 69-1A, pp.238-241

―――――― (1970): Lower Paleozoic Stratigraphy and Sedimentology, Eastern Mackenzie Mountains, Northern Franklin Mountains; Geol. Surv.Canada, Paper 70-1A, pp.225-229

Sandberg, A. (1913): Report on a Reconnaissance Along Lower Coppermine River, Canada; The Copper Bearing Traps of the Coppermine River, Trans.Cda.Mining Inst., Vol.16, pp.83-101

Tassonyi, E.J. (1969): Subsurface Geology Lower Mackenzie River and Anderson River Area, District of Mackenzie; Geol.Surv.Canada, Paper 68-25

Yorath, C.J. and Cook, D.G. (1981): Cretaceous and Tertiary Stratigraphy and Paleogeography, Northern Interior Plain, District of Mackenzie; Geol.Surv.Canada, Memoir 398