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JURASSIC AND LOWER CRETACEOUS SUBSURFACE STRATIGRAPHY OF THE MACKENZIE DELTA–TUKTOYAKTUK PENINSULA, N.W.T.

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Preface

The discovery of hydrocarbons in several Lower Cretaceous rock units in the Mackenzie Delta emphasized the need for a more comprehensive assessment of the Mesozoic geology of the region. Until the preparation of this report our knowledge of the Jurassic-Lower Cretaceous geology of the Yukon and northwestern Northwest Territories had been based on surface studies made west of the Delta.

The present study is based entirely on well data which have been integrated with surface data. Stratigraphic units are identified and correlated and then distribution, thicknesses, lithologies and depositional origins are described and illustrated. Studies such as this are necessary if more precise estimates of the hydrocarbon potential of these rocks are to be made and also to provide geologic models and basic data to facilitate future exploration for hydrocarbons. The data presented in this report are also useful in extending our understanding of the Mesozoic geology of the entire Beaufort-Mackenzie Basin.

R.A. Price
Director General

OTTAWA, July 1982

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JURASSIC AND LOWER CRETACEOUS SUBSURFACE STRATIGRAPHY OF THE MACKENZIE DELTA–TUKTOYAKTUK PENINSULA, N.W.T.

Abstract

The Jurassic-Lower Cretaceous succession in the subsurface of the Mackenzie Delta area consists of alternating sandstone- and shale-rich lithostratigraphic units. Shale-rich units include the Husky, McGuire, Siku (new name), Mount Goodenough and Arctic Red Formations. Sandstone-dominant units include the Bug Creek Group and Martin Creek, Kamik (new name), Rat River and Atkinson Point Formations. The Martin Creek, McGuire and Kamik Formations comprise the newly defined Parsons Group.

Nine depositional-episodes occurred in the Early Jurassic to Albian, each represented by a basinward prograding lens of clastic sediments (depositional-complex). Several of the episodes were interrupted by periods of uplift and subaerial erosion, resulting in major regional unconformities. During depositional-episodes 1 and 3 (represented by the Bug Creek Group) sedimentation was limited to the southwestern part of the Mackenzie Delta but in the following episode deposition expanded southwards and eastwards. In the Early Albian (depositional-episode 9: Arctic Red Formation) there was further expansion of the depositional basin and the strandline migrated well to the south of the Mackenzie Delta area. During each of the depositional-episodes the main source of clastic sediment was to the south and southeast but during certain periods in depositional-episodes 7 and 8 (Late Hauterivian and Late Barremian to Aptian respectively) a local northerly source area existed.

Résumé

La succession jurassique crétacé inférieur, dans le sous-sol de la région du delta du Mackenzie, comprend une alternance d'unités lithostratigraphiques riches en schistes argileux et en grès. Les unités riches en schistes argileux comprennent les formations de Husky, McGuire, Siku (nouvelle désignation), Mount Goodenough et Arctic Red. Les unités où le grès domine comprennent le groupe de Bug Creek et les formations de Martin Creek, Kamik (nouvelle désignation), Rat River et Atkinson Point. Les formations de Martin Creek, McGuire et Kamik comprennent le groupe nouvellement défini de Parsons.

Neuf épisodes de sédimentation se sont produits au début du Jurassique jusqu'à l'Albien, représentés chacun par une lentille de sédiments clastiques (complexe sédimentaire) progressant vers le bassin. Plusieurs des épisodes ont été interrompus par des périodes de soulèvement et d'érosion subaérienne qui ont eu pour résultat des discordances stratigraphiques régionales importantes. Pendant les épisodes 1 et 3 de sédimentation représentés par le groupe de Bug Creek, la sédimentation a été limitée à la partie sud-ouest du delta du Mackenzie, mais dans l'épisode suivant elle s'est étendue au sud et à l'est. Au début de l'Albien (épisode de sédimentation 9: formation d'Arctic Red) il y a eu un agrandissement du bassin sédimentaire et l'ancienne ligne de rivage s'est déplacée bien au sud de la région du delta du Mackenzie. Pendant chacun des épisodes en question, la principale source de sédiments clastiques se trouvait au sud et au sud-est, mais pendant certaines périodes des épisodes 7 et 8 (fin de l'Hauterivien et fin du Barrémien à l'Aptien respectivement), il existait une source locale située plus au nord.

INTRODUCTION

The known subsurface occurrence of Jurassic and Lower Cretaceous rocks extends from the northeastern tip of the Tuktoyaktuk Peninsula 350 km southwestwards to the outcrop in the Aklavik Range, and from the Campbell Lake area in the southeast to the Kugpik O-13 well in the northwest (Fig. 1). Our present knowledge of Jurassic and Lower Cretaceous geology in the Yukon and northwestern Northwest Territories has been based primarily on surface studies west of the Mackenzie Delta. The subsurface data from the adjacent delta area can greatly increase our understanding of these rocks. Furthermore, a comprehensive study of the subsurface will aid in our ability to assess and predict hydrocarbon resources within these rocks. Hydrocarbons have been found in Lower Cretaceous strata: gas and oil in Berriasian-Hauterivan sandstones and oil in a Barremian-Aptian conglomerate/sandstone unit.

This study is based entirely on well data which has been integrated with surface data. Geophysical log data and cuttings samples from seventy-one wells (Fig. 1; Appendix 1) drilled into Lower Cretaceous and Jurassic strata, and core from thirty-one wells are available for examination (Appendix 2). These wells provide the data for a comprehensive stratigraphic-sedimentological analysis. This report identifies stratigraphic units, discusses their distribution and correlation between wells, describes the lithotypes, interprets depositional environments and discusses the geological history and paleogeography of the area.

All cuttings samples and cores are available for inspection at the Geological Survey of Canada (Institute of Sedimentary and Petroleum Geology), Calgary.

PREVIOUS WORK

Subsurface studies of Jurassic and Lower Cretaceous rocks have tended to be either general discussions (Lerand, 1973) or specific to a particular set of rocks or geographic location. Early studies concentrated on single wells (Myhr, 1974; Myhr and Gunther, 1974; Brideaux and Myhr, 1976) but with the discovery and delineation of the Parsons Lake gas field more detailed, but still local, studies were published (Coté et al., 1975; Myhr and Young, 1975). Poulton (1978a) presented some preliminary subsurface correlations of Bug Creek rocks, later (Poulton et al., in press; Poulton, in prep.) incorporating them into a regional analysis of the Bug Creek Group. Dixon (1979) presented a detailed, but local, study of the Barremian-Aptian Atkinson Point Formation. Young et al. (1976) were the first to compile a regional synthesis of Mesozoic and Cenozoic geology of the Beaufort-Mackenzie Basin, incorporating both surface and subsurface

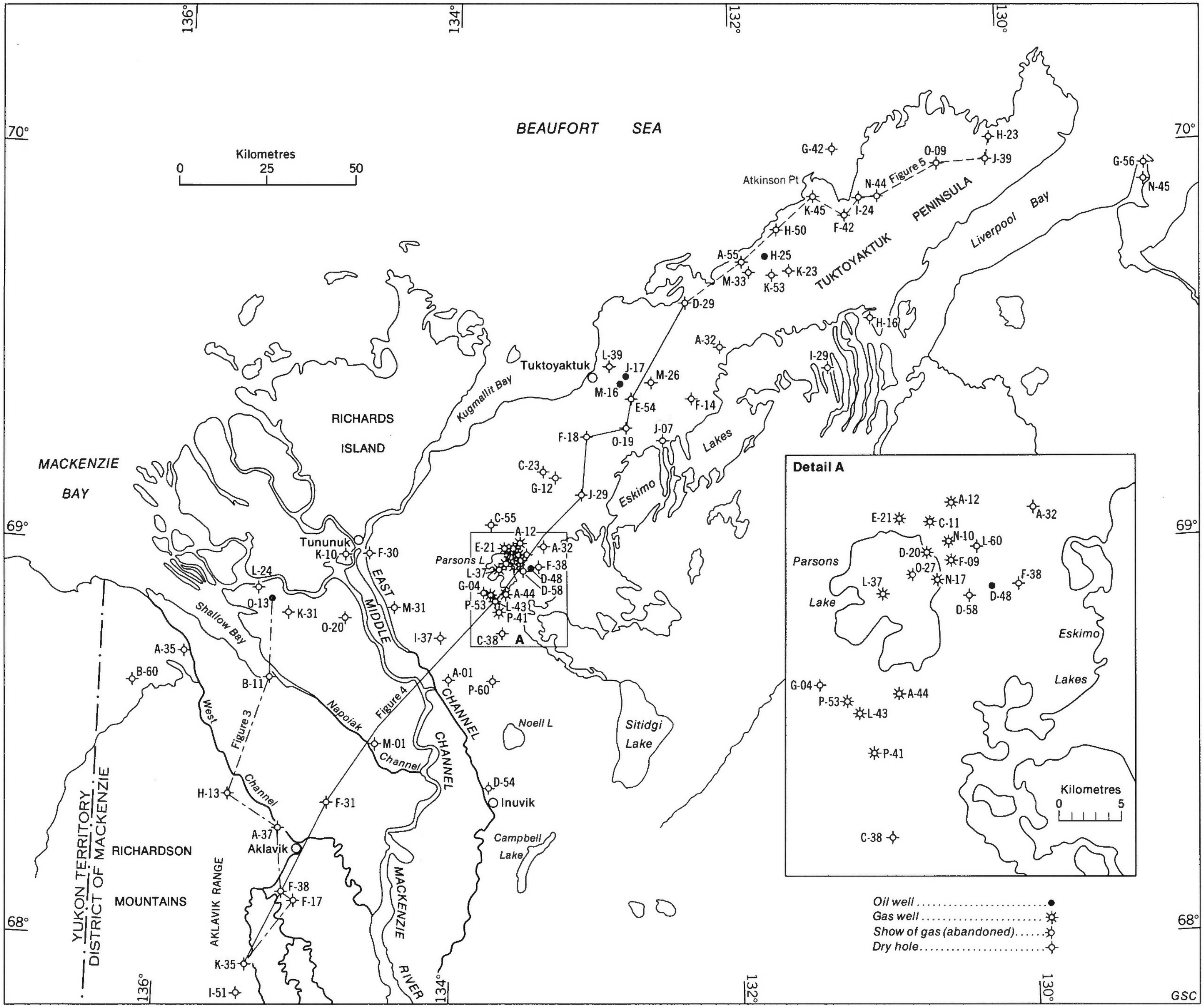

FIGURE 1. *Location of wells, cross sections and geographic names.*

data. Dixon (in prep.) presented a summary of Upper Jurassic-Lower Cretaceous subsurface geology based upon the more comprehensive work that forms the basis of the present report.

Much of our detailed knowledge of Jurassic and Lower Cretaceous geology comes from the study of exposed strata in the northern Richardson Mountains. Jeletzky (1958, 1960, 1961a, b, 1967, 1971, 1972, 1974, 1975, 1977, 1980, in prep.) initiated detailed stratigraphic studies and identified a number of stratigraphic units as well as analyzing the geological history of the area. Young (1971, 1972, 1973a, b, 1974, 1977; Young et al., 1976) also has made significant contributions to our knowledge of the surface and subsurface geology. The Jurassic Bug Creek Group has been studied in detail by Poulton (1978a, b), Poulton et al. (in press) and Poulton and Callomon (1976). Norris (1975, 1977, 1979) mapped the northern Yukon and northwestern Northwest Territories on a 1:250,000 scale and has reported on the structural development of the area (Norris, 1972, 1973, 1974). Yorath (1973) and Yorath and Norris (1975) also have written on structural aspects of the area.

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I would like to thank T.P. Poulton and F.G. Young for their valuable criticisms and comments. I am indebted also to A.F. Embry for informative discussions concerning stratigraphic concepts.

STRUCTURAL ELEMENTS

The structural elements are shown in Figure 2 and the terminology used is based on that presented by Norris (1972, 1973) with some modifications and additions.

Young et al. (1976) isolated Columbian (Late Jurassic to earliest Late Cretaceous) and Laramide (Late Cretaceous and Tertiary) elements, and also attempted to differentiate between highs, uplifts and arches. For example, the Cache Creek structure is referred to as a high in its Columbian expression and as an uplift for its Laramide expression. While it is essential to understand the behaviour of various tectonic elements, the introduction of new or modified names for structural elements that occupy essentially the same space through time is considered unnecessary. No attempt is made to differentiate between highs, uplifts and arches, all are considered to be structurally positive relative to adjacent areas, regardless of present expression or time of origin. Lerand (1973) introduced the Tununuk High for a gravity positive anomaly (Hornal et al., 1970). Later, Young et al. (1976) extended their Columbian Cache Creek High to incorporate the Tununuk High. Isopach (see isopach maps) and gravity data (Hornal et al., 1970) do not support Young et al.'s (*op. cit.*) extension of the Cache Creek High. It can be seen that a depression separates the two structural elements, hence the retention of the term 'Tununuk High'.

Yorath (1973, p. 44) named a positive gravity trend along the Tuktoyaktuk Peninsula, the Kugaluk Arch, but this was later replaced by the more commonly used Eskimo Lakes Arch (Young et al., 1976). Bounding the northwestern margin of Eskimo Lakes Arch is a major fault zone, referred to as the Tuktoyaktuk Fault Flexure Zone by Lerand (1973) and the Eskimo Lakes Fault Zone by Coté et al. (1974) and Young et al. (*op. cit.*). However, Young et al. restricted the latter term to Laramide faults extending across the arch.

Structural depressions include the Canoe Depression and Kugmallit Trough. Young et al. (1976) viewed the Kugmallit Trough as a Columbian element and appear to have expanded it into the area previously named the Canoe Depression (Norris, 1972). Jeletzky (1980, p. 16) also considered the two features to be a single entity but pointed out that the term Canoe Depression has precedence. Both features are retained in this report due to the identification of a small relative positive trend, the Napoiak High (Fig. 2), which separates two isopach maxima and also seen as a minor deflection of isogal contours (Hornal et al., 1970). Consequently, the original definition of the Kugmallit Trough (Young et al., 1976) has been slightly modified to include only the structural depression northeast of the Napoiak High.

STRATIGRAPHY

The correlations and stratigraphic analysis presented in this report are based on standard practices but have also been influenced by the work of Frazier (1974) and Vail and co-workers (in Payton, 1977). They recognized that the sedimentary rock record consists of discrete "packages" of genetically related rock with bounding surfaces being either within a conformable succession or unconformities. Vail and co-workers called such units depositional sequences, with unconformities and their correlative conformities as the bounding surfaces. Frazier, on the other hand, referred to them as depositional-complexes bounded by hiatal surfaces, with erosional unconformities occurring within the depositional-complexes. Both models rely upon relative sea-level changes to account for their respective stratigraphic units. The two models were applied to the Jurassic and Cretaceous rocks in this report but it was found that Frazier's concepts had much greater predictive potential and a consequence of this was that correlation problems were more readily resolved and that the geological history was more readily understood. However, the contribution of Vail and co-workers must also be acknowledged.

Some problems arise in the application of lithostratigraphic terminology, due to the recognition of unconformities and facies changes. These problems have been resolved as much as possible using the presently available terminology and commonly accepted lithostratigraphic principles.

Lithostratigraphic nomenclature established for the Jurassic and Lower Cretaceous rocks of the northern Richardson Mountains (Jeletzky, 1967, in prep.; Poulton et al., in press; Table 1) can be used, for the most part, in the subsurface. Several modifications for use in the subsurface were proposed earlier (Young et al., 1976; Dixon, 1979). Young et al. (1976) used Mountjoy and Chamney's (1969) Arctic Red Formation as equivalent to the informal Albian Shale-Siltstone Division (Jeletzky, 1960). Dixon (1979) introduced the Atkinson Point Formation for a succession of Aptian conglomerate and sandstone in the central Tuktoyaktuk Peninsula. Two new units are identified, the Siku and the Kamik Formations. The latter is introduced to include undifferentiable subsurface equivalents of both the Fault Creek and Lower Canyon Formations of Jeletzky (in prep.). The Siku Formation is a shale succession between the Kamik Formation below and the Mount Goodenough Formation above. Coté et al's. (1975) "Parsons Sandstone" is formally recognized as the Parsons Group and includes the Martin Creek, McGuire and Kamik Formations. Also, it was found that the Husky Formation is more readily divided into two members in the subsurface rather than the four proposed by Jeletzky (1967). Table 1 compares the subsurface terminology in the Mackenzie Delta with that of the surface in the northern Richardson Mountains and also with the older informal terms (Jeletzky, 1958, 1960, 1961a). The general time-spatial inter-relationships of the subsurface formations are shown schematically in Table 2. Three stratigraphic cross-sections are used to illustrate the correlation of units between wells (Figs. 3, 4, 5), showing formation boundaries, erosional unconformities, intra-formational correlations and hiatal surfaces. Also presented are detailed correlations of Upper Jurassic to Middle Hauterivian strata between wells in the Parsons Lake area (Fig. 6).

TABLE 1

Comparison of Surface and Subsurface Lithostratigraphic Terminology

System	Series	NORTHERN RICHARDSON MOUNTAINS: Jeletzky 1958-1960; 1961; 1967; 1980	NORTHERN RICHARDSON MOUNTAINS: Jeletzky in prep. Poulton et al. in press; Poulton and Callomon, 1976	MACKENZIE DELTA: Young et al., 1976; Dixon 1979, in report
CRETACEOUS	LOWER	*Albian Shale-Siltstone Division*	*Albian Shale-Siltstone Division*	*ARCTIC RED FORMATION*
CRETACEOUS	LOWER	*Upper Sandstone Division*	*RAT RIVER FORMATION*	*RAT RIVER FM* / *MOUNT GOODENOUGH FORMATION* / *ATKINSON POINT FM*
CRETACEOUS	LOWER	*Upper Shale-Siltstone Division (Dark grey siltstone Division)*	*MOUNT GOODENOUGH FORMATION*	*MOUNT GOODENOUGH FORMATION*
CRETACEOUS	LOWER			*SIKU FM*
CRETACEOUS	LOWER	*Coal-bearing Division* / *Coaly Quartzite Division*	*LOWER CANYON FORMATION*	*PARSONS GROUP*: *KAMIK FORMATION*
CRETACEOUS	LOWER	*White Quartzite Division* / *Lower Sandstone Division*: *White sandstone mbr*	*FAULT CREEK FORMATION*	*PARSONS GROUP*: *KAMIK FORMATION*
CRETACEOUS	LOWER	*Bluish-grey Shale Division* / *Lower Sandstone Division*: *Buff sandstone member*	*McGUIRE FORMATION*	*PARSONS GROUP*: *McGUIRE FORMATION*
CRETACEOUS	LOWER	*Lower Sandstone Division* / *Lower Sandstone Division*: *Buff sandstone member*	*MARTIN CREEK FM*	*PARSONS GROUP*: *MARTIN CREEK FM*
CRETACEOUS	LOWER	*Lower Shale-Siltstone Division*	*HUSKY FORMATION*: *upper member*	*HUSKY FORMATION*: *upper member*
CRETACEOUS / JURASSIC	LOWER / UPPER	*Lower Shale-Siltstone Division*	*HUSKY FORMATION*: *red-weathering member*	*HUSKY FORMATION*: *upper member*
JURASSIC	UPPER	*Lower Shale-Siltstone Division*	*HUSKY FORMATION*: *arenaceous member*	*HUSKY FORMATION*: *lower member*
JURASSIC	UPPER	*Lower Shale-Siltstone Division*	*HUSKY FORMATION*: *lower member*	*HUSKY FORMATION*: *lower member*
JURASSIC	UPPER	*BUG CREEK FORMATION*: *upper sandstone member*	*BUG CREEK GROUP*: *AKLAVIK FORMATION*	*AKLAVIK FORMATION*
JURASSIC	MIDDLE	*BUG CREEK FORMATION*: *sandstone - siltstone member*	*BUG CREEK GROUP*: *RICHARDSON MOUNTAINS FORMATION*	*RICHARDSON MOUNTAINS FORMATION*
JURASSIC	MIDDLE	*BUG CREEK FORMATION*: *intermediate sandstone mbr*	*BUG CREEK GROUP*: *RICHARDSON MOUNTAINS FORMATION*	*RICHARDSON MOUNTAINS FORMATION*
JURASSIC	LOWER		*BUG CREEK GROUP*: *MANUEL CREEK FORMATION*	*MANUEL CREEK FM*
JURASSIC	LOWER	*BUG CREEK FORMATION*: *intermediate sandstone mbr*	*BUG CREEK GROUP*: *ALMSTROM CREEK FM*	*ALMSTROM CREEK FM*
JURASSIC	LOWER	*BUG CREEK FORMATION*: *grey siltstone member*	*BUG CREEK GROUP*: *MURRAY RIDGE FM*	*MURRAY RIDGE FM*
JURASSIC	LOWER	*BUG CREEK FORMATION*: *basal sandstone mbr*	*BUG CREEK GROUP*: *MURRAY RIDGE FM*	*MURRAY RIDGE FM*

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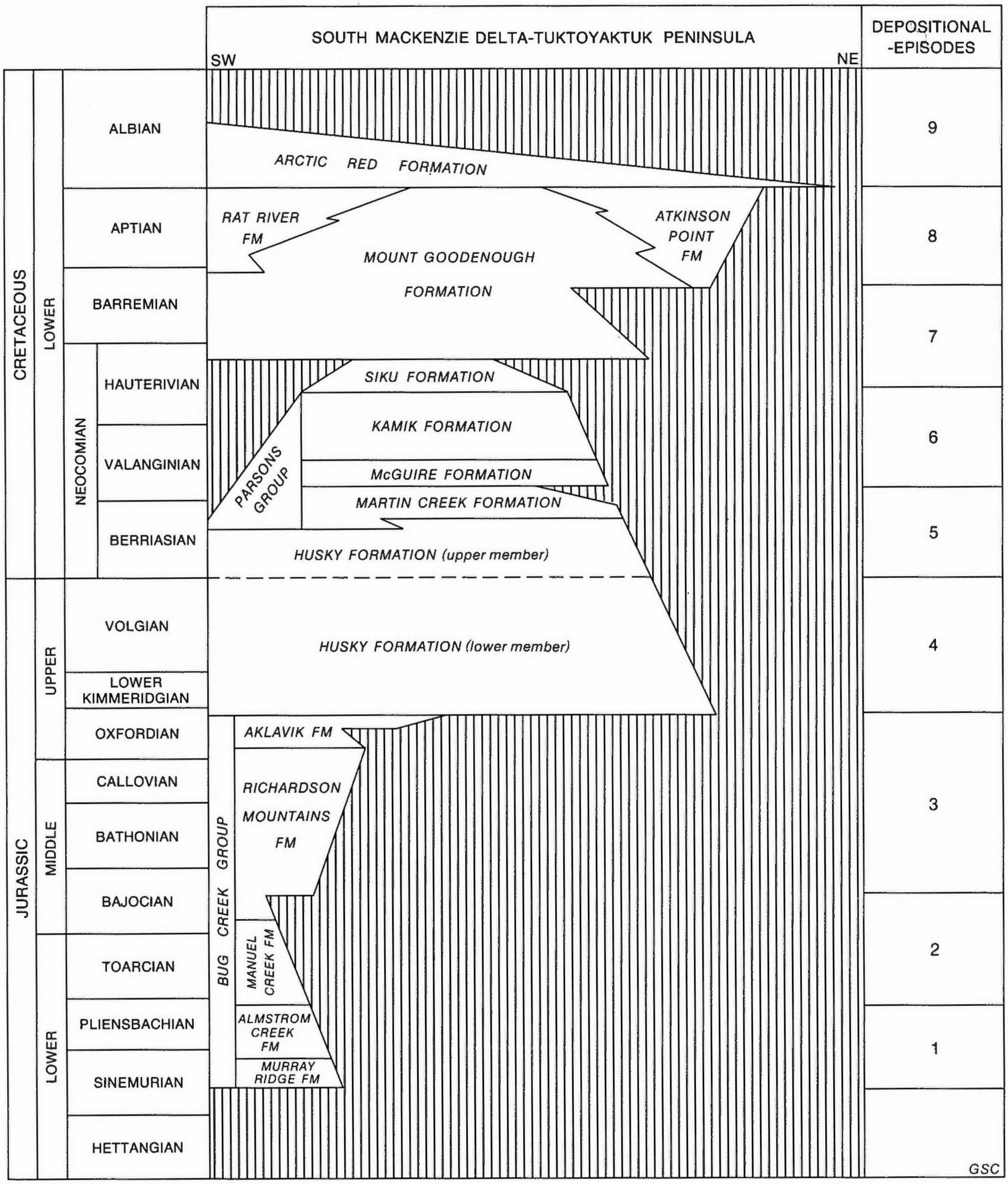
TABLE 2

Jurassic-Lower Cretaceous Formations, Mackenzie Delta-Tuktoyaktuk Peninsula.
Also indicated are the depositional-episodes



Over 2500 m of Jurassic and Lower Cretaceous strata are present in the subsurface (Fig. 7). The thickest known, but incomplete, section occurs at Kipnik O-20 (2574 m) which lies on the northern side of the Kugmallit Trough, consequently a thicker section, probably in excess of 3000 m, is anticipated. To the northeast of the known depocentre, no wells have penetrated Jurassic or Lower Cretaceous strata and it is not known whether the depocentre continues or if the isopachs close around its northeastern end. Strata thin towards the Tununuk High and Eskimo Lakes Arch, both by depositional and erosional thinning.

Bug Creek Group

The Bug Creek Group originally was defined as a formation by Jeletzky (1967) and given group status by Poulton et al. (in press). In Jeletzky's (*op. cit.*) original description five members are recognized at the type section. Later, he recognized three members in the Northern Bell Basin and two in the Vittrekwa River and Rock River areas (Jeletzky, 1972, 1974). These differences in the number of lithostratigraphic divisions are partly explained by facies variations and partly by an intraformational unconformity

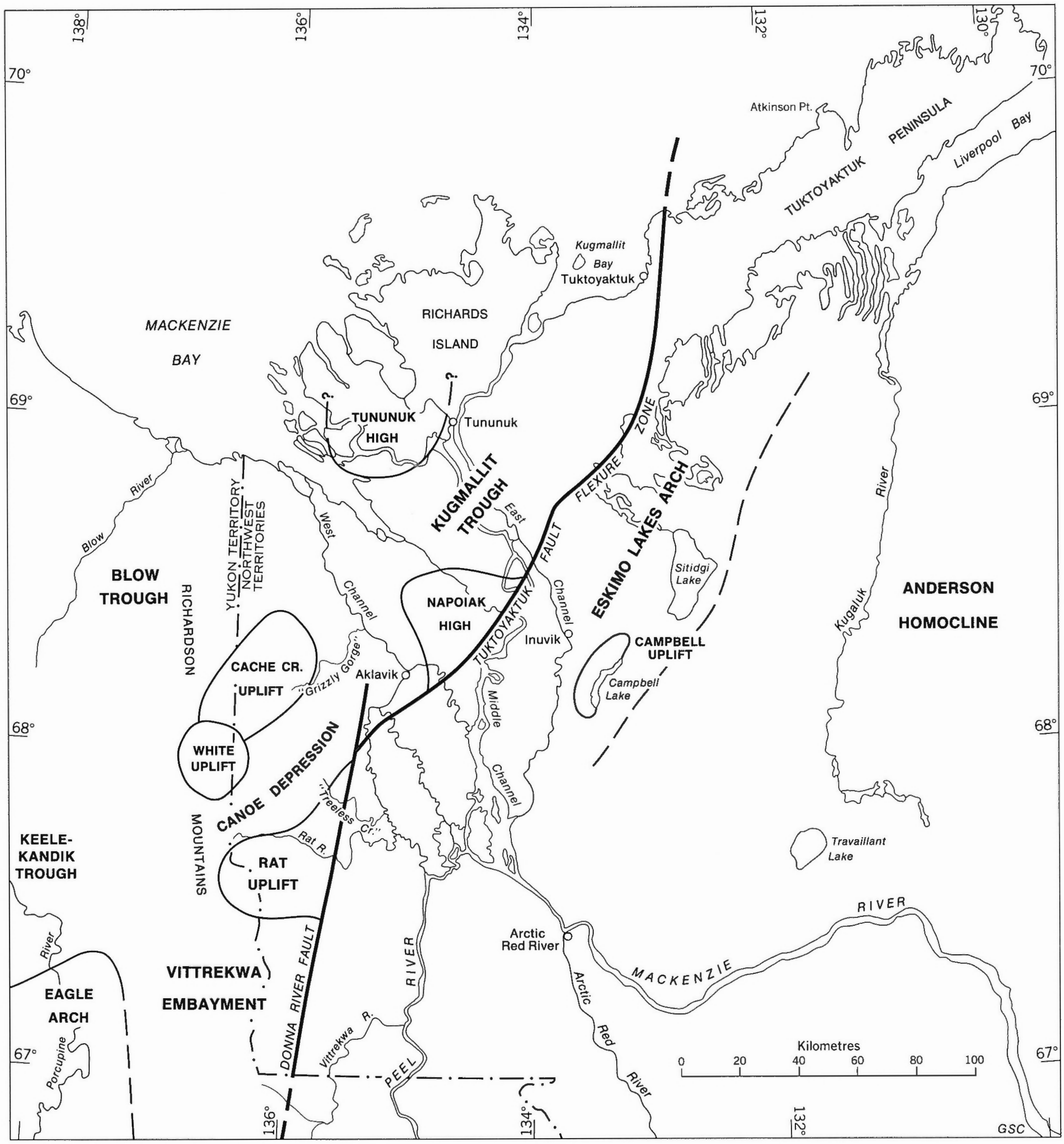


FIGURE 2. *Structural elements.*

(Jeletzky, 1967; Poulton and Callomon, 1976; Poulton, 1978b). Young et al. (1976) incorporated subsurface data into a regional analysis of the Bug Creek rocks but the nature of their work necessitated a rather general account. Poulton (1978a) presented more detailed subsurface log correlations.

Poulton et al's. (in press) Bug Creek Group contains five formations, in descending order these are, Aklavik, Richardson Mountains, Manuel Creek, Almstrom Creek and Murray Ridge Formations. A detailed comparison of these formations with Jeletzky's (1967) original divisions can be found in Poulton et al. (in press). Poulton's (1978a) subsurface units correspond very closely to his surface formations and they will be used, with some modifications, in this report. Bug Creek rocks are recognized in Treeless Creek I-51, Rat Pass K-35, Aklavik F-38, F-17 and A-37, Beaverhouse Creek H-13, Napoiak F-31, Unak B-11, Tullugak K-31 and Ulu A-35. Regional trends (Fig. 8) favour

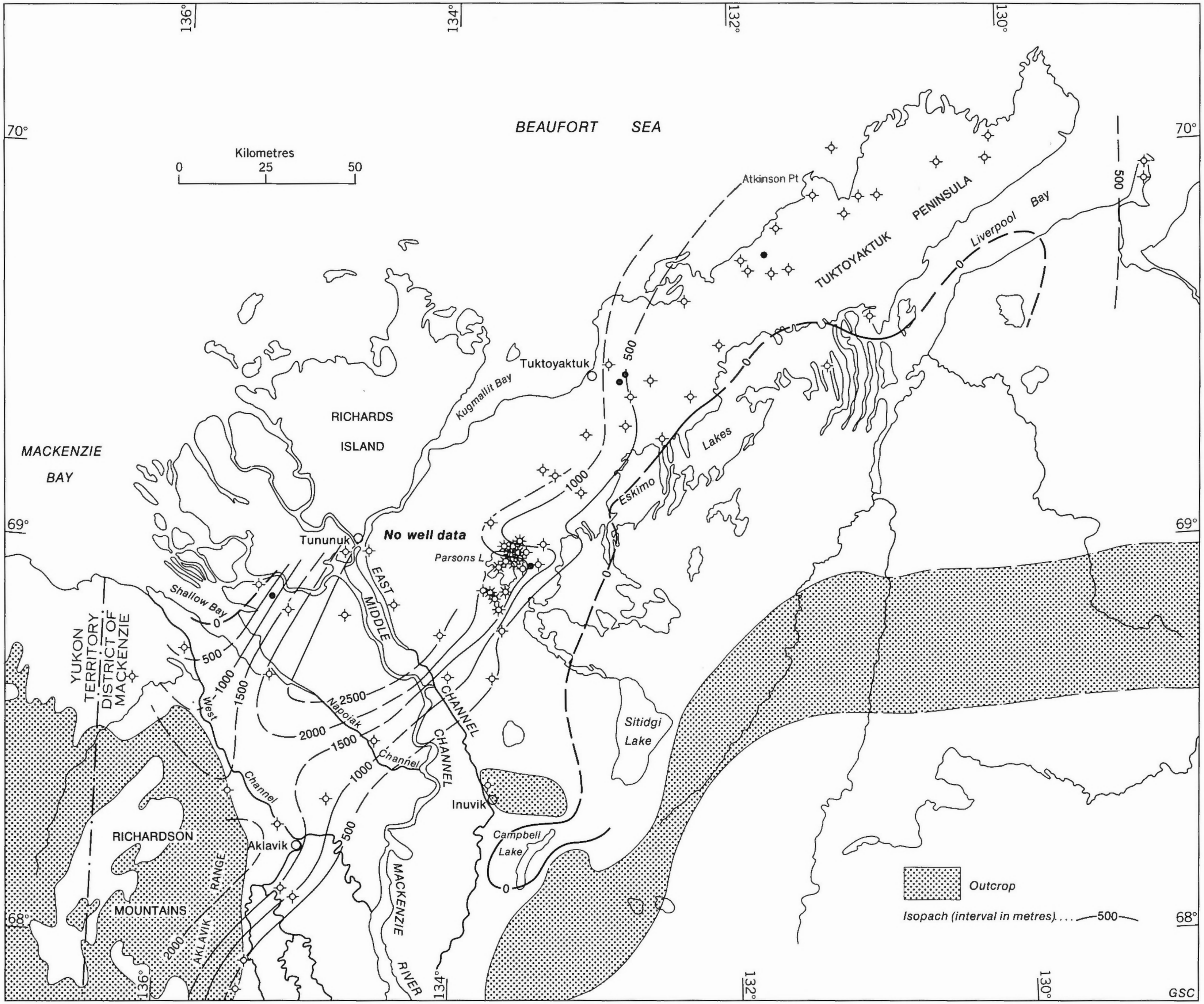


FIGURE 7. *Isopach map of Jurassic and Lower Cretaceous strata.*

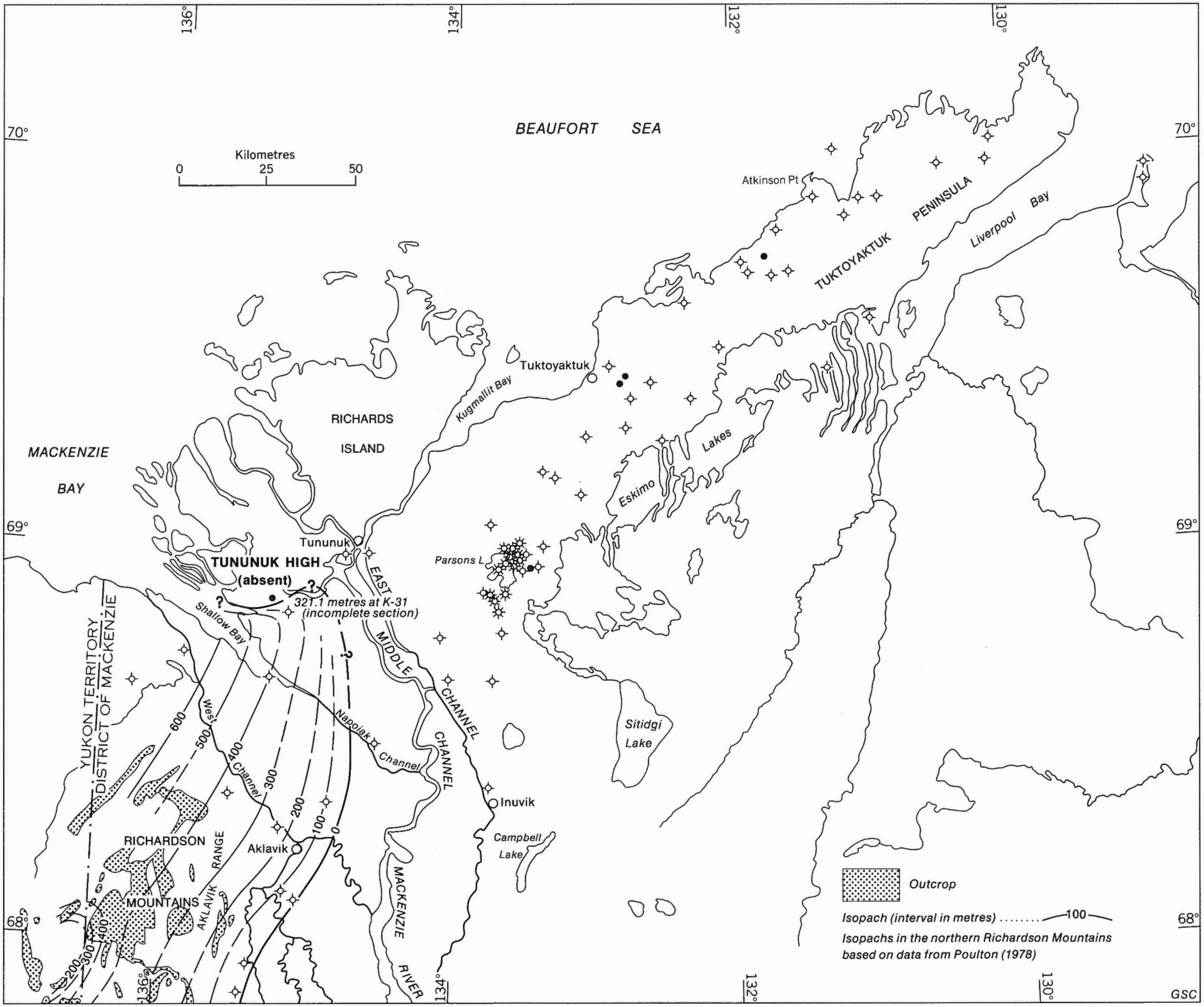


FIGURE 8. *Isopach map, Bug Creek Group.*

the presence of Bug Creek rocks in the subsurface at the Big Fish River B-60 locality. The section in the Big Fish River B-60 well is faulted and the stratigraphy of the Jurassic-Cretaceous part of the section is poorly understood. Poulton (1978a) and Young et al. (1976) recognized Bug Creek strata in the Kugpik O-13 well, whereas I consider these rocks to be pre-Bug Creek, probably Permian. Several reasons lead to this conclusion:

1. The strata in question have a dip of 20-25° whereas Husky strata immediately above, dip about 5° or less. This is seen in cores separated by only 135 m of strata and also is seen on the dipmeter log. A dip change at 3090.7 m (10 140 ft), according to the dipmeter log, occurs at the base of the Husky Formation. Nowhere in the surface or subsurface have Bug Creek rocks been reported to lie with angular discordance below Husky strata.

2. The regionally extensive units comprising the Bug Creek Group cannot be identified in the Kugpik O-13 well, yet are identified in the nearby Tullugak K-13 well.

3. The thinness of the supposedly Bug Creek succession in Kugpik O-13 is anomalous.

4. Regional correlations and lithological character of the succession below 3090.7 m (10 140 ft) favour a Permian designation for the rocks.

In the subsurface, the Bug Creek Group is restricted to the southwestern part of the Mackenzie Delta (Fig. 8), adjacent to the northern Richardson Mountains. The known maximum thickness of a complete section is 378.3 m in the Beaverhouse Creek H-13 well (Fig. 8). An incomplete, faulted section in Unak B-11 is 370 m thick but correlations indicate that a complete section would be much greater than that at H-13 (Fig. 8). This differs from Poulton's (1978b) interpretation of the B-11 stratigraphy. He indicated that a complete section was present and placed the base of the group at 2499.4 m (8200 ft). The interpretation presented here concludes that a fault occurs at the 2499.4 m level and that much of the Almstrom Creek Formation and all of the Murray Ridge Formation are faulted out (Fig. 3). A faulted and incomplete section at Ulu A-35 (351.7 m) is also identified and regional correlations indicate that if a complete section had been present it would have been even thicker than at Unak B-11. Bug Creek rocks thin towards the southeast and east, in part due to depositional thinning, as well as to erosion at internal unconformities (Fig. 3).

Young et al. (1976, Fig. 4) showed the Bug Creek sandstones grading laterally northeast into siltstone. Subsurface data indicate that Bug Creek strata are absent northeast of Napoiak F-31 (Fig. 8) and that the Husky Formation overlaps the Bug Creek Group in a northeastward and southeastward direction.

The subsurface correlations point to the presence of a second unconformity within the Bug Creek Group (Fig. 3). This has been identified as occurring within the Aklavik Formation and offers an explanation for the relationships seen in the Aklavik F-38 and A-37 wells (Fig. 3). No biostratigraphic data is available to pinpoint the timing of the unconformity but based on Poulton et al.'s (in press) dating of the Aklavik Formation, the unconformity developed some time during the Oxfordian. The unconformity originally identified by Jeletzky (1967) and later refined by Poulton and Callomon (1976) is also recognized in the subsurface. This unconformity occurs within the Richardson Mountains Formation in a basinward position, but is at the base of the formation at the basin margin (Fig. 3). It probably developed in Early or Middle Bajocian time (Poulton, in press). A third unconformity is suspected to occur within the uppermost beds of the Almstrom Creek Formation, not far below the base of the Manuel Creek Formation. This is based on the principles advocated by Frazier (1974) whose model predicts an unconformity between hiatal surfaces. However, no biostratigraphic or lithostratigraphic data is available to confirm this suspicion; consequently, the unconformity is not shown on the cross-sections.

Murray Ridge Formation

The Murray Ridge Formation is a thin succession of grey to brownish-grey silty shale at the base of the Bug Creek Group. The shales are commonly calcitic and particulate plant material is a common component. In Aklavik A-37 there is a basal, thin, glauconitic, fine grained sandstone. Poulton (1978a, b) noted on his cross-sections the local occurrence of a basal sandstone within the Murray Ridge Formation (previously the grey siltstone member) and in a later publication (Poulton et al., in press) identified it as the Scho Creek member. Formation thickness varies from 6.1 m at Napoiak F-31 to 18.6 m at Beaverhouse Creek H-13.

Almstrom Creek Formation

The Almstrom Creek Formation consists of interbedded sandstone, siltstone and shale, with sandstone dominant. In the areas of thick development (e.g. Beaverhouse Creek H-13), at least two coarsening-upward units can be recognized from the gamma-ray log response and lithological succession. Sandstones are mostly very fine to fine grained, commonly silty or argillaceous and contain abundant glauconite. Traces of calcite and dolomite cement have been noted in the sandstones. At Aklavik F-38 a pebbly, fine to coarse grained sandstone occurs at the base of the formation. Shales and siltstones are grey or brownish-grey and tend to be more common in the thicker sections of the Formation (e.g. Beaverhouse Creek H-13, Unak B-11).

Core was recovered from the basal part of the formation in the Napoiak F-31 well (1237.8-1259.4 m; 4061-4132 ft). The core contains very fine grained sandstone interbedded with mudstone. Virtually all of the beds are strongly bioturbated and sedimentary laminations are rare. There are several horizons with abundant bivalve shells. Mudstone intraclasts and abrupt planar bedding surfaces within the cored interval indicate penecontemporaneous erosion and/or periods of non-deposition.

Formation thickness varies from 32.2 m at Aklavik F-38 to over 289 m in Ulu A-35 where there appears to be a faulted and incomplete section of the formation. Early or Middle Bajocian erosion, and a possible older erosional event have modified thicknesses at the basin margins, for example at Aklavik F-38 (Fig. 3).

Manuel Creek Formation

The Manuel Creek Formation is a thin succession of shale and mudstone with subordinate interbeds of siltstone and sandstone. All rock types have a grey or brownish-grey colour. In contrast to the Almstrom Creek Formation, glauconite is only a minor component. Fragments of clay ironstone are present in the cuttings samples and probably are derived from concretions within the shale.

The formation attains a known maximum thickness of 59.1 m at Beaverhouse Creek H-13 thinning to 8.5 m at Aklavik A-37. Early or Middle Bajocian erosion has removed this formation from the basin margins (e.g. Aklavik F-38).

Richardson Mountains Formation

The Richardson Mountains Formation consists of interbedded sandstone, siltstone and shale, commonly arranged as a number of coarsening-upward units. Generally the formation rests abruptly on Manuel Creek shale. The proportions of each rock type varies between wells, with a tendency to be shalier in the more basinward wells. All the rocks have the brownish hue typical of Bug Creek strata. Sandstones are usually very fine to fine grained and unlike those of the Almstrom Creek Formation do not contain as much glauconite. Calcite, dolomite and carbonaceous material are common components of shale and siltstone. Ironstone concretions are present within the shales.

The formation ranges in thickness from 223.1 m at Unak B-11 to 34.1 m at Aklavik F-38.

Aklavik Formation

The Aklavik Formation is the uppermost unit within the Bug Creek Group and consists of a very distinct succession of sandstones. This formation is approximately equivalent to Jeletzky's (1967) upper sandstone member. However, Poulton et al. (in press) shifted the base of the formation upward with respect to the base of Jeletzky's upper sandstone member. Originally the base of the upper sandstone member was chosen where underlying shales were succeeded by a transitional zone of interbedded sandstone and shale. Poulton et al. chose the base of the Aklavik Formation as the first vertically persistent, and generally cliff-forming, sandstone. In Poulton's (1978a) subsurface correlations the base of the upper sandstone member was chosen where the gamma ray log began to deflect leftward in response to an increase in sandstone in the section. However, in keeping with Poulton et al's. (in press) definition of the Aklavik Formation, in the subsurface, the base is chosen at the point of maximum, or near maximum, leftward deflection of the gamma ray log trace. The top of the formation is readily identified lithologically and from geophysical logs, where Husky shale abruptly overlies Aklavik sandstone.

A sandstone unit in Aklavik A-37, between depths 1513.6-1532 m (4966-5026 ft), was placed in the Husky Formation by Poulton (1978b). Its lithological and log response characteristics are atypical of Husky strata and correlations (Fig. 3) within the Bug Creek Group and Husky Formations strongly favour it as being part of the Bug Creek Group. In a southern tributary of Beaverhouse Creek (northern Richardson Mountains) the uppermost beds of the Bug Creek Group contain a shale unit separating two prominent sandstone sections (pers. obs., 1978), similar to that interpreted at Aklavik A-37. This reinterpretation of the succession also led to the identification of an unconformity within the Aklavik Formation. In Aklavik A-37 the unconformity occurs at the base of the uppermost sandstone unit. At Aklavik F-38, where the Aklavik Formation appears to be a single succession of sandstone, a prominent low velocity zone at 1524.6 m (5002 ft) is the level of the unconformity (Fig. 3). An unconformity within the Aklavik Formation also explains the presence of a thin Aklavik succession at Aklavik F-17, Rat Pass K-35 and Treeless Creek I-51, representing the post-unconformity transgressive beds.

The typical Aklavik Formation (Poulton et al., in press) is a cliff-forming sandstone succession in which no internal hiatus was recognized. In order to accommodate the reinterpreted Aklavik A-37 section, I propose to include the two prominent sandstone units in the Aklavik Formation, separated by a tongue of Richardson Mountain-type strata. The proposed reinterpretation also recognizes that the lower sandstone becomes increasingly more shaly basinward (e.g. Beaverhouse Creek H-13) and these shaly rocks are better identified as Richardson Mountain-type strata (Fig. 3). The upper sandstone can be correlated throughout the subsurface but even this unit becomes more shaly basinward, a feature also recognized by Poulton (1978b).

The Aklavik Formation consists of very fine to fine grained, locally medium to coarse grained, brownish grey sandstone. Most of the sandstones are quartz-arenites with minor to trace amounts of glauconite, chert, mica, plagioclase and heavy minerals. Finely comminuted organic material is abundant, dispersed throughout the rock as a pore-fill. The organic content probably imparts the brownish colour. Carbonized logs have been seen in exposures on Martin Creek in the Aklavik Range (pers. obs., 1978). The shale tongue in Aklavik A-37, and seen in outcrop near Beaverhouse Creek, consists of brownish-grey to dark grey silty shale and mudstone, with thin interbeds of siltstone and sandstone.

Core from the Aklavik Formation was cut in Aklavik A-37 and Unak B-11. Only a few centimetres of broken core was recovered from Unak B-11. In Aklavik A-37 the core consists mostly of an apparently structureless, very fine to fine grained sandstone. Traces of crossbedding can be seen in the top 50 cm of core and a few vertical burrows occur scattered throughout the core. At approximately 1592.3 m in the core depth there is a 30-50 cm thick band of grey, microcrystalline carbonate containing wispy, undulose clay, or organic rich laminae. Similar laminae are locally present in the enclosing sandstone.

Sedimentology

The lack of core material from the Bug Creek Group precludes a detailed sedimentological analysis. However, general conclusions are possible and the proximity of subsurface and surface sections allows for some reasonable comparisons. Marine fossils (ammonites, bivalves, scaphopods and belemnites are the most common) occur throughout the Bug Creek Group, as does glauconite, another marine indicator. The abundance of sandstone in the succession, the northwestward shale-out trend (Poulton, 1978b) and the proximity to the basin margin all suggest a nearshore to inner shelf depositional setting.

In the nearby outcrops it was noted (pers. obs., 1978) that the most common sedimentary structure in sandstones of the group was low angle crossbedding, either as single sets or cosets, varying from medium to large scale; the latter most commonly occurring in parts of the Aklavik Formation. Festoon crossbeds were noted in a few sandstone beds of the Almstrom Creek Formation and ripple crossbedding is surprisingly rare in the rocks examined in outcrop. Thick units of apparently structureless sandstone are common. Bioturbated and burrowed sandstone and mudstone are abundant. Carbonized woody debris and particulate carbonaceous material is a common component in some intervals, suggesting proximity to a shoreline.

The coarsening-upward cycles seen in the Almstrom Creek and Richardson Mountains Formations, both in the subsurface and outcrop, probably were formed by the build-up of offshore bars or submarine dune fields.

Age

Detailed biostratigraphic analysis of the Bug Creek Group is available only from surface work (Jeletzky, 1967; Poulton et al., in press), but the results should apply equally well to the subsurface sections. Jeletzky (1967, p. 3) dated the lowermost beds (i.e. those below the unconformity identified by Jeletzky) in the Aklavik Range as Sinemurian to Pliensbachian. Poulton (in Young, 1978, Fig. 16) concurred with this age range but noted that basinward Toarcian and some Bajocian strata are preserved. The post-unconformity section was dated as Bajocian to about mid-Oxfordian by Jeletzky (*op. cit.*) who also indicated a possible diachronous upper boundary. This interpretation of a diachronous upper boundary is not followed by Poulton et al. (in press) nor in my analysis. Jeletzky (*op. cit.*) places a younger age limit on the Bug Creek strata from fossils collected in the overlying Husky Formation, not from the poorly fossiliferous Aklavik Formation. The abrupt contact between the Husky and Aklavik Formations and the overlapping relationship of the former would suggest that the basal Husky beds are more likely to be diachronous, than are the uppermost Aklavik beds. Poulton (in Young, 1978; Poulton et al., in press) also gave a Bajocian to Oxfordian age for the post-unconformity beds. Both Jeletzky (*op. cit.*) and Poulton et al. (in press) indicated that the beds immediately above the older unconformity become younger towards the basin margin.

Poulton et al. (in press) dated the individual formations as follows:

a) Murray Ridge Formation: probably Early Sinemurian to Late Sinemurian.

b) Almstrom Creek Formation: ?Late Sinemurian to Pliensbachian, possibly as young as Toarcian.

c) Manuel Creek Formation: Toarcian to Early Bajocian.

d) Richardson Mountains Formation: Middle Bajocian to Early Oxfordian.

e) Aklavik Formation: Oxfordian.

Husky Formation

The Husky Formation was defined by Jeletzky (1967), prior to which it had been known informally as the Lower Shale-siltstone Division (Jeletzky, 1958, 1960, 1961a). Jeletzky (1967) recognized four members from the outcrops of the Aklavik Range, which, in descending order, he named the upper, the red-weathering, the arenaceous and the lower members.

The Husky Formation rests abruptly on Bug Creek strata in the Aklavik Range (Jeletzky, 1967; Poulton et al., in press) and in the western area of its subsurface occurrence (Figs. 3, 4). Eastwards and northeastwards the Husky Formation overlaps Bug Creek rocks and rests on a variety of Paleozoic units (Fig. 4). On the Eskimo Lakes Arch, the Husky Formation is generally absent but near the Tuktoyaktuk Fault Flexure Zone thin erosional remnants are present locally (e.g. Kimik D-29, Rat Pass K-35, Aklavik F-17). Middle or early Late Hauterivian and/or Late Albian erosion removed most of the Husky Formation from the Eskimo Lakes Arch. The uppermost beds of the Husky Formation grade into the overlying sandstone of the Martin Creek Formation. Both the lower and upper contacts are readily identified from geophysical logs. The lower contact is abrupt both lithologically and in its log response (Figs. 3, 4, 5, 6), whereas the upper contact is gradational. On geophysical logs, the upper contact is chosen at the point where the gamma ray log trace begins to deflect continuously to the left (Figs. 3, 4, 5, 6). This leftward deflection is in response to the decrease in shale and the increase in sandstone content.

In the subsurface the Husky Formation attains a maximum, but incomplete, known thickness of 886.4 m at Tununuk F-30. Isopach and depositional trends indicate that the thickest accumulation is probably just to the south or southeast of the F-30 well (Fig. 9). The formation thins to the north and northwest against the Tununuk High and to the south and southeast towards the Eskimo Lakes Arch (Fig. 9).

In the subsurface the Husky Formation has been divided into two members, the lower and upper. The lower member corresponds to Jeletzky's (1967) lower and arenaceous members, and the upper member to his red-weathering and upper members. Shale of the upper member rests abruptly on sandstone of the lower member and this abrupt lithological change is reflected in an abrupt deflection of the log trace (Figs. 3, 4, 5, 6). The contact between the two members is identified as a hiatal surface (*sensu* Frazier, 1974).

Lower member

The lower member of the Husky Formation rests abruptly on older strata and consists of predominantly shale and mudstone with variable amounts of interbedded siltstone, sandstone and thin carbonate concretionary beds. Light to dark bluish-black colours are dominant with brownish hues also being common. Generally shale or mudstone rests directly on older rocks (see Mayogiak J-17 core, depth 2854.8-2859.9 m; 9366-9383 ft) but locally there may be silty or sandy beds present at the base. The lowermost few metres to a few tens of metres are invariably black shale or mudstone (Figs. 3, 4, 5, 6) overlain by a succession in which siltstone and sandstone are interbedded with shale. Typically the coarse clastic beds occur in thin coarsening-upward cycles, many of which can be correlated throughout the subsurface (Fig. 6) for many kilometres. The uppermost beds of the lower member form a prominent, regionally extensive, coarsening-upward cycle and this cycle is equivalent to Jeletzky's (1967) arenaceous member. Most of the coarsening-upward cycles are capped by only a few metres of siltstone or sandstone but the uppermost cycle tends to have a much thicker sandstone cap. Sandstone beds are mostly very fine to fine grained and may contain scattered glauconite grains. Local concentrations of glauconite are also common (e.g. in the Mayogiak J-17 core). Similar coarsening-upward cycles have been noted in equivalent strata from the Aklavik Range (Hedinger, 1979, p. 22-23; Fedoruk, 1980, p. 92, Plate 1) and Jeletzky's (*op. cit.*) arenaceous member is a particularly well developed cycle. In outcrop, the coarsening-upward cycles consist of interbedded sandstone and shale in the lower beds, grading upwards into, or abruptly capped by, crossbedded (low angle plane beds or festoon crossbeds) sandstone. The uppermost cycle consists of granular to pebbly, fine and medium grained, glauconitic sandstone, containing horizontal beds and planar and festoon crossbeds (pers. obs., 1978). Each of the cycles is generally abruptly overlain by shale.

Five cores have been obtained from the lower member: in the Kugpik O-13, Kimik D-29, Pikiolik E-54, East Reindeer C-38 and Mayogiak J-17 wells. Most of the core material consists of either black fissile shale or bioturbated mudstone. Thin interbeds and laminae of siltstone and very fine grained sandstone are common and these beds may exhibit any of the following: plane laminations, ripple laminations, structureless, burrowed or completely

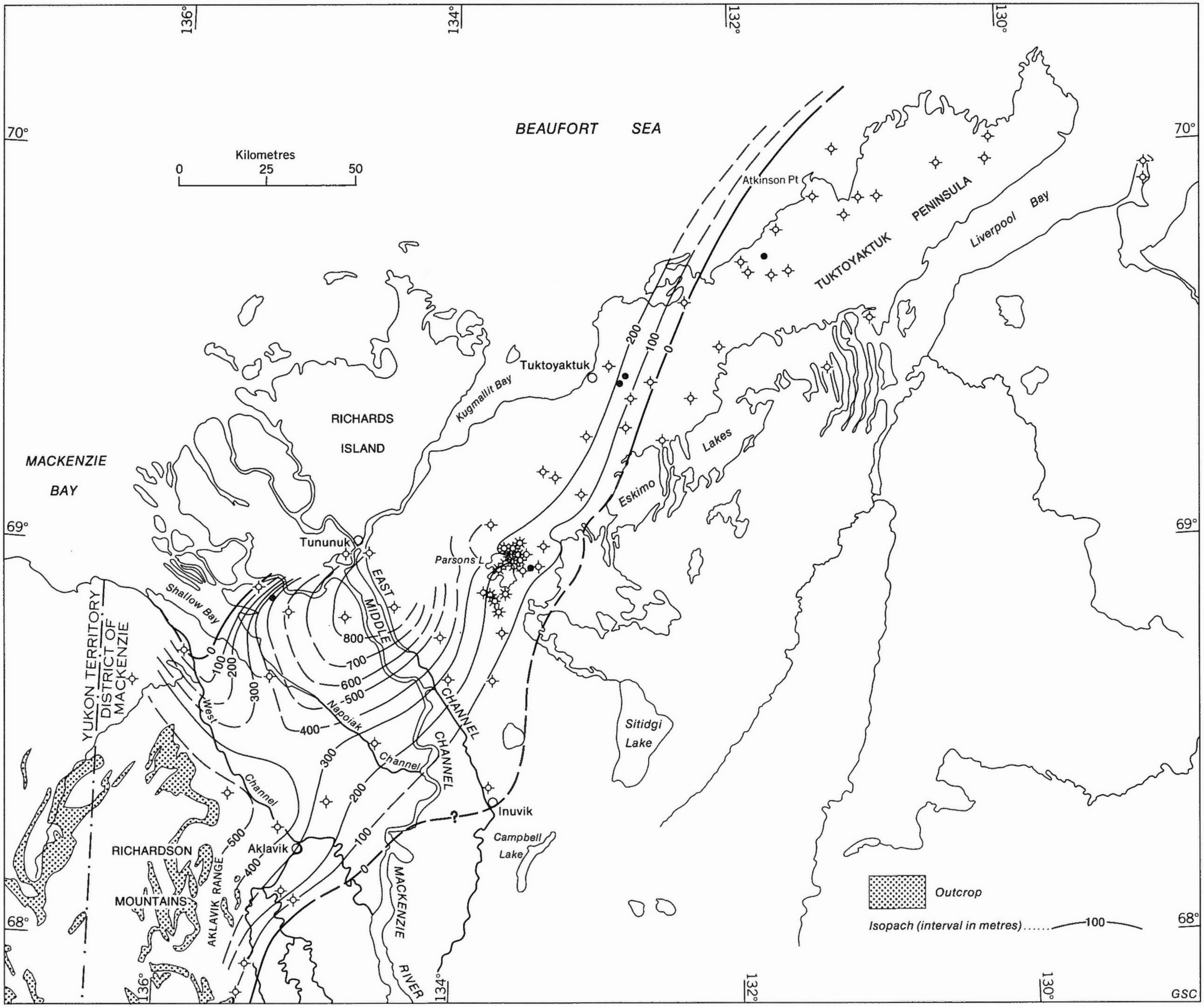


FIGURE 9. *Isopach map, Husky Formation.*

bioturbated. Layers, lenses or isolated pebbles occur within the shales and have been noted in the Kimik D-29, Pikiolik E-54 and East Reindeer C-38 cores. In outcrop, similar pebbly horizons have been seen and clasts up to small boulder size noted (Treeless Creek, pers. obs., 1978). Bivalve shells of **Buchia** species have been recovered from some cores (Pikiolik E-54, Kugpik O-13, Mayogiak J-17).

Upper member

The upper member consists of dark grey to black, or greyish brown shale and mudstone resting abruptly on sandstone of the lower member. Siltstone, sandstone and carbonate concretionary beds are minor components and the coarser clastics are less prominent than those in the lower member. Carbonate beds are generally very thin, commonly sideritic and are more prevalent in the lower part of the member.

In general, the lowermost beds are shale-dominant and tend to have a brownish hue. Gradationally succeeding these beds are more silty shales and mudstone containing thin interbeds of siltstone and very fine grained sandstone. The coarse clastic content gradually increases upward into the Martin Creek Formation.

Core from the upper member is available from Parsons N-10 and Tuktu O-19. The two deepest cores in Tununuk K-10 also may be from the upper member, but due to poor stratigraphic control they could be either from the lower member or even the much younger Siku Formation. The N-10 core (2842.3-2899.3 m; 9325-9512 ft) cuts across the transition between the Martin Creek and Husky Formations. The lower 6.4 m of the core consists of thoroughly bioturbated silty to sandy mudstone, herein identified as part of the upper member, Husky Formation. These rocks are gradationally succeeded by 16.5 m of extensively bioturbated, very fine grained, argillaceous sandstone, considered to be the basal beds of the Martin Creek Formation. Similarly the core from Tuktu O-19 (2097.9-2107.1 m; 6883-6913 ft) probably cuts through the Husky-Martin Creek Formation contact. The core consists of completely bioturbated very fine to fine grained, argillaceous sandstone in the upper part, becoming increasingly more argillaceous downward. A rare remnant of subhorizontal laminations is preserved and about 1 m below the top of the core there is a thin zone containing numerous well rounded, small pebbles. The gradational change from sandy mudstone to argillaceous sandstone makes it difficult to choose an exact core depth for the formation contact. Instead, the gamma ray log character has been used and the formation contact was chosen at 2101.6 m (6895 ft) which falls within the given core depths.

Sedimentology

The predominance of shale and mudstone containing marine fossils, in both the lower and upper members, indicates a generally calm water, marine setting. In the lower member the coarsening-upward cycles represent the periodic aggradation of coarse clastics into current or wave agitated zones. The upper member forms the lower part of a thick and widespread, coarsening-upward cycle that includes the Martin Creek Formation and as such represents the more offshore facies of the cycle. The coarsening-upward cycles in the lower member are relatively thin and most likely were deposited as submarine bars. The extensive bioturbation in many beds of the Husky Formation suggests that reasonably well oxygenated bottom conditions prevailed during the deposition of some beds. Pebble and small boulder clasts, although not abundant, occur quite frequently in the lower member. Their origin, in what is predominantly a calm water setting, requires either a high energy depositional event or are dropstones (from floating logs perhaps). Many of the pebbles occur in a single bed and are in either a clay or muddy sand matrix. These features would favour an origin as submarine mud flows, which in turn, suggests the presence of an inclined depositional slope. Isolated pebbles within shales could result from reworking of pebble beds by burrowing organisms.

Jeletzky's (1975, Fig. 10) reconstruction of Kimmeridgian to early Portlandian paleogeography (i.e. lower part of the lower member) shows northeast-southwest trending depositional zones in the northern Richardson Mountains. Extrapolated into the Mackenzie Delta area these trends would indicate a littoral zone in the southeast rapidly changing to "outer neritic and ?upper bathyal" in a northwest direction. No rocks in the subsurface can be identified as littoral and the sedimentological interpretation of the preserved rocks would suggest a shelf, most probably inner shelf, setting. Young et al. (1976, p. 13, 15) also concluded that the bulk of the Husky Formation in the Mackenzie Delta area was deposited on a "shelf-like platform" with predominantly mudstone deposition and periodic development of marine sand-waves and offshore bars.

Age

Most of the detailed dating of the Husky Formation comes from surface data and as the subsurface and surface rocks are readily correlated no major age discrepancies should exist. Jeletzky (1967) dated his lower and arenaceous members, equivalent to the subsurface lower member, as ranging from Late Oxfordian-Early Kimmeridgian to Late Volgian. In the subsurface, macro- and microfossils collected from core material have proved most reliable for dating. The lower member has been dated as Late Oxfordian-Early Kimmeridgian to Late Volgian using fossils collected from cores in the following wells: Kimik D-29 (Chamney in Brideaux et al., 1975; Brideaux in Brideaux et al., 1976); Pikiolik E-54 (Chamney and Jeletzky in Brideaux et al., 1976); Kugpik O-13 (Brideaux and Jeletzky in Brideaux et al., 1976) and Mayogiak J-17 (Chamney in Barnes et al., 1974; Jeletzky in Brideaux et al., 1975). Chamney's (in Brideaux et al., 1975) dating of the Husky Formation in Kimik D-29 as Early to Middle Jurassic must be doubted in light of Brideaux's (in Brideaux et al., 1976) Late Jurassic age assignment and the regional age range of the Husky Formation as Late Jurassic to Early Cretaceous.

Buchia okensis was identified in a core from Mayogiak J-17 by Jeletzky (in Brideaux et al., 1975). The fossil is from strata correlated with the uppermost coarsening-upward cycle of the lower member of the Husky. Jeletzky (*op. cit.*) assigned a Berriasian age to these strata which would suggest a correlation with the upper member. In earlier publications Jeletzky (1967, p. 33-34) noted that varieties of **B. okensis** occur in the uppermost beds of his arenaceous member. Alternatively, Berriasian strata may be present and their occurrence can be explained using Frazier's (1974) concept of depositional-episodes. The contact between the upper and lower members is interpreted to be a hiatal surface, below which transgressive beds are likely to be present. The transgressive beds in turn may be underlain by an erosional surface. Jeletzky (1960) suggested the presence of a hiatus within Upper Tithonian (Upper Volgian) strata of his arenaceous member. The abundance of glauconite in the top few metres of the arenaceous member and equivalent subsurface strata could be indicative of a transgressive facies. Consequently Berriasian strata may be present within the uppermost beds of the lower member, occurring within a transgressive facies overlying an, as yet unidentified, erosional surface.

Jeletzky's (1967) red-weathering and upper members, equivalent to the subsurface upper member, were dated as Early Berriasian, spanning the **Buchia okensis B. uncitoides** and part of the younger **B. volgensis** zones. The uppermost beds of the Husky Formation cored in Tuktu O-19 contained foraminifera dated as Late Jurassic by Chamney (in Barnes et al., 1974). This age seems unlikely in light of the regional correlations and known age range of the upper member. In the same publication Chamney (*op. cit.*) identified a higher core in Tuktu O-19 (1985.2-1994.3 m; 6513-6543 ft) as Husky rocks containing foraminifera indicating an age close to the Cretaceous-Jurassic boundary. Correlations between Tuktu O-19 and the better dated Pikiolik E-54 well (Fig. 3) clearly show that the previously mentioned core was obtained from the much younger Atkinson Point Formation.

The boundary between the Husky and Martin Creek Formations is a facies boundary, consequently the boundary is diachronous to some degree. Jeletzky (1961a) was able to document a diachronous boundary, noting that in the western Richardson Mountains the contact occurs in the **Buchia uncitoides** zone, whereas in the east, it is in the younger **B. volgensis** zone.

Cuttings samples have been used to recover microfossils but the ages indicated by the fossils are highly variable and commonly not as age specific as macro-, and to some extent, micro-fossils recovered from cores. In general, paleontological analysis of the cuttings samples tends to confirm the Late Jurassic to Early Cretaceous age span for the Husky Formation (e.g. Brideaux and Myhr, 1976; Brideaux in Brideaux et al., 1976, p. 4; Hedinger, 1979).

Parsons Group

Coté et al. (1973, p. 623) used the informal term "Parsons Sandstone" for the sandstone-dominant succession that includes the Martin Creek, McGuire and Kamik Formations in the subsurface of the Mackenzie Delta area. The three formations form a readily mapped and lithologically similar unit and it is desirable to retain the Parsons sandstone as a lithostratigraphic entity. Consequently, it is proposed that the three formations be placed in the Parsons Group. The type locality for the Parsons Groups is the Gulf Mobil Parsons F-09 well (68°58'34"N, 133°31'33"W; spudded 20/12/71; completed 19/04/72; KB 5.6 m; 18.5 ft, Fig. 6) between depths 2698.1-3081.5 m (8852-10110 ft), and is the same well used by Coté et al. (*op. cit.*) for their description of the "Parsons Sandstone". The base of the group is slightly deeper than that given by Coté et al. (*op. cit.*, 10055 ft). I chose the base at the depth where the trace of the gamma-ray log begins to deflect continuously to the left, reflecting a gradual increase in sandstone content in the succession. The upper boundary of the group is placed at the top of the last prominent sandstone in the Kamik Formation. The upper contact is usually abrupt and readily identified in the gamma-ray or electrical logs. Gradationally underlying the Parsons Group is the Husky Formation, and abruptly overlying the group is the Siku Formation; both formations are shale-rich successions. A Late Berriasian to possibly Middle Hauterivian age is indicated for the rocks within the Parsons Group (see later discussion of component formations for details).

Surface equivalents of the Parsons Group in the northern Richardson Mountains include the Martin Creek, McGuire, Fault Creek and Lower Canyon Formations. The latter two formations are equivalent to the subsurface Kamik Formation. Norris (1975) mapped all the above units in parts of the Aklavik Range as one, to which the name Parsons Group would be most appropriately applied.

Martin Creek Formation

The Martin Creek Formation was defined by Jeletzky (in prep.) and is essentially the previously termed Buff sandstone member of the Lower Sandstone Division (Jeletzky, 1958, 1960). In the original definition of the Buff sandstone member it was overlain directly by the White sandstone member but later Jeletzky (1961a, p. 14) recognized a thin equivalent of the Blue-grey Shale Division between the two sandstone members. This shale he later termed a tongue of the McGuire Formation (Jeletzky, in prep.).

In outcrop and in subsurface, the lower contact with the Husky Formation is gradational. In the subsurface the lower contact is chosen at a level where the gamma-ray log begins to deflect continuously to the left, indicating a predominantly sandstone content. This practice differs slightly from that of Myhr and Young (1975) who placed the base of the Buff sandstone member (i.e. Martin Creek Formation) at a level where 'clean' shoreface sandstone was the dominant lithology (*op. cit.*, Fig. 42.4). It is felt that Myhr and Young's criteria are subjective, requiring an interpretation of what constitutes a 'clean' sandstone and whether or not it is of shoreface origin, an impossible task without cores. The gamma-ray log technique is less subjective and offers a more consistent mapping horizon in the subsurface. On the southern margin of the Kugmallit Trough and Canoe Depression the McGuire shale rests abruptly on a thick succession of Martin Creek sandstone. Within the Trough axis the upper part of the Martin Creek Formation contains interbedded sandstone and shale and the upper boundary has to be chosen with more care. However, within this upper Martin Creek succession there is a consistent horizon at which shale becomes more prevalent and this is taken to be the base of the McGuire Formation (e.g. Unak B-11 and Kugpik O-13 in Fig. 3).

The maximum known thickness occurs in the Kipnik O-20 well (169.8 m) but isopach trends (Fig. 10) indicate that the maximum thickness occurs to the southwest of Kipnik O-20 and may attain or exceed 200 m. Strata thin to the south and north of the depocentre, both depositionally and by erosion (Fig. 3).

Basal beds of the Martin Creek Formation have been cored at Parsons N-10 and Tuktu O-19, and both cores cut across the Husky-Martin Creek Formation boundary. Strata identified as basal Martin Creek Formation are predominantly bioturbated, muddy to silty, very fine to fine grained sandstone. In the N-10 core the sandstones are very argillaceous in the lower 12.8 m, becoming less argillaceous upwards. These lower bioturbated beds in the N-10 core are 16.5 m thick. As previously noted, there is a complete lithological gradation between the Husky and Martin Creek Formations in the Tuktu O-19 core.

The mid-part of the Martin Creek Formation is predominantly very fine grained sandstone and the Parsons N-10 core includes this interval. In the Parsons N-10 core this part of the formation is 28.4 m thick and consists of structureless and crossbedded units with a few thin interbeds of finely laminated (horizontal- or ripple-) mudstone and argillaceous sandstone. Crossbedding is either low or high angle. Vertical burrows are present in a few sandstone beds. Concentrations of thin-shelled bivalves are common along bedding planes or overlying scour surfaces. Laminated muddy

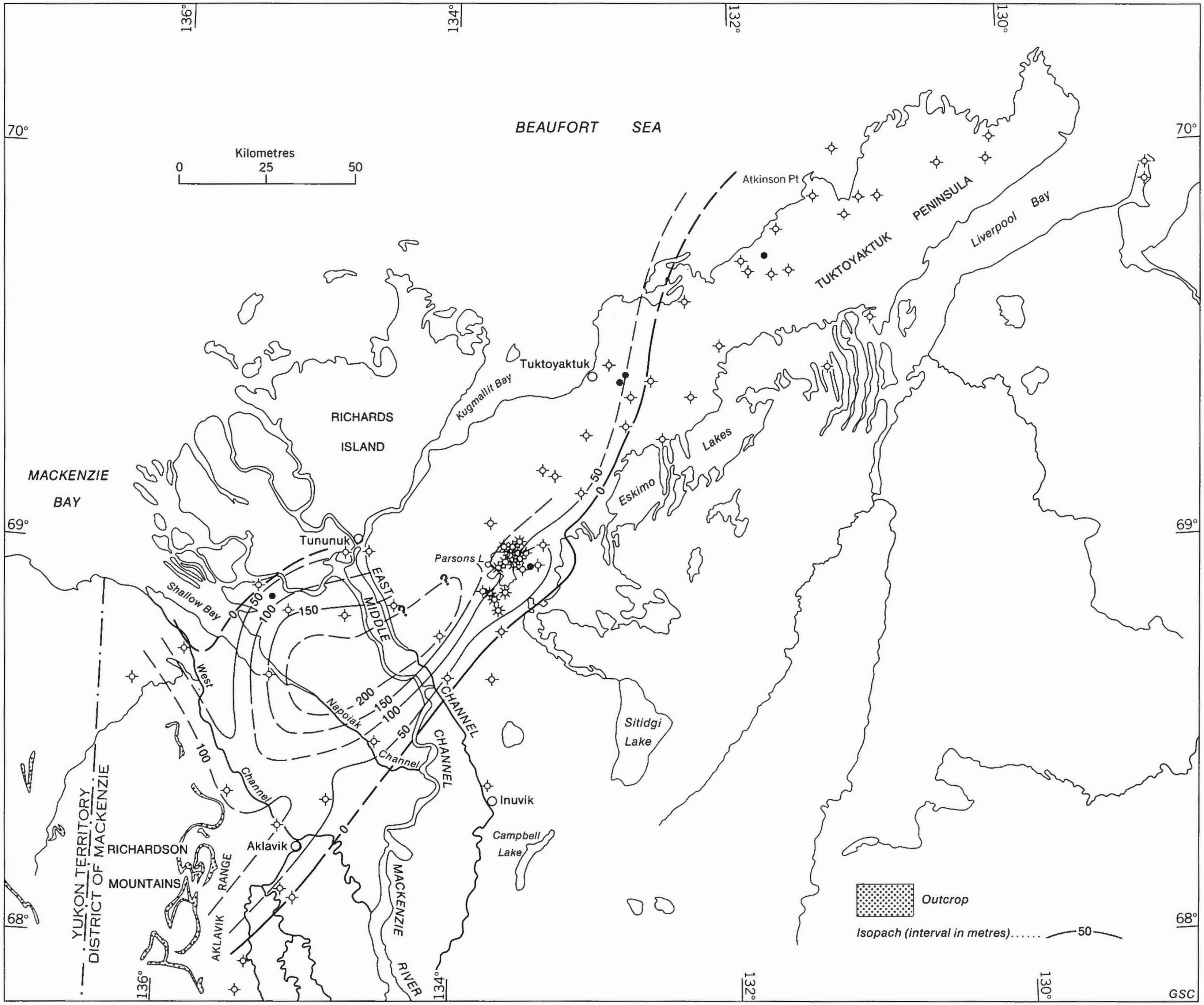


FIGURE 10. *Isopach map, Martin Creek Formation.*

beds are present in the lower part of this interval and some contain burrow structures. Contorted beds and bed-scale microfaulting are present locally indicating soft-sediment deformation. At Pikiolik E-54, 0.3 m of Martin Creek strata was cored (core 2590.2-2593.4 m; 8498-8509 ft), unconformably overlain by Mount Goodenough strata. The basal 26 cm consists of low angle crossbedded, fine grained sandstone containing at least two internal truncation surfaces (?reactivation surfaces). Abruptly overlying the crossbedded sandstone is 4 cm of plane laminated sandstone, in turn erosionally overlain by Mount Goodenough Formation. The Martin Creek rocks in the N-10 core are abruptly overlain by McGuire shale and contain a pebbly layer at the contact. The subsurface character of the Martin Creek Formation is very similar to that described from the surface rocks (Jeletzky, 1958; Young, 1978; pers. obs., 1978).

The uppermost beds of the Martin Creek Formation consist of interbedded fine to medium grained sandstone and mudstone or shale, with rare, very thin coal seams (e.g. Ogruknang M-31 core, 4028.2-4038 m; 13216-13248 ft). This part of the Martin Creek succession is preserved only in the Kugmallit Trough and no comparable rocks have been identified from surface exposures. Sandstone is the predominant lithology and occurs in units a few centimetres to 5 m thick. No diagnostic log shapes are discernible and correlation of individual sandstone units between wells has not been possible. Core is available only from the Ogruknang M-31 well (Fig. 11) and contains interbedded fine to medium grained sandstone and mudstone, with thin seams and laminae of coal in mudstone units. Ripple and plane laminations are the most common sedimentary structures, and crossbeds occur in a 1.5 m thick sandstone at the base of the core.

Sedimentology

The Martin Creek Formation represents the coarse clastic part of a thick and laterally extensive, coarsening-upward cycle that includes the upper member of the Husky Formation. This cycle has calm-water muds and silts at the base (Husky Formation) grading upwards through bioturbated muds and sands into wave- and current-deposited crossbedded sands and capped by a mixture of calm-water and current-deposited sands and muds. The vertical succession of lithotypes and sedimentary structures, the lateral extent and general linear trend parallel to depositional strike all suggest an origin as a prograding barrier island depositional system (Bernard et al., 1962a; Hayes and Kana, 1976; Elliot in Reading, 1978; Reinson, 1979). Thus the succession would be interpreted as offshore mud and silt at the base grading upward into shoreface sand and overlain by lagoonal sand and mud. The lack of lagoonal sediments on the southern margin of the depositional basin is most likely due to pre-McGuire erosion. The lateral continuity of the Martin Creek succession, the similarity of known facies assemblages in the subsurface and surface and the apparent lack of tidal channel-tidal inlet deposits suggests that the barrier was relatively continuous, a type of barrier typically formed in microtidal regimes (Hayes and Kana, 1976).

Coté et al. (1975, p. 623) suggested a beach-shoreface origin for the Martin Creek Formation and Myhr and Young (1975, p. 255[1]) favoured a barrier-shoreline complex. In a later paper Young et al. (1976, p. 18) included offshore sand-shoals and possible barrier islands in their interpretation of Berriasian deposition in the area of the Cache Creek Uplift and Eskimo Lakes Arch. Some of the surface rocks have also been interpreted as beach, barrier and/or lagoonal in origin (Jeletzky, 1974, 1975), as well as nonmarine and offshore marine facies.

Age

The age of the Martin Creek Formation is best documented using macro-fossils collected from surface exposures (Jeletzky, 1958, 1960, 1961a, 1975). In early papers Jeletzky (1958, 1960) dated the Buff sandstone member as Late Berriasian to Early Valanginian. Jeletzky (1960, p. 7) considered the uppermost beds on the east flank of the Richardson Mountains to be slightly younger than those in the Aklavik Range. At this time, Jeletzky (1958, 1960) had not recognized a thin equivalent of the Bluish-grey Shale Division (i.e. McGuire Formation) between the Buff sandstone and White sandstone members in the Aklavik Range. Consequently, some or all of the fauna collected from the uppermost beds of the Buff sandstone could in fact have been from McGuire beds. In a later paper, Jeletzky (1961a) recognized a thin Bluish-grey Shale equivalent in the eastern Richardson Mountains and dated equivalents of the Martin Creek Formation as Early to Late Berriasian. As previously noted in the section dealing with the Husky Formation, the lower Martin Creek Formation boundary can be slightly diachronous (Jeletzky, 1961a).

Dating of the subsurface occurrences of Martin Creek rocks has been entirely by microfossils. Brideaux and Myhr (1976) dated Martin Creek strata as Berriasian, based on dinoflagellates recovered from the Parsons N-10 core. This age is consistent with that obtained using macrofossils.

McGuire Formation

The McGuire Formation of the western Richardson Mountains was formally described by Jeletzky (in prep.), prior to which it had been informally known as the Bluish-grey Shale Division. Jeletzky (1961a, in prep.) regarded a thin (5 m) laterally equivalent shale in the eastern Richardson Mountains as a tongue of the McGuire Formation. Coté et al. (1975, Figs. 21, 22) and Young (1978, Fig. 41) identified a 18-30 m thick McGuire equivalent in the Aklavik Range. Coté et al. (*op. cit.*) carried the correlation into the subsurface where McGuire-equivalent strata were referred to as the "shale marker". The lateral continuity and distinctiveness of this shale unit in the subsurface is such that formation status is merited regardless of thickness (Figs. 3, 4).

Basal beds of the McGuire Formation rest abruptly on Martin Creek rocks in the subsurface and in many areas of the surface. Jeletzky (1980, Fig. 4) however, demonstrated that McGuire strata may rest on rocks as old as Tithonian (i.e. Husky Formation). These relationships suggest locally significant pre-McGuire erosion. A thin pebble layer at the base of the McGuire Formation, present in core from the Parsons N-10 well (see Coté et al., 1975, Fig. 12), may be indicative of erosion and transgression. The upper contact with the overlying Kamik Formation is usually abrupt, probably due to channel sands resting directly on McGuire shale. Locally a thin transition zone (up to 10 m thick) is present, identified from gamma-ray log character (e.g. Kamik F-38).

[1]Due to a typographical error in Myhr and Young's (1975) manuscript the captions for their figures 42-12 and 42-13 were inverted. Their figure 42-13 should have read "Berriasian paleogeography" which would then be consistent with their interpretations in the text.

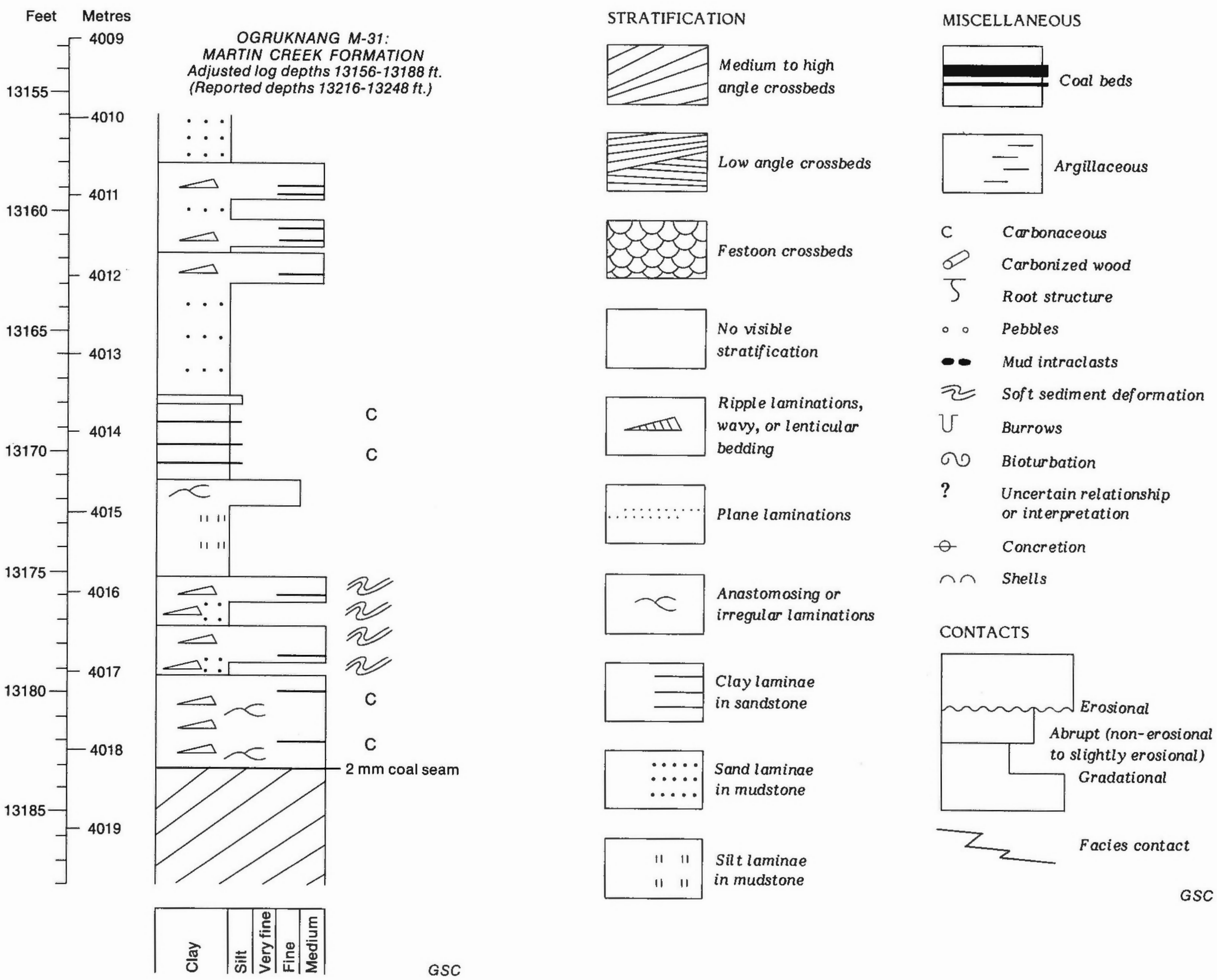


FIGURE 11. *Graphic display of core, Ogruknang M-31, Martin Creek Formation.*

Known complete thicknesses vary from 14.6 m at Parsons P-41 on the southern basin margin to 64.9 m at Kipnik O-20 in a more basin-centre position. Regional trends indicate that the Kipnik O-20 well is slightly north of the basin centre, consequently thicknesses in excess of 65 m are to be expected. The rocks are absent on the Eskimo Lakes Arch, although it is possible they were never deposited on the Arch. At Kugpik L-24, Late Albian or Early Cenomanian erosion has removed the formation. At Aklavik F-38, Late Hauterivian Mount Goodenough rocks rest on a partially eroded McGuire section (Fig. 3).

Dark grey to black shale and mudstone are the dominant lithotypes, with subordinate amounts of siltstone and very fine grained sandstone. Coaly material and carbonaceous shales have been reported from cuttings samples (e.g. Kugpik O-13: Canadian Stratigraphic Service Ltd., log number D-NWT-537). Low velocity and high resistivity readings in proximity to the reported coaly material could indicate the presence of discrete coal beds, as opposed to disseminated carbonized plant material. The coarser clastics commonly occur in thin (3-5 m) coarsening-upward units, as well as in units with no apparent consistent vertical character.

Cores from the McGuire Formation have been obtained from Parsons F-09 and N-10 (see Coté et al., 1975; Myhr and Young, 1975; Myhr and Gunther, 1974; Brideaux and Myhr, 1976 for additional descriptions and illustrations). Both cores are dominantly bioturbated mudstone, with lenses and laminae of siltstone and very fine grained sandstone. The coarser clastics may be bioturbated, burrowed, or have wavy to lenticular bedding (see Myhr and Young, 1975, Fig. 42.9; Coté et al., 1975, Fig. 14). The Parsons F-09 core contains the lower part of a coarsening-upward unit and consists of bioturbated sandy mudstone at the base, grading upwards into interlaminated to interbedded, moderately bioturbated sandstone and mudstone, locally containing primary sedimentary laminations (plane and ripple).

Sedimentology

The presence of marine fossils, extensive bioturbation and the predominance of mudstone suggests a generally calm water, marine setting. Nonmarine, or marginal marine sedimentation, such as in lagoons or salt marshes, may have occurred as is evident by the possible presence of thin coal beds. Coarsening-upward units can form in both marine and nonmarine environments but the close association of bioturbation and burrowing with wavy and lenticular bedding in such units favours a marine or marginal marine origin. Such associations have been described in tidal flat sediments (Reineck and Wunderlich, 1968; Reineck and Singh, 1973) sublittoral deposits (Goldring, 1971; Goldring and Bridges, 1973) and also may form in lagoons.

There is insufficient data to be definitive about the depositional environments but the general setting is most probably a low energy, nearshore environment. Tidal-flat sedimentation tends to produce fining-upward units (see Elliot in Reading, 1978, p. 177), in contrast to the coarsening-upward trends most commonly found in the McGuire Formation. Myhr and Young (1975, Fig. 42.9, p. 249) interpreted the coarse clastics of the Parsons F-09 core as lagoonal tidal-flat deposits resting on lagoonal muds. Coté et al. (1975, p. 627) suggested a lagoon, bay and, in part, a nearshore shelf origin for the McGuire beds. Myhr and Gunther (1974, p. 26) suggested that the palynomorphs recovered from the Parsons F-09 core were typical of a lower coastal plain environment, whereas Brideaux (in Brideaux et al., 1975, p. 5) interpreted them as upper coastal plain and that the rocks were deposited close to a terrestrial source.

Age

Jeletzky (1961a, p. 12-14) dated the lowest beds of the Bluish-grey Shale Division (McGuire Formation) in the western Richardson Mountains as Early Valanginian but found no age diagnostic fossils in the upper beds. Based on stratigraphic position he assumed (*op. cit.*, p. 14) that the upper beds were probably Early to Middle Valanginian. In the same publication (*op. cit.*) he noted that a thin equivalent of the McGuire Formation on the eastern slopes of the Richardson Mountains contained a similar Early Valanginian fauna.

Gunther (in Myhr and Gunther, 1974, p. 26) dated the McGuire Formation in Parsons F-09 as, "late Neocomian (Hauterivian) or Barremian", and Brideaux (in Brideaux et al., 1975, p. 4) assigned an Early Cretaceous, Hauterivian to Barremian age to the same rocks. Palynomorphs were used in both cases. Gunther (*op. cit.*) further suggested that, based on the ages given, the McGuire rocks in Parsons F-09 were much younger than those in the Richardson Mountains (i.e Valanginian, Jeletzky, 1961a). Such a large diachroneity over a relatively short distance in a unit that has consistent stratigraphic relationships to rocks above and below is untenable and not supported by the known geology. The broad age spans indicated by palynomorphs further indicates that their conclusion was based on biostratigraphic data of insufficient accuracy. Brideaux and Myhr (1976) placed most of the McGuire Formation within their biostratigraphic division IVe which they dated as, "Valanginian?-Hauterivian". The lowermost part of the formation was placed in division IVf and assigned a Berriasian age. The ages assigned by Brideaux and Myhr (*op. cit.*) were based on dinoflagellates recovered from cuttings samples. The general age assignments given by Brideaux and Myhr (*op. cit.*) fall within the ages assigned from surface work (Jeletzky, 1961a). Obviously the microfossils are not age specific in McGuire rocks and it is assumed that the Early to Middle Valanginian age assigned using macrofossils obtained from outcrop applies to the subsurface occurrences.

Kamik Formation (new name)

The Kamik Formation is a sandstone-dominant succession lying between the shale-rich McGuire Formation below and the Siku Formation above. Surface equivalents are the Fault Creek and Lower Canyon Formations (Jeletzky, in prep.; Table 1) which are undifferentiable in the subsurface. The Kamik Formation includes the bulk of what was informally known as the Parsons sandstone (Coté et al., 1975; Myhr and Young, 1975). The Gulf Mobil Kamik F-38 well (68°57'25"N; 133°23'54"W; spudded 13/12/76; completed 28/02/77: KB 37.1 m; 89 ft) contains the type section between log depths 3006.5-3236.4 m (9864-10618 ft) (see Appendix 3). Both the lower and upper contacts in the type well are readily identified on the gamma-ray log; the upper contact is abrupt and the lower, transitional over a 5.5 m interval. Gulf Mobil Parsons L-43 (68°52'39"N, 133°01'56"W) is designated a reference well as it contains the most core material within the Kamik Formation. Cores and cuttings samples are available for examination at the Geological Survey of Canada (Institute of Sedimentary and Petroleum Geology), Calgary.

Coté et al. (1975) and Myhr and Young (1975, Fig. 42.8) divided the Kamik-equivalent part of the Parsons sandstone into marine and nonmarine lithogenetic units, in part successional and laterally equivalent. The present study shows a consistent vertical succession of major lithogenetic units and offers some different sedimentological interpretations. The basal third of the Kamik Formation is dominated by sandstone units and is overlain by a succession with significantly more mudstone interbeds (see Fig. 6 for general character). The basal third is also characteristically divisible into two successive parts, the lower part consists of thick sandstone units and thin shale interbeds (reflected on the gamma-ray log as a blocky log trace) overlain by thinner sandstone units interbedded with shale and coal. Fine to coarse grained, locally pebbly, sandstones are typical of the basal third of the Kamik Formation, and there is a general tendency for the sandstones to become less coarse upwards in the succession. The contact with the underlying McGuire Formation may be either abrupt or transitional over a few metres. Abrupt contacts are attributed to channel sandstone resting on McGuire shale.

The upper two-thirds of the Kamik Formation typically consists of interbedded sandstone and mudstone in which there is generally more than 30 per cent mudstone. This part of the succession is arranged in a number of coarsening-upward cycles (see Fig. 6 for gamma-ray log and lithological character). Although a consistent horizon separating the basal third from the upper two-thirds of the Kamik Formation can be correlated between wells (Fig. 6), at least in the Parsons Lake area, the total succession is part of a genetically related depositional event and it is considered impractical and pointless to segregate units within the Kamik Formation. The upper contact with the Siku Formation usually is abrupt and generally corresponds to the top of Coté et al.'s (1975, Fig. 8) 'C' marker.

On the surface the Fault Creek Formation is a prominent, cliff-forming sandstone with abundant coarse grained sandstone but few shale interbeds. Gradationally overlying these beds is the Lower Canyon Formation consisting of interbedded sandstone, siltstone, shale and coal in the lower part (originally the lower member, Coal-bearing Division), beds of which in turn are succeeded by strata containing more shale and siltstone, less coal and including marine fossils (originally the upper member, Coal-bearing Division). The three successive units identified from the Richardson Mountains are very similar to those seen in the Kamik Formation of the subsurface. Although similar units in the subsurface and surface can be identified, the overall character of the total succession is such that a single formation is still preferred.

The Kamik Formation exceeds 800 m in thickness in the Kugmallit Trough (Fig. 12) thinning towards the Tununuk High and Eskimo Lakes Arch, both by depositional thinning and erosional truncation (Fig. 3). Late Albian or Early Cenomanian erosion has completely removed Kamik strata in the Kugpik L-24 well. The absence of Kamik-equivalent strata on the Cache Creek Uplift is due mostly to Middle or Late Hauterivian erosion. There is no irrefutable published evidence to suggest depositional thinning over the Uplift as was suggested by Jeletzky (1975, Fig. 8, section G-4), Myhr and Young (1975) and Young (1978). The evidence presented by these authors is based on a section from "Grizzly Gorge" (Fig. 2) which is open to re-interpretation. The stratigraphic relationships between the various Lower Cretaceous units around the Cache Creek Uplift (mapped by Norris, 1975, 1979) and as seen in the adjacent subsurface (e.g. Beaverhouse Creek H-13, Aklavik A-37, F-38) clearly show that Mount Goodenough strata rest on progressively older rocks towards the Cache Creek Uplift. This simple unconformable relationship more readily explains the section at "Grizzly Gorge", than having a rather abrupt thinning and facies change as suggested by Jeletzky (*op. cit.*). Furthermore, the presence of **Simbirskites** in the so-called "Coal-bearing Division" (i.e. Lower Canyon Formation) at "Grizzly Gorge" can be interpreted to indicate a correlation with basal Mount Goodenough strata. Virtually everywhere in the northern Richardson Mountains this fossil occurs only in the lowermost beds of the Mount Goodenough Formation (Jeletzky, 1960, 1975, 1980). However, the Cache Creek High has been a periodically positive region during the Mesozoic and it is possible that some thinning did occur during the deposition of Kamik rocks, but not as much as Jeletzky, Myhr and Young indicated.

Sedimentology

Kamik strata contain significant reserves of gas in the Parsons Lake gas field and lesser amounts of oil elsewhere (Kugpik O-13, Kamik D-48), consequently these rocks have been cored quite extensively (see Appendix 2). Most of the cores are from the Parsons Lake gas field and adjacent wells. When the core data are integrated with the other well data (Fig. 6) a comprehensive sedimentological analysis is possible.

Deposits from three depositional realms can be recognized: 1) alluvial sediments, 2) coastal plain sediments and, 3) offshore, barrier island and lagoonal sediments (Fig. 6). These three sets of sedimentary deposits occur in a consistent vertical succession, the alluvial deposits are the oldest, followed by the transitional coastal deposits, in turn overlain by the barrier island sediments. Because this consistent vertical succession is observed throughout the study area the detailed sedimentological interpretations obtained from the Parsons Lake area can be extrapolated with a great deal of confidence to include the whole study area.

Alluvial sediments consist of three types of deposit: fluvial channel, crevasse splay and/or levée and overbank or floodplain. These sediments are limited to the lowermost beds of the Kamik Formation and have a typical blocky gamma-ray or SP log character. Cores from Parsons L-43 (2932.8-2945.9 m; 9622-9665 ft) and Parsons N-10 (2795.6-2804.8 m; 9172-9202 ft) contain examples of the different types of alluvial sediments (Figs. 13, 14). The Parsons L-43 core contains a fining-upward cycle, with coarse fluvial channel deposits at the base, gradationally overlain by finer grained floodplain deposits (Fig. 13). The channel deposit rests erosionally on older beds and consists of pebbly, very coarse grained, crossbedded sandstone. These beds grade upwards into coarse grained sandstone, in turn capped by about 0.2 m of plane-, ripple- and irregularly-laminated medium grained sandstone and mudstone. Overlying the channel deposits are interbedded very fine to fine grained sandstone and mudstone of floodplain origin. The sandstone units are thin, a few centimetres to about 30 cm thick, and are either ripple- or plane-laminated. Mudstone units are of similar thicknesses and contain abundant carbonaceous debris and numerous silt and sand laminae and/or ripples.

The Parsons N-10 (Fig. 14) core mostly consists of crevasse splay, levée and floodplain deposits, with the uppermost 3.2 m being part of a channel deposit. Crevasse splay and levée deposits consist of plane- to slightly undulose-laminated, very fine to fine grained sandstone with numerous thin mud laminae. These deposits occur as thin (0.75 to 1 m) units, either coarsening- or fining-upward. The lowest crevasse sandstone in the N-10 core is crossbedded and probably was deposited in a shallow crevasse channel. Separating the sandstone units are silty to sandy mudstones of floodplain origin. Carbonaceous debris is a common component of the mudstone as well as silt and sand laminae. A very thin coal seam is present immediately below the last crevasse sandstone (Fig. 14, at about 2765.6 m; 9182 ft). Young (in Shawa, 1974) interpreted the N-10 core as consisting of delta plain and distributary channel deposits. Delta plain and alluvial plain deposits can be very similar but the regional distribution of equivalent strata favour an alluvial, rather than deltaic setting (see section on Geological History and Paleogeography).

A core from Ikhil I-37 (3908.8-3912.7 m; 12824-12837 ft) was recovered from the basal beds of the Kamik Formation but there is insufficent core to be certain of an interpretation. The core consists of medium to coarse grained sandstone with scattered granules and pebbles, and rare fragments of carbonized wood. Crossbeds can be discerned. The core is from an interval with a blocky gamma ray/SP log character that can be correlated with the basal Kamik beds in the Parsons Lake wells and it is likely that the core was cut in a fluvial channel deposit.

Overlying the alluvial deposits are the coastal plain sediments. These sediments probably were deposited in small fluvial channels, floodplains, swamps or marshes, lagoons, estuaries and tidal flats. Typically this interval consists of interbedded sandstone, mudstone and coal, and the gamma-ray/SP logs show frequent deflections in response to the interbedded character. Only one core is available from these rocks, in Parsons F-09 (Fig. 15; 2845.9-2864.2 m; 9337-9397 ft), of which only that part below 2849 m (9347 ft) is interpreted to be within the interval of coastal plain deposits. The upper 3 m of the core is believed to be a transgressive unit preceding the deposition of a prograding barrier island complex. The appropriate interval in the F-09 core consists of predominantly fine grained sandstone with thin laminae and interbeds of mudstone, the latter occurring more frequently towards the base of the core. Most of the sandstone appears structureless but there are horizons of ripple-, plane- and undulose-laminae as well as bioturbated zones. A 15 cm thick coal seam is present in the lower part of the core. The lithotypes and sedimentary features in the F-09 core are here interpreted as lagoonal or possibly estuarine in origin, although it is recognized that alternative interpretations are possible. Some of the thicker coal beds present in this interval of coastal plain deposits most likely were deposited in swamps or marshes.

Myhr and Young (1975, Fig. 42.8) interpreted equivalent strata (i.e. basal third of Kamik Formation) as delta plain in origin, and the Parsons F-09 core straddling delta plain to delta front/prodelta deposits. Coté et al. (1975) gave a general nonmarine interpretation in which fluvial cycles were believed to be prevalent (*op. cit.*, p. 627).

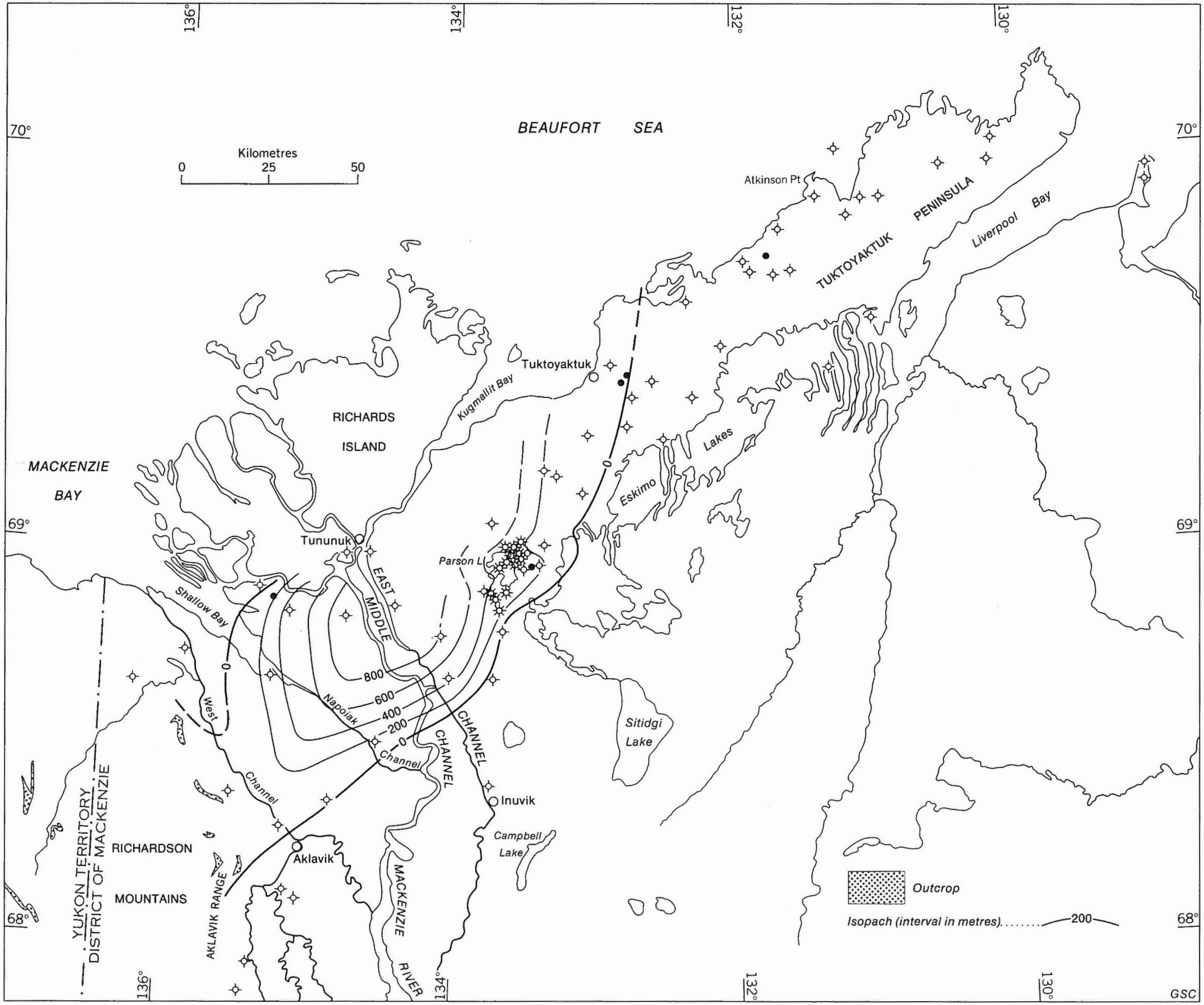


FIGURE 12. *Isopach map, Kamik Formation.*

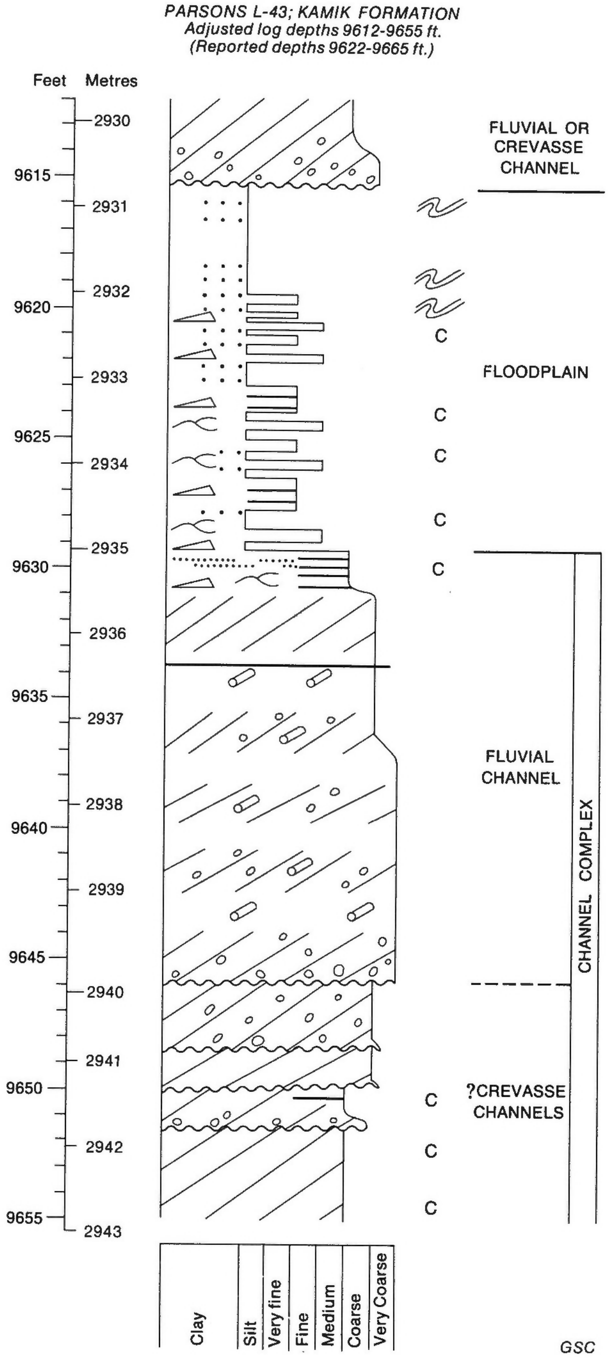


FIGURE 13. *Graphic display of core and sedimentological interpretations, Parsons L-43, Kamik Formation (see Fig. 11 for explanation of symbols).*

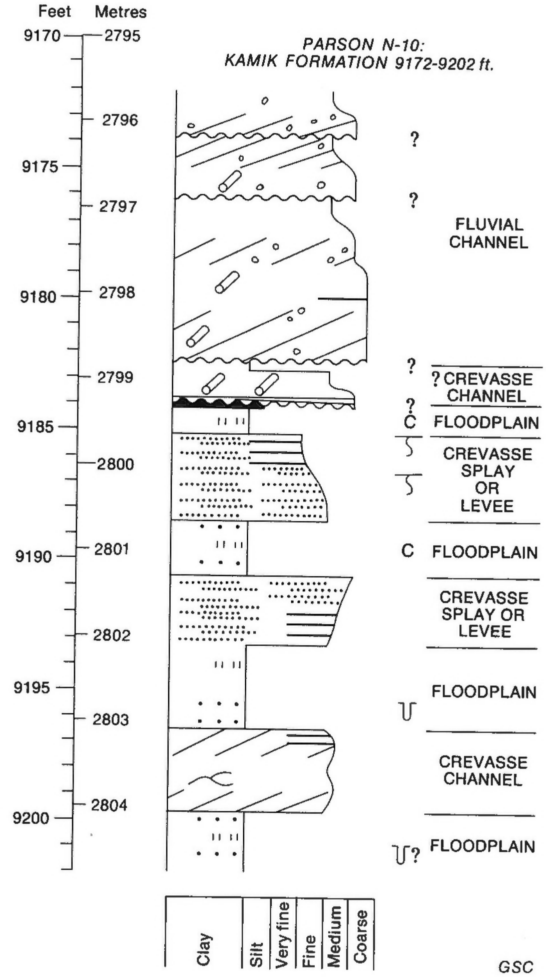


FIGURE 14. *Graphic display of core and sedimentological interpretations, Parsons N-10, Kamik Formation (see Fig. 11 for explanation of symbols).*

The upper two-thirds of the Kamik Formation consists of several coarsening-upward cycles, readily identified on gamma-ray and SP logs (Fig. 6). In the Parsons Lake area three cycles can be recognized (Fig. 6), the lower two are well defined, whereas the upper one is less well developed. These three cycles can be readily correlated between wells in the Parsons Lake and adjacent areas for distances up to 45 km, and possibly as much as 65 km (Fig. 6). However, it has proven difficult to correlate these cycles into and across the Kugmallit Trough, even though coarsening-upward cycles are present. In the Parsons Lake area a number of cores (Fig. 6) were cut in the two lower cycles and detailed correlations indicate that the cores can be stacked such that an almost continuous vertical section through the two cycles is available. Only the upper beds in each cycle are poorly represented in the cores. Figure 16 illustrates the vertical succession of the second cycle. A similar vertical succession was seen in the lowest cycle.

These cycles are interpreted as barrier island deposits and deposits from a number of subenvironments can be recognized, which include offshore, shoreface, tidal channel and lagoonal. Each coarsening-upward cycle begins with a transgressive sandstone (Fig. 16) overlying the previous cycle, or, in the case of the oldest cycle, overlies coastal plain sediments (e.g. Parsons F-09, Fig. 15). In the Reindeer G-04 core (Fig. 16), the transgressive sandstone is fine grained and contains low angle cross-strata, whereas in Parsons F-09 it is structureless or ripple laminated and contains numerous clay laminae.

Depending upon the relative landward or shoreward position, the basal transgressive sandstone is overlain abruptly by either offshore or shoreface sediments. At Reindeer G-04, offshore sediments directly overlie the transgressive sandstone, whereas at Parsons P-41, in the same cycle, correlations and a core cut just above the transgressive sandstone indicate shoreface deposits overlie the transgressive sandstone (Fig. 16). Offshore deposits are

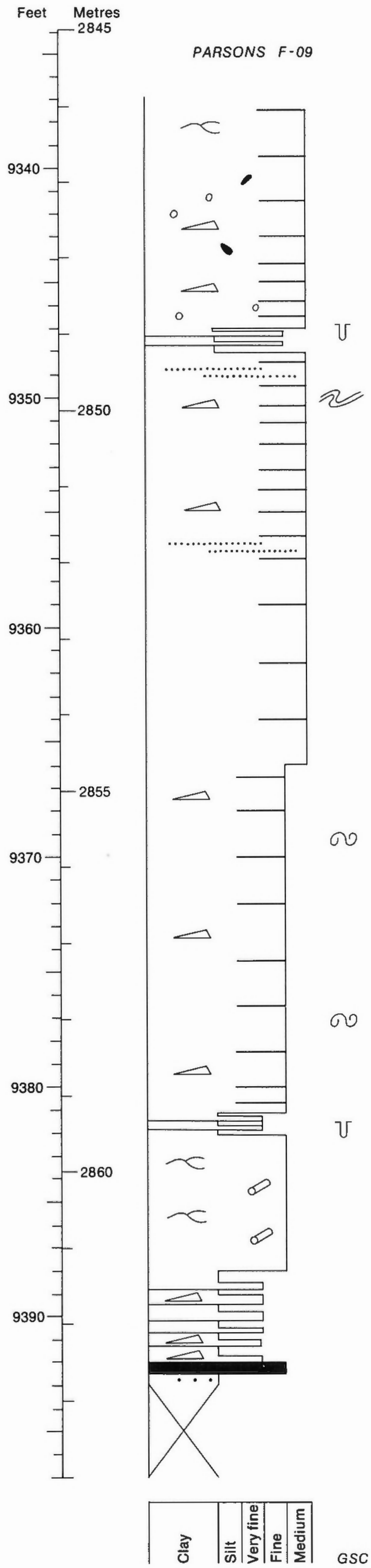


***FIGURE 15.** Graphic display of core and sedimentological interpretations, Parson F-09, Kamik Formation (see Fig. 11 for explanation of symbols).*

predominantly mudstone with some thin interbeds of laminated siltstone to fine grained sandstone. The mudstone is either structureless or extensively bioturbated and may contain plane or undulose laminae of silt and very fine sand (e.g. Reindeer G-04, Fig. 16).

Shoreface deposits can be divided into lower, middle and upper shoreface. The change from offshore to lower shoreface deposits is transitional and consists of interbedded sandstone and mudstone (Fig. 16). Individual beds in the transitional zone and lower shoreface may range in thickness from thin laminae up to 30 cm thick. Mudstone beds are generally bioturbated with a few remnant patches of laminated sand and silt. Sandstone beds have abrupt bases and gradational tops, and are usually ripple- or plane-laminated. Rare, small-scale festoon cross-laminae may occur (migrating linguoid or lunate ripples). The number and thickness of sandstone beds increases upwards and in middle and upper shoreface deposits, sandstone is prevalent, interbedded with a few thin mudstone beds (Fig. 16). Sandstone beds contain low to medium angle crossbeds, which occur as single sets or cosets (Fig. 16). Burrow structures are commonly present in the upper parts of sandstone beds. Mudstone units invariably contain plane- or ripple-laminae of silt or very fine sand and are commonly burrowed or bioturbated.

In Parsons P-41 there is a very prominent sandstone-rich interval within the middle/upper shoreface deposits, between depths 2969.4-2975.2 m (9742-9761 ft) (Fig. 16). This interval contains at least three fining-upward units, each consisting of a basal part that is structureless or faintly crossbedded grading upwards into a slightly finer grained crossbedded sandstone with numerous mud intercalations. These fining-upward units are interpreted as stacked offshore sand bar deposits. Other sandstone units in the middle/upper shoreface probably were deposited as smaller bedforms such as low amplitude megaripples, small sand bars or ripples. Plane-laminated beds may be the result of high energy storm surges.

No foreshore (beach) deposits have been recognized in any of the cores, due to the fact that the upper part of the cored barrier islands is represented by channel deposits, presumably tidal channels, in all of the cores. Channel deposits are very distinct, forming fining-upward units that rest erosionally on underlying strata, commonly cutting down to as deep as lower shoreface deposits. The lower part of the channel deposit consists of structureless or faintly crossbedded, medium to coarse grained, pebbly sandstone. Grain size becomes finer upward, the crossbedding becomes more distinct and mud intercalations occur more frequently. At Parsons L-43 the lower part of the channel deposits is overlain by at least eight, thin fining-upward cycles (Fig. 16) believed to have been deposited on either a lagoonal tidal flat or channel margin sand flat that migrated over the deep-channel deposit. In other cores (Siku E-21 and A-12, Parsons P-41) containing channel deposits, mud intercalations are common, especially in the upper parts of the deposit. The mud occurs as thin laminae within ripple-, plane- or irregularly-laminated sand, or as thin mudstone beds usually containing ripple- and plane-laminated sand or silt. Burrow structures are present but not very common in the mudstone beds. The presence of mud beds suggests that the channel deposits were not deposited in the tidal inlet, where energy levels are high and mud would most likely be removed, but are part of tidal-delta deposits. There is insufficient data to be able to identify them conclusively as ebb or flood tidal-deltas. Carbonaceous debris and a thin coal seam present in the upper part of a channel deposit in the core from Siku E-21 (first barrier island cycle) were most likely derived from organic matter within a lagoon and would tend to favour a flood tidal-delta for at least this example.

In the cored wells the tidal-delta/tidal channel deposits are overlain by a thin succession of interbedded sandstone, and mudstone. Thin coal beds have been identified from cuttings samples. These beds are interpreted as back barrier and lagoonal deposits (Fig. 16). They consist of various sandstone and mudstone facies, such as: structureless mudstone; mudstone containing ripple- or plane-laminated sand; thin interbeds of plane- or ripple-laminated sandstone and mudstone; thick units of structureless to faintly laminated sandstone; and thin fining-upward units with crossbedded sandstone grading upwards into interlaminated mud and sand. Bioturbation is more common in the mudstone units, and burrows may occur in both lithotypes. These deposits represent the various subenvironments within a lagoon, such as calm-water subtidal lagoon, lagoonal tidal-flats, tidal-creeks, back-barrier sand flats and washover fans. The coal beds represent salt- to brackish-water marshes.

No dune deposits were recognized in the cores, and the lack of thick, 'clean' sandstones between the lagoonal and foreshore/shoreface deposits, as determined by log character, indicates that they are probably not present in the Parsons Lake area. The preservation potential of dune sands is probably very slight, and their absence is not unexpected. Each of the barrier-cycles is terminated by a transgressive sandstone, above which a new barrier developed, or in the case of the last cycle was succeeded by offshore mud sediments of the Siku Formation.

The barrier-island interpretation is favoured by the vertical succession (see Elliot in Reading, 1978; Reinson, 1979; for excellent summaries of barrier-island deposition) and isopach trends (Fig. 17). The second barrier-island cycle shows a strong northeast-southwest alignment, parallel to subparallel with the presumed paleoshoreline (Fig. 17; this figure shows three alternative ways of contouring the thickness data, but all show the same linear trend). A similar trend has also been noted for the first barrier-island cycle. Campbell (1971) showed that the barrier-island deposits of the Upper Cretaceous Gallup Sandstone of New Mexico were imbricated, a feature probably typical for many barrier-island deposits. However, detailed correlations across depositional strike in the Kamik barriers failed to show any obvious imbrication. The en échelon isopach pattern seen in both the first and second barrier cycles (Fig. 17) could be due to imbrication of the barrier deposits, but not detected by the correlations. Tidal-channels and associated tidal-deltas are common to mesotidal regimes (Hayes and Kana, 1976), whereas near-continuous barriers are more typical of microtidal regimes, therefore the Kamik barriers were most likely deposited under a mesotidal regime. However, Reinson (1980) has shown that under suitable conditions of the tidal prism, sediment supply and coastal physiography, tidal-deltas can form in microtidal regimes, factors that cannot be determined for the Kamik barriers.

The preceding sedimentological analysis of the Kamik rocks differs slightly from that of Coté et al. (1975) and Myhr and Young (1975). These authors also recognized the prevalence of nonmarine rocks in the basal part of the formation but either had a complex interdigitation of marine and nonmarine rocks in the overlying strata (Myhr and Young, 1975) or extended the nonmarine rocks much higher into the upper part of the Kamik Formation (Coté et al., 1975, Fig. 8). Myhr and Young (1975) considered the coarsening-upward cycles to be prodelta to delta front deposits with some interbedded channel and delta plain sediments. Coté et al. (*op. cit.*) recognized barrier island cycles for some of the upper Kamik rocks, but included others in their nonmarine strata. My interpretation of the Kamik succession shows that there is a consistent vertical succession of deposits and that the boundaries between successive deposits are not major diachronous facies boundaries as indicated by Coté et al. (*op. cit.*) and Myhr and Young (*op. cit.*). However, slight diachroneity, probably beyond the resolution of any fossils contained in the strata, is to be expected. This consistent vertical succession is identifiable both along depositional strike (Fig. 6) in the Parsons Lake area, and into the Kugmallit Trough where the Kamik is thickest.

Age

Macro- and micro-fossils are not particularly abundant in the Kamik and equivalent surface formations. Microfossils recovered from Kamik strata indicate a Valanginian to Hauterivian age (Myhr and Gunther, 1974; Brideaux and Myhr, 1976). Myhr and Gunther's (*op. cit.*) lithostratigraphic correlation of their "lithogenetic units A" in East Reindeer G-04 with the Upper Shale-siltstone Division (i.e. Mount Goodenough Formation) should be viewed critically. Detailed regional correlations (Fig. 6) and their own age dates show it is part of the Kamik Formation.

The paucity of fossils from equivalent surface strata led Jeletzky (1960, 1961a) to rely heavily on stratigraphic position between more fossiliferous strata to date the rocks. This approach indicates that Kamik-equivalent rocks are Middle or Late Valanginian to Middle Hauterivian in age. A few belemnites from the upper member of the Coal-bearing Division (i.e. Lower Canyon Formation) indicate a possible Middle Hauterivian age (Jeletzky, 1960, p. 9). A number of undiagnostic bivalves also were recovered from the same strata (Jeletzky, 1960). The deductions of Jeletzky (*op. cit.*) apply equally well to the Kamik Formation.

Siku Formation (new name)

The Siku Formation is introduced for a previously unnamed shale succession between the Kamik and Mount Goodenough Formations. This formation has not been identified from surface exposures, because either it is truly absent, or it has been incorporated into the lithologically similar, overlying Mount Goodenough Formation. Earlier workers included the Siku Formation in equivalents of the Mount Goodenough Formation (i.e. Upper Shale-siltstone Division) when correlating subsurface sections (Coté et al., 1975; Myhr and Young, 1975; Brideaux and Myhr, 1976; Young et al., 1976). However, it is important to identify a correct and meaningful base for the Mount Goodenough Formation, which happens to be an unconformity at the basin margins, becoming conformable basinward, and coincides with the base of Coté et al.'s (1975) 'D' marker (Fig. 5).

The type section is located in the Gulf Mobil Siku A-12 well (69°01'31"N, 133°32'32"W; KB 67.4 m; 221 ft; spudded 14/04/76; completed 28/06/76) between log depths 2575.6-2657.9 m (8450-8720 ft) (see Appendix 4). Gulf Mobil Reindeer G-04 is cited as a reference well as it contains the only core from the Siku Formation. The formation contacts are abrupt in the type well and are readily identified on the gamma-ray log. Core and cuttings samples are available for examination at the Geological Survey of Canada (Institute of Sedimentary and Petroleum Geology), Calgary.

Siku shale rests abruptly on Kamik sandstone and is abruptly, and generally unconformably, overlain by a variably thick sandstone of the Mount Goodenough Formation. In a more basinward position the upper contact may be transitional (e.g. Ogruknang M-31; Unak B-11, Fig. 3). Middle to Late Hauterivian erosion (i.e. pre-Mount Goodenough) has severely modified the distribution of Siku strata, such that it is preserved only in the tectonically downwarped areas of the

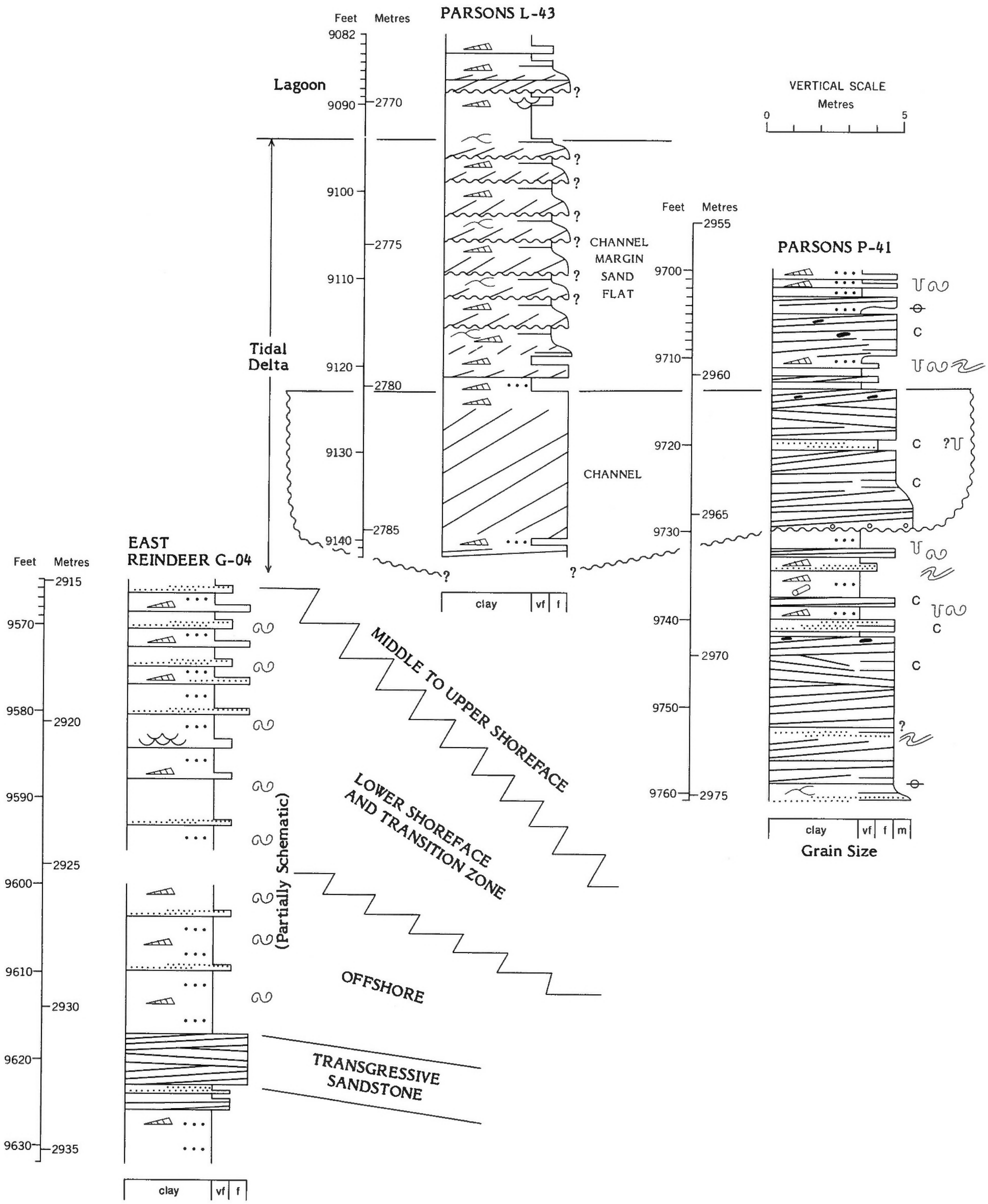


***FIGURE 16.** Graphic display of cores and sedimentological interpretations through barrier-island cycle number 2, Kamik Formation.*

Kugmallit Trough (Fig. 18). The thickest known section is in Kipnik O-20 where there is 271.3 m of strata but the isopach trends indicate that the depocentre is slightly to the south where the Siku Formation may exceed 300 m (Fig. 18).

There is very little variation in lithology within the Siku Formation, dark grey to black, or brownish grey shale and mudstone are predominant. Thin siltstone and very fine grained sandstone beds may be present locally, either at the

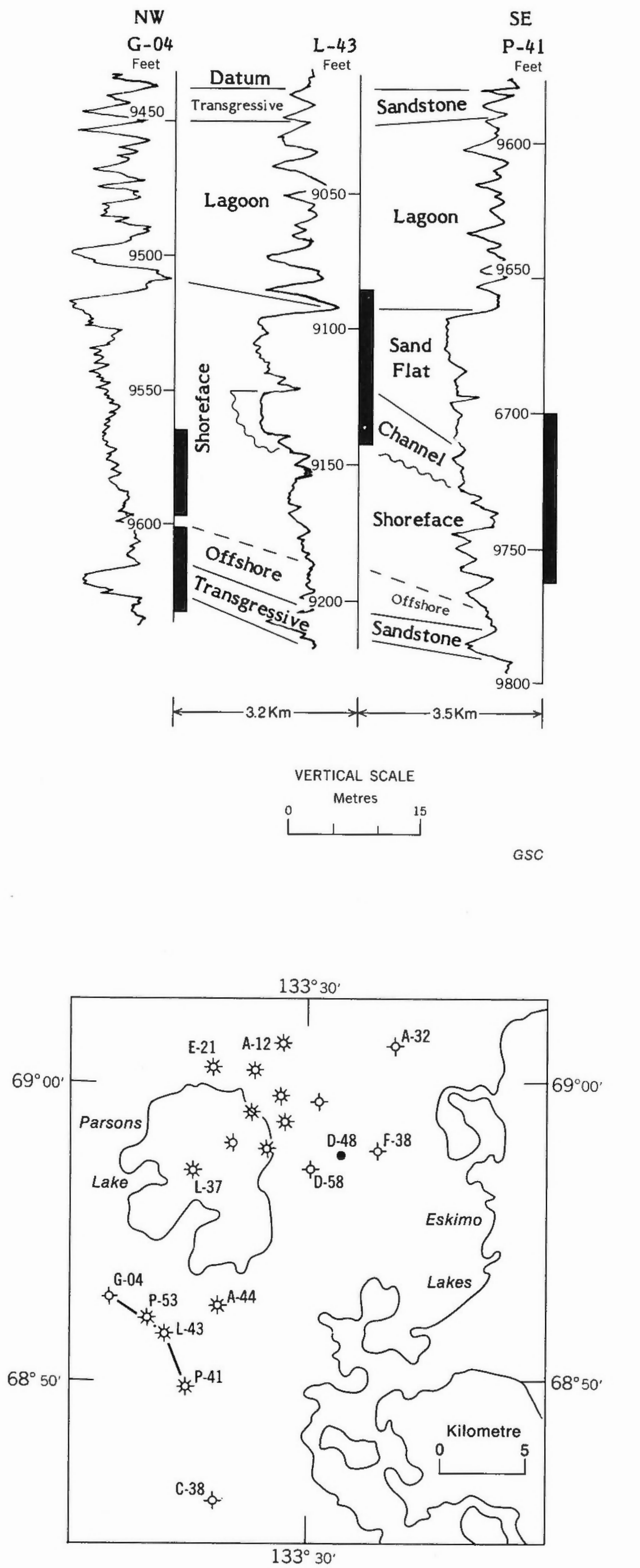


FIGURE 16. *(cont'd).*

base of the formation or towards the top where a transitional upper contact is preserved (e.g. Ogruknang M-31, Unak B-11). The shales are generally calcitic or dolomitic and may contain claystone and ironstone concretions. The only core from the Siku Formation was cut in the East Reindeer G-04 well and the lithology is typical.

Sedimentology

The dominance of shale and mudstone, and the fact that they overlie barrier island deposits of the Kamik Formation point to a marine origin for the Siku rocks. A calm-water, shelf environment is most likely.

Age

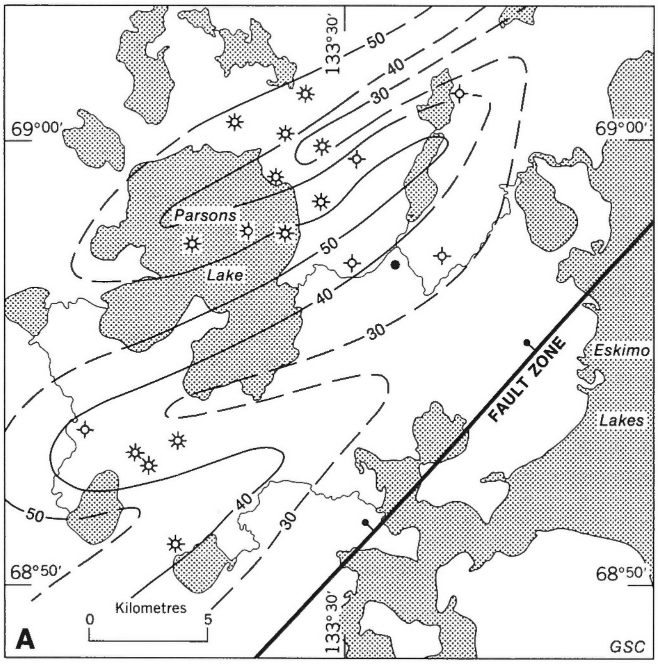
No accurate age determination from indigenous fossils is available for the Siku Formation, and its age is best determined by stratigraphic position. Siku strata occur below Late Hauterivian beds of the lower Mount Goodenough Formation (Jeletzky, 1960, 1961a, in prep.) and above possible Middle Hauterivian Kamik strata (Jeletzky, 1960, p. 9). Brideaux and Myhr (1976) placed Siku strata within their division IVe, an interval that includes strata of the Kamik to middle of the Mount Goodenough Formations and which was dated as, "Valanginian?-Hauterivian". A Middle or early Late Hauterivian age is probable for the Siku Formation.

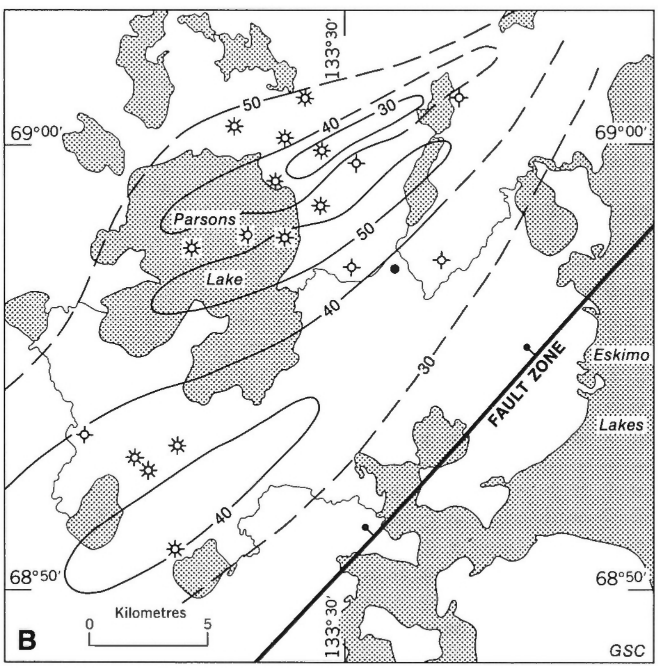
Mount Goodenough-Rat River-Atkinson Point Formation

Jeletzky (in prep.) formally named the Mount Goodenough and Rat River Formations, previously having been known as the Upper Shale-siltstone and Upper Sandstone Divisions, respectively. Dixon (1979) named and modified (Dixon, in prep.) the Atkinson Point Formation, and also recognized it as a lateral equivalent of the Rat River Formation and at least the upper part of the Mount Goodenough Formation. The successional nature and, in part, lateral equivalence of these three formations (Figs. 3, 4; Dixon, in prep.) make it desirable to discuss them together.

Throughout the northern Richardson Mountains the Mount Goodenough Formation has long been recognized as resting on a regional unconformity (Jeletzky, 1958, 1960, 1961a, 1974, 1975, 1980; Norris, 1975, 1977, 1979). Dixon (in prep.) emphasized the importance of this relationship for recognizing the correct base in the subsurface and using detailed correlations concluded that the base of Coté et al.'s (1975) 'D' marker sandstone was the true base of the Mount Goodenough Formation in the subsurface. Prior to Dixon's work the Kamik to Mount Goodenough succession was interpreted to be gradational in parts of the subsurface. This is partially true but the earlier workers failed to recognize the Siku Formation as a distinct unit between the Kamik and Mount Goodenough Formations. The amount of erosional truncation at the basal unconformity can vary very rapidly, for example at Aklavik F-17, Mount Goodenough strata lie on a thin remnant of the lowermost Husky beds, yet only a few kilometres to the north, at Aklavik F-38, they rest on the McGuire Formation (Fig. 3). This rapid change in amount of truncation is common adjacent to the major positive tectonic elements.

At the base of the Mount Goodenough Formation there is a sandstone ('D' marker of Coté et al., 1975) which in many areas, especially in and on the southern margins of the Kugmallit Trough is thin and very argillaceous. Immediately overlying this basal sandstone there is a thick succession of predominantly shale and siltstone (Figs. 3, 4). In some areas, most notably adjacent to the Tununuk High (e.g. Kipnik O-20, Tununuk K-10), the basal sandstone is generally thicker and cleaner, and is overlain by a succession of interbedded sandstone and shale, in turn succeeded by shale and siltstone (see Dixon, in prep., Fig. 7). This twofold subdivision of the Mount Goodenough Formation is readily seen on the gamma logs. Even where the lowermost beds are shale- and siltstone-rich there tends to be an upper shale-rich section





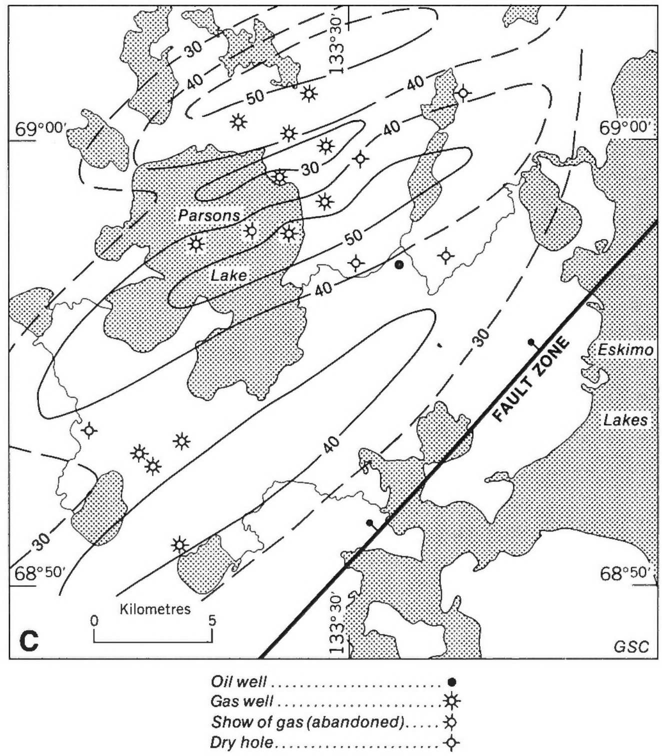


FIGURE 17. *Isopach map of barrier-island cycle number 2, Kamik Formation: three alternatives of contouring the thickness data are given, however each shows the same en échelon arrangement of isopach maxima and minima.*

(in the middle part of the section where the Mount Goodenough includes Rat River equivalents). The two subdivisions bear no relationship to Jeletzky's (1958) lower and upper members of the Upper Shale-siltstone Division (Mount Goodenough Formation).

The gradational contact between the Mount Goodenough and Rat River Formations, and the interbedded sandstone-shale aspect of the latter in the subsurface does not allow a precisely corresponding contact to that of surface sections to be made. In the subsurface, the contact is more readily chosen from the gamma log, where the log trace begins to deflect to the left in response to a decrease in shale content in the section.

In the west, adjacent to the Cache Creek Uplift and Tununuk High, Mount Goodenough shale and siltstone are gradationally overlain by interbedded sandstone and shale of the Rat River Formation. Across the Kugmallit Trough the sandy Rat River beds are replaced laterally by shale, mudstone and siltstone and only a thin sandstone unit is present at the very top of the succession (Figs. 3, 4). This lateral facies change calls for the Mount Goodenough Formation to be extended to include all the strata between the Arctic Red and Siku Formations where no significant sandstones occur in the upper part of the succession (see Dixon, in prep.). A similar situation is seen in the Wagnark G-12, C-23 and Siku C-55 wells, where the upper beds of an equivalent interval are sandstone- and siltstone-rich, and because of their proximity to the Atkinson area, are referred to the Atkinson Point Formation (see Appendix 1 for formation tops). Only a few kilometres southeast of C-55, in the Parsons Lake area, the equivalent beds are much more shaly and silty, although some sandstone is present.

In the Atkinson Point area Dixon (1979) demonstrated that conglomerate and sandstone of the Atkinson Point Formation grade laterally into more silty and shaly beds of the upper Mount Goodenough Formation and that they are laterally equivalent to Rat River strata. Exact age relationships between the three formations are not clear due to the lack of biostratigraphic control. Correlations between wells, however, strongly favour the lateral relationships suggested above (Fig. 4) and this would suggest a Late Barremian to Aptian age for the Atkinson Point and laterally equivalent strata.

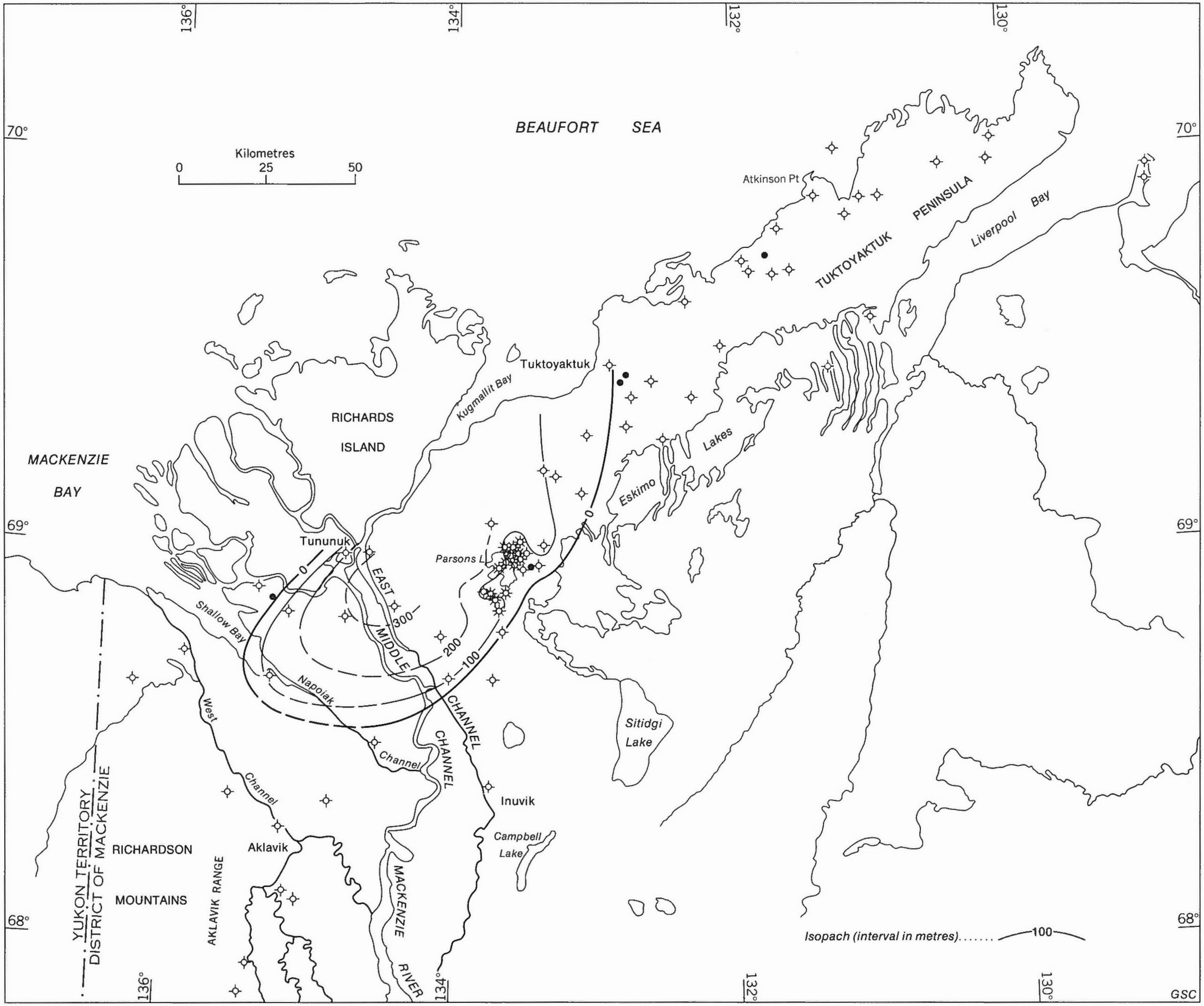


FIGURE 18. *Isopach map, Siku Formation.*

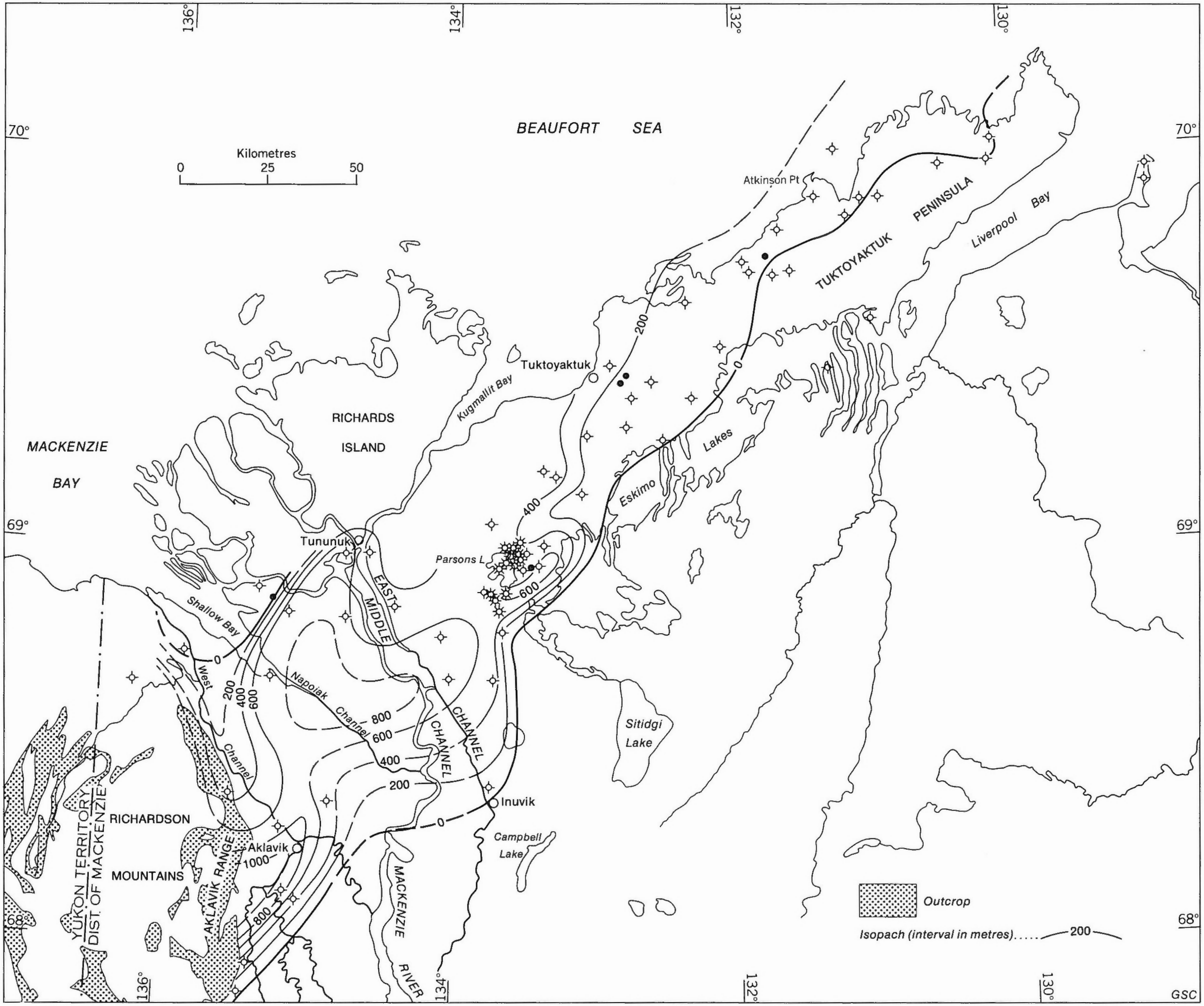


FIGURE 19. *Isopach map, Mount Goodenough, Rat River and Atkinson Point Formations.*

Formational thicknesses are highly variable due not only to depositional thinning but also facies changes, consequently an isopach map for all three formations is presented (Fig. 19). Thickness trends are very similar to those seen in older rocks, a depocentre in the Kugmallit Trough and thinning towards the Eskimo Lakes Arch and Tununuk High. For the first time, depositional thinning to the northeast can be demonstrated (Fig. 19). Late Albian or Early Cenomanian erosion has removed the Mount Goodenough-Rat River succession in the Kugpik area, and Tertiary to Holocene erosion has removed or partially truncated the succession in the southwest Delta area (e.g. Beaverhouse Creek H-13). Much of the thinning seen between Shallow Bay and Aklavik (Fig. 19) is due to Holocene erosion, although some depositional thinning is also present.

The Rat River Formation is generally less than 150 m thick in the subsurface, in contrast to the 200-250 m reported from the Aklavik Range (Young et al., 1976, p. 21). Mount Goodenough strata attain thicknesses in excess of 800 m within the Kugmallit Trough where they include lateral equivalents of the Rat River Formation. Where the two formations are successional, the Mount Goodenough Formation is up to 628.5 m thick (Unak B-11). The Atkinson Point Formation has a known maximum thickness of 120 m (Louth K-45) thinning to a true depositional zero edge to the southeast. Southeast of Eskimo J-07, Late Albian or Early Cenomanian erosion has removed Atkinson Point or equivalent strata.

Sedimentology

Cores from the three formations were cut in fifteen wells (see Appendix), although most of the cores were cut in the Atkinson Point Formation. The good core control in the Atkinson Point Formation allowed Dixon (1979) to present a detailed sedimentological model. Detailed interpretations of the other two formations are not as readily obtained.

The dominance of shale and mudstone, presence of marine fossils (Jeletzky, 1958, 1960, 1961a; Brideaux and Myhr, 1976) and the abundance of bioturbated rocks seen in the available cores all suggest a mostly marine origin for the Mount Goodenough Formation. Core material from the lowermost Mount Goodenough beds in Unak B-11 and Kipnik O-20 present two contrasting facies assemblages. In the Unak B-11 core (1195.4-1204 m; 3922-3950 ft) the rocks consist of very fine to fine grained, ripple-, undulose- or horizontally laminated sandstone, interbedded to interlaminated with silty to sandy mudstone. Bioturbation and burrows are abundant, especially in the muddier sediments. These features are similar to sublittoral deposits described by Goldring (1971) and Goldring and Bridges (1973), deposited in a marine, generally low energy, setting with periodic incursions of coarser clastic material during higher energy conditions, such as storms.

At Kipnik O-20 the rocks have a very different character, consisting of three thin coarsening-upward units, two of which contain thin coal seams in the shale part of the unit (Fig. 20). Also present are at least two sandstone beds with abrupt upper and lower contacts and usually less than 30 cm thick (Fig. 20). The shales are very carbonaceous and contain abundant sand and silt laminae. Bioturbation and burrows are present in the shale beds, and in mud laminae within sandstone beds. Fine to medium grained sandstone beds are mostly horizontally laminated, with ripple and irregular laminae in the upper, coarsening-upward unit. Mud laminae are very common in the sandstone beds. Woody debris is a common component of the sandstones, and small pebbles or rounded mud clasts are locally present. These cored beds of the basal Mount Goodenough Formation are interpreted as lagoonal and the terrestrial influence is obvious in the amount of plant material within these beds. Immediately under- and overlying beds in the Kipnik O-20 well contain coaly material in the cuttings samples, further indicating a strong terrestrial influence. The marginal marine to possibly coastal plain sediments in the Kipnik O-20 well contrast to the offshore marine beds recognized in Unak B-11. However, in the Kipnik O-20 well, marine beds apparently become more prevalent higher in the Mount Goodenough section. The sandy basal beds in Tullugak K-31 and K-10 are very similar lithologically and in log character to those seen in the nearby Kipnik O-20 well and it is expected that these wells also contain marginal marine to marine sediments. However, coaly material does not appear to be as prevalent in the adjacent three wells. South of the Kipnik area, in the Kugmallit Trough and on its southern margin, the basal Mount Goodenough beds are mostly shale and mudstone with minor amounts of siltstone and sandstone, and are interpreted as low energy, marine deposits.

At Pikiolik E-54 is a core that cuts across the basal unconformity at 2593.2 m (8508 ft) with Mount Goodenough rocks overlying truncated Martin Creek strata (see Myhr and Young, 1975, Fig. 42.11, for photograph of core). The 3 m of Mount Goodenough strata in the core consists of a basal 25 cm of conglomerate abruptly overlain by bioturbated, argillaceous to silty, very fine grained sandstone. The conglomerate unit contains at least eight discrete beds varying from 2 to 10 cm in thickness. Each bed has an abrupt basal contact, and some of the thicker beds show a crude fining-upward trend. Clasts are up to 5 cm long, well

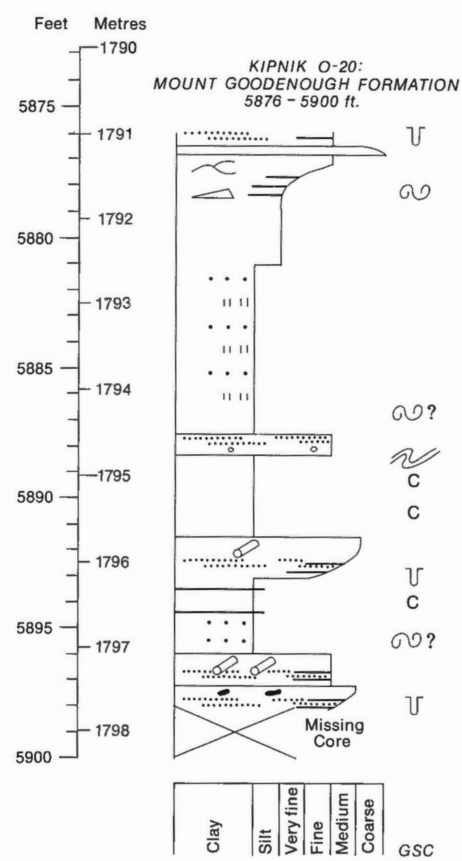


FIGURE 20. *Graphic display of core, Kipnik O-20, Mount Goodenough Formation (see Fig. 11 for explanation of symbols).*

rounded, slightly elongate and consist of quartzite, sandstone, black indurated shale, chert and at least one clast of silicified oolites. Most beds are matrix supported conglomerates, the clasts being embedded in clay to granule size particles. The overlying bioturbated sandstone has scattered pebbles in the lowest 30-50 cm, and in the same interval there are traces of original bedding seen as streaks and lenses of sand. In the conglomerate, the clast types clearly are not derived from the underlying beds, nor are they typical of other older Cretaceous and Jurassic rocks, but are more characteristic of Paleozoic and ?Proterozoic rocks of this area. The thin-bedded nature of the conglomerate and the matrix supported character point to an origin as density flows, a rather unusual origin for a basal conglomerate overlying an unconformity. The proximity of the Pikiolik E-54 well to the Eskimo Lakes Arch and the known occurrence of Paleozoic and older rocks in the Arch would favour an origin from the Arch.

Other core material from the Mount Goodenough Formation (see Appendix) is predominantly mudstone or shale. Bioturbation is the most common sedimentary feature, with ripple-, undulose- or horizontal-laminations also occurring quite commonly. Laminated units are usually silts or very fine sands. Log character and cuttings samples indicate the prevalence of mudstone and shale in most of the Mount Goodenough succession and the above general core description is considered typical for much of the uncored parts of the section.

No core has been cut in the Rat River Formation, consequently detailed sedimentological interpretations are not possible from the subsurface data. The gradational contact with underlying marine Mount Goodenough mudstone beds, presence of glauconite and marine fossils in the nearby outcrop (Jeletzky, 1960) point to marine conditions during Rat River deposition. An inner shelf to nearshore setting is probable, evident from the sandstone-rich character of the formation.

The better core control in the Atkinson Point Formation allows for a more rigorous sedimentological analysis. Details of the various facies types can be found in Dixon (1979) and will not be repeated here. Dixon (*op. cit.*) recognized an areally limited succession of conglomerate-sandstone cycles as fan-delta deposits, laterally replaced to the southeast by, and overlain by, marine sandstone. Farther basinward, the marine sandstone grades laterally into a more silty and shaly succession (Figs. 4, 5). Although the definition and distribution of the Atkinson Point Formation was modified slightly (Dixon, in prep.) no changes in the sedimentological model were necessary.

Age

Jeletzky (1958, 1960, 1961a) dated the Mount Goodenough Formation as Late Hauterivian to Barremian, possibly as young as Aptian, and the Rat River Formation as Aptian and possibly as old as Late Barremian. The transitional boundary between the Mount Goodenough and Rat River Formations and their lateral equivalence in parts of the Kugmallit Trough would favour a strongly diachronous boundary. The age of the uppermost Mount Goodenough beds within the Kugmallit Trough must be as young as Aptian due to their being laterally equivalent to all of the Rat River Formation. Data from the subsurface (Chamney, in Brideaux et al., 1975; Brideaux and Myhr, 1976) is in general agreement with the ages suggested by Jeletzky (*op. cit.*). Chamney (1973, and in Barnes et al., 1974) dated the upper marine beds of the Atkinson Point Formation as Aptian, and possibly Early Albian. The abrupt contact of the Albian Arctic Red Formation with the underlying rocks and the known age range of the Arctic Red rocks (see next section) indicate that the uppermost strata of the Rat River, Mount Goodenough and Atkinson Point Formations are likely to be mostly Aptian in age. The oldest strata of the Atkinson Point Formation are not well dated due to a lack of biostratigraphic control. However, physical correlation of the Atkinson Point Formation with the Rat River and uppermost Mount Goodenough Formations (see Figs. 4, 5) would favour a Late Barremian age for the oldest beds, possibly slightly older for those beds below the hiatal surface identified in Kimik D-29 (Figs. 4, 5).

Arctic Red Formation

Young et al. (1976) extended Mountjoy and Chamney's (1969) Arctic Red Formation of the southern Richardson Mountains to include rocks of the Albian Shale-siltstone Division (Jeletzky, 1960) exposed in the northern Richardson Mountains and also present in the subsurface. Where bentonite beds are present in equivalent strata, such as in the northern Tuktoyaktuk Peninsula, Young et al. (1976) preferred to correlate with the Horton River Formation (Yorath et al., 1975) of the Anderson Plains east of the Mackenzie Delta. However, as only one prominent bentonite bed has been identified from these strata in the subsurface of the Mackenzie Delta and Tuktoyaktuk Peninsula (Myhr, 1975) I will refer to all these Albian rocks as Arctic Red Formation.

The Arctic Red Formation rests abruptly on older strata (Figs. 3-5), and overlaps Aptian beds to rest directly on Paleozoic and Proterozoic strata on the Eskimo Lakes Arch. Equivalent strata in parts of the northern Richardson Mountains have been shown to rest unconformably on older rocks (Jeletzky, 1958, 1960, 1975; Young et al., 1976). Overlying the Arctic Red Formation, erosionally and unconformably, is the Upper Cretaceous Boundary Creek/Smoking Hills Formation. Late Albian or Early Cenomanian erosion has severely modified the thickness and distribution of the Arctic Red Formation. Thickest sections are preserved in the Kugmallit Trough where the thickest known section is 598.9 m (Reindeer G-04). Towards and over the Eskimo Lakes Arch, thicknesses decrease rapidly and in places Arctic Red strata have been completely eroded so that the Boundary Creek Formation rests directly on Paleozoic strata (e.g. Kiligvak I-29). Likewise in the Kugpik area, Arctic Red rocks have been eroded (Fig. 3).

In the subsurface, the Arctic Red Formation is predominantly dark grey shale with subordinate mudstone, siltstone and minor sandstone. The lithological character remains fairly constant throughout its known distribution. Carbonate concretionary beds are locally very abundant, especially over the northern parts of the Eskimo Lakes Arch (Figs. 4, 5). Fish scales and shell fragments of **Inoceramus** are commonly found in the cuttings samples. Where the Arctic Red Formation rests directly on Paleozoic or Proterozoic rocks local sandy beds may develop at the base, for example, at Nuvorak O-09 (Fig. 5) and Amaguk H-16. The Nuvorak O-09 sandstone is about 8.5 m thick, medium grained and relatively 'clean'. At Amaguk H-16 there is about 31.7 m of interbedded mudstone, siltstone and argillaceous fine grained sandstone. Core from the Amaguk well (depths 944.3-947.3 m; 3098-3108 ft) consists of thick, unbedded units of very argillaceous, very fine grained sandstone grading upwards into sandy mudstone. Sandy beds below Arctic Red shales in Kapik J-29 (Fig. 5) and Russell H-23 have been identified as Atkinson Point rocks but it is possible they are basal sandy beds of the Arctic Red Formation. If the bentonitic bed ('F' marker of Myhr, 1975) in the Arctic Red Formation in these two wells is correlative with a similar bentonitic bed in the Amorak N-44, Kanguk F-42 and I-24 wells (Fig. 5) then the stratigraphic level of the sandstone beds in J-29 and H-23 is more consistent with an Arctic Red equivalence.

Other core material from the Arctic Red Formation is scarce and is available from the Reindeer G-04, Tuk F-18 and Natagnak K-23 wells (Appendix 2). Dark grey to black fissile shale containing a few bivalve shells is present in the G-04 and K-23 cores. A similar lithology is present in the F-18 core but also present are fine to coarse laminae of silt and very fine grained sand, locally developed as lenticular beds. The lithology and sedimentary structures in these cores are probably typical for most of the Arctic Red Formation. Very little variation in overall lithology is seen in the cuttings samples. On the northern Tuktoyaktuk Peninsula there is at least one prominent radioactive shale (Fig. 5, marker 'F' of Myhr, 1975) which is probably bentonitic (Myhr, 1975).

Sedimentology

The predominance of shale and the presence of marine fossils in the formation all point to a marine, calm water, depositional setting. Shale facies of the Arctic Red and Horton River Formations extend as far south as Norman Wells (Yorath and Cook, 1981) and eastwards into the Horton-Anderson Plains (Yorath et al., 1975). The wide extent of these beds would indicate a broad shelf depositional realm, and the Mackenzie Delta area was probably located in a mid to outer shelf position. West of the Mackenzie Delta, in the Rapid Depression (also known as the Blow Trough), turbidites are present (Young, 1973a; Young et al., 1976) and these were probably deposited on an epicontinental slope and basin, further suggesting that the Mackenzie Delta area was in an outer epicontinental shelf position during the Albian.

Age

Mountjoy and Chamney (1969) dated the Arctic Red Formation from the Snake and Peel River areas as Early to Late Albian. Jeletzky (1960) dated the equivalent Albian Shale-siltstone Division as Early to Middle Albian. The erosive upper contact could account for the absence of Late Albian strata in the northern Richardson Mountains. Ages for the Arctic Red Formation obtained from subsurface data agree with the Albian age (Chamney in Brideaux et al., 1975; Brideaux in Barnes et al., 1974; Myhr, 1975, Fig. 3). The equivalent Horton River Formation contains late Early to early Middle Albian ammonites in its middle and upper parts, Middle Albian foraminifera from its upper part and Middle Albian palynomorphs, apparently throughout the entire section (Yorath et al., 1975, p. 17; Brideaux and McIntyre, 1975).

GEOLOGICAL HISTORY AND PALEOGEOGRAPHY

To discuss geological history and paleogeography it is necessary to present it within a time framework and this can be done by either arbitrarily choosing two points in time and discussing the rocks deposited during the chosen time interval, or choosing real basinwide events as points of reference. The latter approach is used herein and is essentially the concept of depositional-episodes advocated by Frazier (1974).

In the Quaternary deposits of the Gulf Coast (U.S.A.), Frazier (*op. cit.*) identified discrete genetically related depositional units (depositional-complexes) bounded by hiatal surfaces. Each of the basin-wide depositional-complexes is a composite of local depositional units, facies-sequences of Frazier (*op. cit.*, p. 4). A depositional-complex forms during a depositional-episode and a facies-sequence during a depositional-event. The hiatal surfaces bounding a depositional-complex are basin-wide and, "are related to hiatal conditions imposed by marine transgressions" (Frazier, 1974, p. 1). A transgression marks the final phase of a depositional-episode and transgressive deposits may overlie an erosional unconformity. Figure 21 summarizes some of the features of depositional-episodes.

Frazier (*op. cit.*) attributed the origin of the Gulf Coast Quaternary depositional-episodes to glacio-eustatic fluctuations of sea-level. As these sea-level changes were worldwide, the associated depositional-complexes must also be recognizable on a worldwide scale with some modifications depending upon basin type (Frazier, *op cit.*, p. 26). Implicit in Frazier's work is that depositional-episodes should be identifiable in older sedimentary basins. Whether or not he intended to indicate worldwide synchroneity of older depositional-episodes is not clear.

Vail and co-workers (in Payton, 1977) have strongly advocated the concept of worldwide stratigraphic units, which they term sequences. Sequences are bounded by unconformities and correlative conformities and were identified by the stratigraphic interpretation of reflection seismic profiles, with the seismic data correlated to well information, wherever possible. Vail and co-workers attribute the origin of sequences to worldwide relative changes in sea-level.

Both methods of basin analysis have merit, and offer a realistic approach to subdividing the stratigraphic column into significant, genetic units, unlike the conventional lithostratigraphic approach of subdividing into formations. The two concepts were applied to the Jurassic-Lower Cretaceous strata of the Mackenzie Delta. Both were successful, but overall I felt that Frazier's (1974) concept was more realistic and offered a greater degree of prediction, and consequently a greater aid in resolving correlation problems. Within the Jurassic-Lower Cretaceous succession, at least nine depositional-episodes have been recognized (Figs. 3, 4, 5, Table 2). Formation and member boundaries are not necessarily related to the hiatal-surfaces bounding depositional-complexes, although in many cases they do coincide. A depositional-complex may contain part of only one, or more than one, conventional formations. In Figures 3 to 5 the hiatal surfaces are identified and labelled with the letter H. The contact between Mesozoic and Paleozoic strata is a hiatal surface, and also an unconformity in many cases, that forms a lower boundary to several depositional-episodes. Hiatal surfaces are identified at the base of distinct low velocity shale zones, or high velocity concretion-rich shaly beds. Commonly the hiatal surfaces rest on a transgressive facies that may show up as a fining-upward unit, reflected both lithologically and on geophysical/electric logs. The post-unconformity part of the depositional-complex may be thick, such as in depositional-episode 7 (Siku to lower Mount Goodenough Formations) or so thin that it cannot be distinguished using the subsurface data. In extreme cases the hiatal surface and the plane of unconformity may coincide; this happens when sediment supply is either very local or low to non-existent during a major transgression and basin expansion (e.g. base of Husky Formation, in contact with Paleozoic rocks).

Thickness trends of the depositional-complexes are strongly influenced by the various tectonic elements. This is especially true for the Eskimo Lakes Arch, and to a lesser degree for the Cache Creek Uplift and Tununuk High. There is rapid thinning towards and over these positive elements,

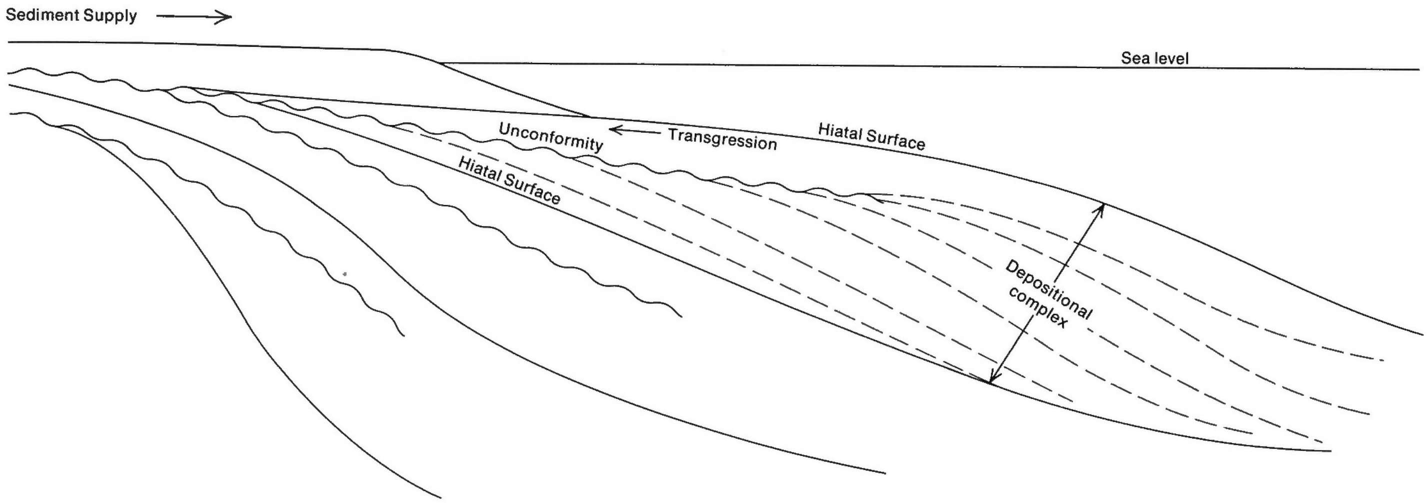


FIGURE 21. *Diagram illustrating Frazier's (1974) concept of depositional-complexes.*

attributable to both depositional and erosional thinning. Growth faulting along the Tuktoyuktak Fault Flexure Zone has occurred during many of the depositional-episodes, consequently the Arch has been a significant local source of clastic sediment. Many of the unconformities identified in the Jurassic-Lower Cretaceous section merge towards the positive tectonic elements, such that only a single unconformity appears to be present, but really results from several erosional episodes. This feature is typical of a structural element that has undergone repeated uplift and erosion, such as the Eskimo Lakes Arch.

In the following presentation, depositional-episodes 1 to 3 (Bug Creek Group) are discussed together because they have a common basinal setting and similar sedimentological characteristics. The succeeding depositional-episodes are discussed separately, each having a distinct depositional character. Depositional-episodes 4 to 8 occupied an areally similar depositional basin, whereas the basin expanded considerably during depositional-episode 9.

Depositional-episodes 1 to 3

Depositional-episodes 1 to 3 are represented by the Bug Creek Group: number 1 consists of the Murray Ridge and Almstrom Creek Formations; number 2 the Manuel Creek and the lowermost beds of the Richardson Mountains Formations and number 3 the upper Richardson Mountains beds and the Aklavik Formation. An earlier Jurassic depositional-episode may be represented by Hettangian sandstone present in the Bonnet Lake area (Jeletzky, 1971; Frebold and Poulton, 1977; Poulton, in press) about 100 km to the west of the Delta, but not represented in the eastern areas of the Bug Creek occurrence. It seems apparent that after deposition of the Hettangian sandstone the basin-margin extended to the southeast and east very rapidly, during either Late Hettangian or Early Sinemurian time. The best available age dates for the Mackenzie Delta depositional-episodes are: (a) depositional-episode 1, Early Sinemurian to Pliensbachian, possibly as young as Toarcian, (b) depositional-episode 2, Toarcian to probably Bathonian, and (c) depositional-episode 3, Bathonian to Early Oxfordian.

Each of the Sinemurian to Oxfordian depositional-complexes occupied a similar basin configuration. The eastern basin margin in the subsurface appears to be controlled by the Napoiak High, and southwestern end of the Eskimo Lakes Arch, east of which no Bug Creek strata are present. Due to the absence of Bug Creek rocks in the Kugpik O-13 well the zero trend swings approximately east-west. Several explanations for this trend change are possible: (1) it is a depositional edge related to the faulted margin of the Tununuk High; (2) Bug Creek strata were deposited over the Kugpik area but have since been removed. If this was the case, erosion must have taken place before deposition of the Husky Formation; and (3) the Kugpik area has been moved laterally from the east along a left-lateral strike slip fault for about 35 km. Such a fault could exist as a splay fault between the Kaltag-Rapid Fault Array (Young et al., 1976, Fig. 5) to the west and the subsurface extension of the Donna River Fault (Jeletzky, 1960, Fig. 2) on the eastern margin of the Tununuk High, two major fault systems which appear to show strike slip movement. The present eastern zero-edge trend apparently was not too far removed from the depositional limits, as is apparent from the internal stratigraphy and sedimentological interpretations. Poulton et al. (in press) and Poulton (in prep.) expressed similar views concerning depositional limits.

Each of the depositional-complexes show a northwesterly shale-out trend (Poulton, 1978, in press; Poulton et al., in press) consistent with a southeasterly to easterly source area. Nonmarine strata were identified by Jeletzky (1975) and Young et al. (1976) but the same strata were mapped as younger units by Norris (1975). An indicator of proximity to the shoreline is the abundance of carbonaceous debris, and especially carbonized log fragments in the Aklavik Formation. Each of the three depositional-complexes is characterized by marine, shelf sediments oscillating between fine and coarse clastic deposition as a result of variable sediment supply, several erosional episodes and transgressive and regressive phases. The successions representing each of the three depositional-episodes characteristically have a shale-rich basal section gradationally succeeded by siltier and sandier beds, and usually identifiable as a single cycle or series of coarsening-upward cycles. An erosional unconformity probably occurs in the upper part of each depositional-episode, although it has not always been identified from the available data. Transgressive beds overlie the unconformities and usually consist of a clean sandstone that may fine upward. The transgressive beds are abruptly overlain by shale of the next depositional-episode, the contact between the two being a hiatal-surface.

Uplift and erosion can be documented in depositional-episodes 2 and 3, but is not identifiable from the rocks of depositional-episode 1. The unconformity in depositional-episode 2 corresponds to that identified by Jeletzky (1967) and which Poulton and Callomon (1976) recognized as separating Middle Bajocian from older strata. The younger unconformity within the Aklavik Formation can be dated as probably occurring some time in the Oxfordian.

For a fuller and more regional account of the Bug Creek Group the reader is referred to the work of Jeletzky (1967, 1975), Poulton et al. (in press) and Poulton (in prep.). These authors do not use the approach adopted in my report, in fact Jeletzky (1977) is an opponent of worldwide eustatic cycles. They also advance two very different paleogeographic interpretations. Thus Jeletzky (1975) cites evidence for both a western and an eastern source area, separated by a marine trough, whereas Young et al. (1976); Poulton et al. (in press); and Poulton (in prep.) reject the western source and the intervening trough. The subsurface data are too removed geographically to resolve these contrasting two viewpoints.

Depositional-episode 4

Depositional-episode 4 occurred during the Late Oxfordian/Early Kimmeridgian to Tithonian, and possibly earliest Berriasian, and rocks of the lower member of the Husky Formation were deposited. The basin margins during depositional-episode 4 extended dramatically, as compared to those of the preceding basin limits. Husky rocks are present in the Kugmallit Trough and adjacent to the Eskimo Lakes Arch. In nearby areas equivalent rocks were deposited in the Anderson Plains (Yorath et al., 1975; Brideaux and Fisher, 1976) and Banks Island (Miall, 1975). Remnants of lower Husky strata on the Eskimo Lake Arch (e.g. Aklavik F-17, East Reindeer P-60 and C-38) indicate that the depositional limits were slightly further to the south and southeast. However, depositional thinning towards the Eskimo Lakes Arch is evident, and it must have been a relatively positive area during depositional-episode 4. Likewise, the Tununuk High was mildly positive, but there is no evidence to suggest it was a source area.

In the subsurface of the Mackenzie Delta area the rocks of the lower member, Husky Formation, are predominantly marine shale, with several thin coarsening-upward cycles. The source area for these clastics rocks was probably from the Vittrekwa River area, to the south-southwest of the Delta, where Jeletzky (1975, Fig. 10; 1980, Figs. 6, 7; also Young et al., 1976) described a sandstone-conglomerate succession of equivalent age (North Branch Formation). Jeletzky (*op. cit.*) considered the North Branch rocks to be mostly nonmarine. However, he identified marine fossils from the lowermost beds, and his descriptions of the succession are insufficient to make conclusive sedimentological conclusions. Regardless of their depositional setting, it is obvious that the North Branch rocks reflect their proximity to a sediment-input area. Northeastward longshore and shelf-ward transport of sediment from the Vittrekwa area could have supplied the clastic material deposited in the Mackenzie Delta area. Periodic influxes of coarse sediment would account for the coarsening-upward cycles and density current flow from the Vittrekwa source area could have deposited the pebble beds seen in the lower Husky Formation.

Jeletzky (1975, Fig. 10; 1980, Figs. 6, 7) also identified the age equivalent, sandstone-dominant Porcupine Formation a few tens of kilometres west of the Vittrekwa area. However, he considered this sandstone succession to be derived from a western source area (Old Crow Landmass), whereas Young et al. (1976) concluded that a southerly source area was more likely. Jeletzky (1980) also had a local "White Island" source area within the depositional basin, north of the Vittrekwa area.

Other evidence for proximity to a strandline is available in the Horton River G-02 well, northeast of the Mackenzie Delta, in the Anderson Plains. Brideaux and Fisher (1976, p. 8-9) identified Late Oxfordian to Middle or Late Kimmeridgian microfossils in what was identified as part of the Gilmore Lake Member, Langton Bay Formation (Yorath et al., 1975). A re-evaluation of the Jurassic-Cretaceous stratigraphy in the Horton River G-02 well in light of Brideaux and Fisher's paleontological data is necessary. These authors recognized that the Upper Jurassic strata were immediately overlain by strata containing Aptian to Early Albian microfossils, clearly pointing to the presence of a major hiatus within the succession. Strata between depths 466-544.7 m (1530-1820 ft) are coeval with, and, in part, lithologically similar to, the lower member, Husky Formation. The immediately overlying rocks are equivalent in age to the Atkinson Point, Rat River and uppermost Mount Goodenough Formations. The unconformity separating the two successions corresponds to that noted at the base of the Atkinson Point and Mount Goodenough Formations. The post-unconformity succession apparently oversteps the Husky-equivalent strata in a southerly direction and in the Anderson Plains outcrop, rests directly on Paleozoic rocks (see descriptions of Yorath et al., 1976; Plauchut and Jutard, 1976).

The Husky-equivalent strata have a basal, 24 m thick sandstone that grades up into a more shaly section, in which there are numerous thin sandstone interbeds. A coal bed may be present at 490.7 m (1610 ft). This succession contrasts with the shale-dominant basal beds in the Mackenzie Delta area. The sandy aspect of the strata in the G-02 well, and the possible coal bed, are interpreted to reflect proximity to a strandline, although these beds are still mostly marine, containing bivalve fragments, foraminifera and dinoflagellates.

Using the Vittrekwa and Horton River G-02 data as indicative of strandline and/or source area proximity, it can be concluded that the depositional edge had a northeast-southwest regional trend between the two areas. This would indicate that in the Mackenzie Delta area the depositional edge was not too far to the south of the present preservational edge.

Within the northern Richardson Mountains and Mackenzie Delta areas, two depocentres were present during depositional-episode 4 (Fig. 9 also reflects the trends seen in the lower member, Husky Formation), in the Kugmallit Trough and Canoe Depression. The Napoiak Uplift, a relative positive, separated the two depocentres.

The final phase of depositional-episode 4 is marked by a basin-wide regressive unit (the arenaceous member of Jeletzky, 1967) which is believed to be capped by a thin transgressive sandstone (see previous section dealing with the Husky Formation). According to the depositional-episode hypothesis there should be an unconformity within these arenaceous beds, but there is insufficient evidence to pinpoint its position. Jeletzky (1967) noted that there was a possible hiatus in the Tithonian beds, which I consider a correct interpretation. Also the uppermost beds, which would be part of the final transgressive phase, may be as young as earliest Berriasian. The transgressive phase is represented by the glauconite-rich upper few metres of the lower member. In a basinward position the transgression would tend to result in a curtailment or reduction in sediment supply favouring marine reworking of underlying beds and deposition of glauconitic material.

Depositional-episode 5

The upper member, Husky Formation and Martin Creek Formation, of Berriasian to Early Valanginian age represent depositional-episode 5. Isopach and facies trends of depositional-episode 5 show no major change in basin configuration from that during depositional-episode 4. The Canoe Depression and Kugmallit Trough continued to be depocentres and the Tununuk High and Eskimo Lakes Arch were positive regions, the latter forming the southeastern basin margin.

Depositional-episode 5 is characterized by a thick, widespread coarsening-upward cycle, representing a prograding, basin-filling, offshore to barrier island succession. The younger part of the episode contains the coarse clastic barrier sediments and extends from Pikiolik E-54 (its known northernmost occurrence) into the Aklavik Range and possibly even further southwest. The similarity of facies throughout its occurrence and the isopach trends indicate a continuous barrier island setting, with few tidal inlets and/or river channels.

The upper beds of the North Branch Formation (Glauconitic sandstone member, Jeletzky, 1967, 1974, p. 6) from the Vittrekwa River area are equivalent to the lower beds of the upper member, Husky Formation (**Buchia okensis** zone of Jeletzky, 1967). The occurrence of **B. okensis** and the abundance of glauconite indicate a marine origin for the Glauconitic sandstone member. Jeletzky (1974, p. 6) stated that the Glauconitic sandstone member of the North Branch Formation probably was equivalent to the Martin Creek Formation, but the presence of **B. okensis** would suggest an equivalent with the upper member, Husky Formation. Therefore, the Glauconitic sandstone member is an arenaceous facies of laterally equivalent shales and probably reflects proximity to a sediment-input area (similar to that of depositional-episode 4). Nowhere in the subsurface, or in the immediately adjacent outcrop, can nonmarine rocks be conclusively identified in depositional-episode 5. Most of the Upper Berriasian nonmarine and marine rocks identified by Jeletzky (1975, Fig. 11) between Treeless Creek and Vittrekwa River were later reassigned to other formations (Jeletzky, 1980). Martin Creek strata were found to be absent due to either pre-McGuire and/or pre-Mount Goodenough erosion. The southernmost outcrop of nonmarine strata in Jeletzky's figure (1975, Fig. 11) are presumably North Branch rocks (Jeletzky, 1960, 1974) but he places them 25 km west of the locality from which they were originally described (Jeletzky, 1960, 1974). These North Branch rocks have not been demonstrated to include strata as young as Late Berriasian. The nonmarine rocks on the north flank of the Rat Uplift (Jeletzky, 1975, Fig. 11) were identified in a section by Treeless Creek (Jeletzky, 1960, p. 6 and map; 1967, p 14). However, an alternative explanation of Jeletzky's stratigraphy is possible. The rocks Jeletzky (1960, 1967) assigned to the Lower Sandstone Division (i.e. Martin Creek Formation) are unusually thin and lithologically atypical when compared to nearby Martin Creek strata. Also, in the Treeless Creek section the thin, so-called Martin Creek equivalent, separates Husky from Mount Goodenough strata. This close vertical juxtaposition of the two latter formations would favour an interpretation of a truncated section below the Mount Goodenough Formation. Such an interpretation is consistent with the known occurrence of a major regional unconformity at the base of the Mount Goodenough Formation. The sandstone between the Mount Goodenough and Husky Formations would most likely be the basal unit of the Mount Goodenough succession. Jeletzky (1960, p. 6) originally suggested that the thin section of Treeless Creek may have been due to a "mid-Lower Cretaceous transgression", but in subsequent work he preferred to interpret the succession as due to facies change and thinning on the Rat Uplift. Other evidence in support of the reinterpretation is the presence of a 'normal' Martin Creek succession a few kilometres upstream from Jeletzky's section (pers. obs., 1978; Norris, 1977). About 100 m of Martin Creek rocks cap a 1250 m high, north-trending ridge from about 67°52'N, and along longitude 135°45'W. Jeletzky (1960, Fig. 2, map unit 16) mapped these rocks as Jurassic strata, implying a Bug Creek equivalence. It is structurally impossible for these ridge-forming sandstones to underlie the Husky Formation as implied by Jeletzky's mapping. Bug Creek rocks occur on the western slope of the ridge, separated from the Martin Creek Formation by a slightly recessive interval of Husky shales. South of 67°52'N, Jeletzky's map unit 1b is correctly identified as Jurassic strata and Martin Creek rocks have been truncated under the Mount Goodenough Formation. Also, with the reinterpretation of Jeletzky's (1960, 1967) Treeless Creek section the Rat Uplift need not necessarily have been a strong positive element during Berriasian deposition as was interpreted by Jeletzky (1975).

During the Late Berriasian or earliest Valanginian there was uplift of the basin margins and erosion supplied clastic material for the late phases of sedimentation in depositional-episode 5. In the Early Valanginian there was a transgression, terminating depositional-episode 5.

Depositional-episode 6

Depositional-episode 6 is represented by the McGuire and Kamik Formations, and occurred during the Early Valanginian to Middle Hauterivian. The depositional basin was similar in extent to that during depositional-episodes 4 and 5 and the two major depocentres continued through into depositional-episode 6. Equivalent rocks are not known from the Anderson Plains, possibly because they were eroded. Thinning trends were also similar and once again there is no conclusive evidence to indicate major thinning towards and over the Cache Creek Uplift (see section on Kamik Formation for a more thorough discussion of the arguments). Regional facies and isopach trends indicate the main source area was to the south and southeast, and the depositional edge was probably not too far removed from the present preservational edge (see Fig. 12). Major thickening occurs immediately basinward of the Tuktoyaktuk Fault Flexure Zone. Thinning of units over the Parsons Lake gas field structure is evidence for syndepositional movement, probably related to movement along the adjacent Tuktoyaktuk Fault Flexure Zone. These features suggest that there was growth faulting along the margins of the Eskimo Lakes Arch, and that the Arch was a major supply area of clastic sediments. The thick accumulation of coarse sediments during depositional-episode 6 would suggest that these fault movements were long-lived and of significant magnitude.

The initial marine sedimentation (McGuire Formation) was short-lived and rapidly succeeded by a phase of alluvial deposition. A period of major fault movement and uplift of the Eskimo Lakes Arch is believed to have initiated this change in depositional patterns. Following alluvial deposition there was an extended period when sedimentation oscillated between the offshore marine and the strandline. These alternations may have been caused by a decline in the magnitude and frequency of fault movements, resulting in reduced and more intermittent sediment supply. Basin-subsidence and downfaulting would also contribute to the cyclicity seen in the upper part of depositional-episode 6. The wide extent of these vertical changes in the succession along depositional strike, and also seen across strike, suggests an approximate synchroneity of the successive changes.

There does not appear to have been any single point source for the older clastics, rather a broad alluvial plain developed adjacent to the southern source area from which numerous, sediment-laden rivers must have flowed. However, in the younger marine phase of deposition, there may have been either a point source, or small rivers from the hinterland fed the system, which were unable to create deltas or alluvial plains. Myhr and Young (1975, Fig. 42.14) and Jeletzky (1974, 1975) considered that a major sediment input area existed in the McDougall Pass area during Early to Middle Hauterivian time. However, these authors based their interpretations on data that Jeletzky (1980) reinterpreted to show that Lower and Middle Hauterivian strata were absent in the McDougall Pass area. At present, there is insufficient data to locate a distinct point source, and a more diffuse source is considered more probable.

Depositional-episode 7

The Siku Formation and lower third to one half of the Mount Goodenough Formation, of Middle Hauterivian to Early Barremian age were deposited during depositional-episode 7. On the Eskimo Lakes Arch only a thin sandstone is preserved as part of the depositional-complex (e.g. Pikiolik E-54 to Kimik O-29, and Rat Pass A-35 to Aklavik F-17; Figs. 3, 4). During depositional-episode 7 there was a major period of uplift in the latest Middle, or earliest Late Hauterivian, resulting in a regionally extensive unconformity. The Eskimo Lakes Arch, Cache Creek Uplift and the Tununuk High were uplifted and parts were subaerially eroded.

Middle Hauterivian deposition is represented by the marine shales of the Siku Formation, which are preserved only in the central areas of the Kugmallit Trough, having been eroded elsewhere during the Middle/Late Hauterivian uplift. Consequently it cannot be shown where the basin margins were at this time.

Facies trends for the post-unconformity succession clearly show a sandstone-dominant section on the southern margin of the Tununuk High grading southwards into a shale-dominant section in the depocentre (Fig. 22). Sandstone is a minor component on the southeastern margin of the Canoe Depression, near the Napoiak High (Napoiak F-11, Aklavik F-38). The paleogeographic conclusions of Jeletzky (1975, Fig. 14, 1980, Fig. 9) that deal with the lower member, Mount Goodenough Formation (i.e. Upper Shale-siltstone Division - roughly equivalent to the post-unconformity part of depositional-episode 7) show a major source of coarse clastics from the Stony Creek area, to the southwest of the Mackenzie Delta, which he called the Barrier River-Stony Creek deltaic lobe. These coarse clastics grade northwestward into finer clastics in the Canoe Depression. The trends suggest that the Kugmallit Trough filled from both the north and southwest and the Canoe depression from the south. In the preceding depositional-episodes the source areas were always to the south and southeast and a northerly source has not been documented (possibly because of a lack of data). Also, for the first time it is possible to show a northeasterly thinning of strata in the Kugmallit Trough (see Fig. 19 which has similar isopach trends to depositional-complex 7).

An unusual aspect of this depositional-episode is that in the Pikiolik to Kimik area of the Tuktoyaktuk Peninsula only a thin sandstone is representative of the post-unconformity part of this depositional-episode. Also, the sedimentological interpretation of this sandstone in the Pikiolik E-54 well (see section re: Mount Goodenough Formation) is that it is a density flow deposit, immediately adjacent to the Arch. If the Pikiolik sandstone is typical of others in the area then it would appear that the northeastern end of the Arch may not have contributed much sediment to the depositional basin. In fact it is postulated that this end of the Arch was a submarine high, possibly covered by a shallow water column, and the basal sandstone was derived by submarine erosion off the slope. Another indication for this interpretation is the lack of coarse clastic material in the Parsons Lake to Napartok M-01 area, an area very close to the Eskimo Lakes Arch.

As sediment supply declined a transgression developed and finer sediments became more prevalent, and finally depositional-episode 7 was terminated.

Depositional-episode 8

Depositional-episode 8 consists of the upper Mount Goodenough Formation, and the Rat River and Atkinson Point Formations. An ?Early, or possibly Late Barremian to Aptian age is indicated. Basin configuration and facies trends were similar to those of depositional-episode 7 although in the central Tuktoyaktuk Peninsula some unique facies developed.

Progressive uplift of the Eskimo Lakes Arch and Tununuk High created local source areas during Late Barremian and earliest Aptian time and local sandstone facies developed adjacent to these regional structures. The older sediments are shale-dominant and represent the early basin fill. As uplift proceeded and sediment supply increased, sandier facies (Rat River Formation) were developed adjacent to the Tununuk High and, in the southwest, adjacent to the Rat Uplift (Jeletzky, 1975; Young et al., 1976). In the intervening areas of the Canoe Depression and Kugmallit Trough, laterally equivalent strata are more shaly and silty, only sandy in the uppermost few metres of the succession. In the central Tuktoyaktuk Peninsula a local conglomerate-sandstone facies developed in the Atkinson Point Formation. These rocks rest on Paleozoic and ?Proterozoic strata and are interpreted to be coastal fan-delta deposits (Dixon, 1979) developed adjacent to a possible fault-scarp on the Eskimo Lakes Arch. Laterally, the fan-delta deposits are replaced by marine sandstone, in turn grading into a shale-siltstone section. The preserved zero edge of the Atkinson Point Formation is considered to be also the true depositional edge and the sedimentological interpretations allow a local paleostrandline to be located (Dixon, 1979, Fig. 11). In the Aklavik to Parsons Lake area, on the southern margin of the Kugmallit Trough and adjacent to the Eskimo Lakes Arch, equivalent rocks are shale-dominant (Fig. 23).

To the east of the study area, in the Anderson Plains, equivalent rocks are the upper beds of the Gilmore Lake Member, Langton Bay Formation (Yorath et al., 1975; Plauchut and Jutard, 1976). These beds have been interpreted as fluvial in origin, grading laterally into marine beds to the north. South and southwest of the study area, the Rat River Formation is predominantly marine (Jeletzky, 1975, Fig. 15) although Young et al. (1976, Fig. 10) identified nonmarine clastics in the Vittrekwa Embayment.

A major sediment input area was the Vittrekwa Embayment (Young et al., 1976) whereas parts of the Eskimo Lakes Arch were local source areas. Facies trends (Fig. 23) also indicate that there was a local source area to the north.

The final phase of sedimentation in depositional-episode 8 was a marine transgression. This is readily seen in the Atkinson area where the fan-delta deposits are overlain and overstepped by marine beds (Dixon, 1979) of the uppermost Atkinson Point Formation.

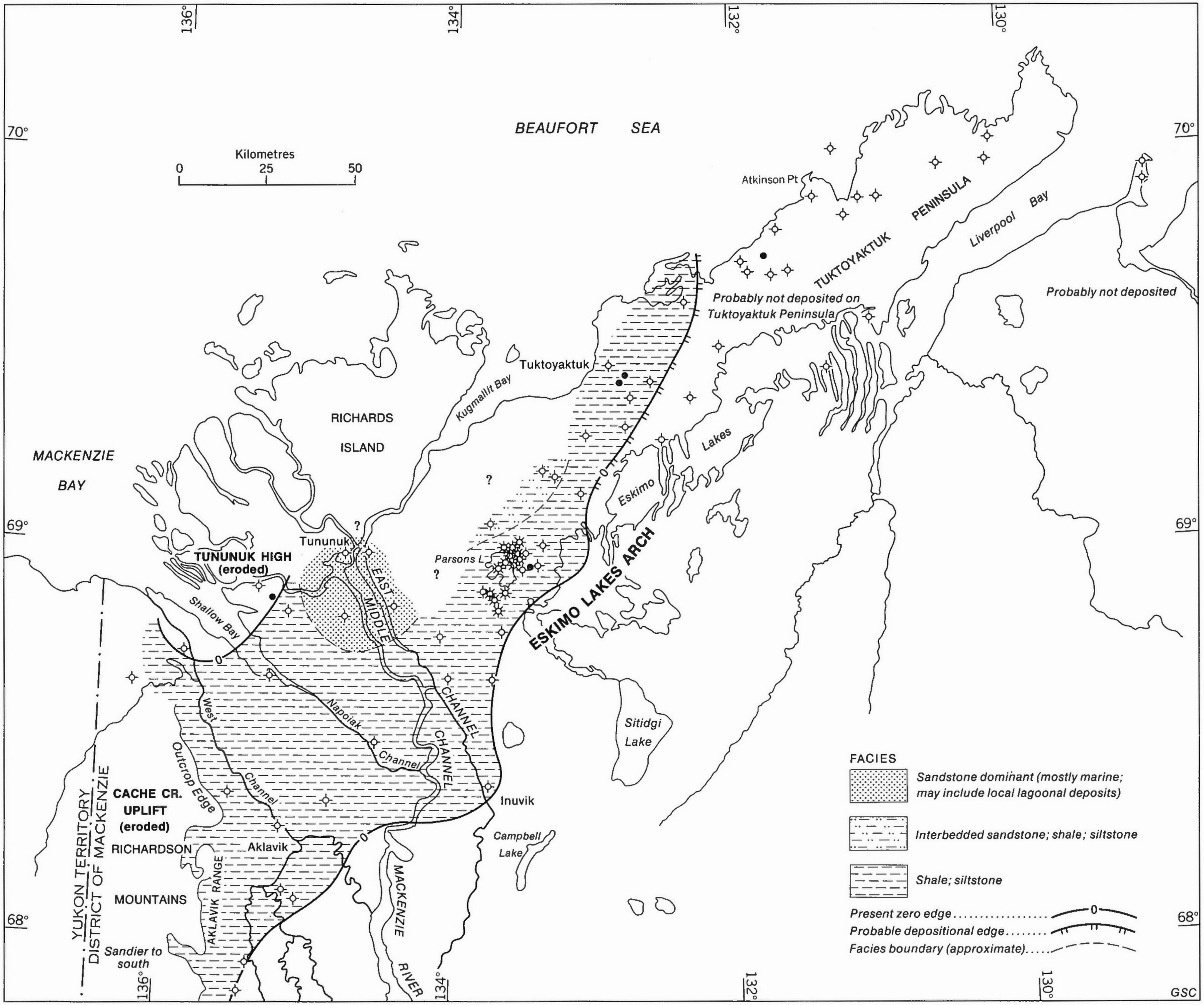


FIGURE 22. *Facies map of the post-unconformity part of depositional-complex 7 (includes data from Jeletzky, 1980, Fig. 9): approximately Upper Hauterivian. Lower Mount Goodenough Formation.*

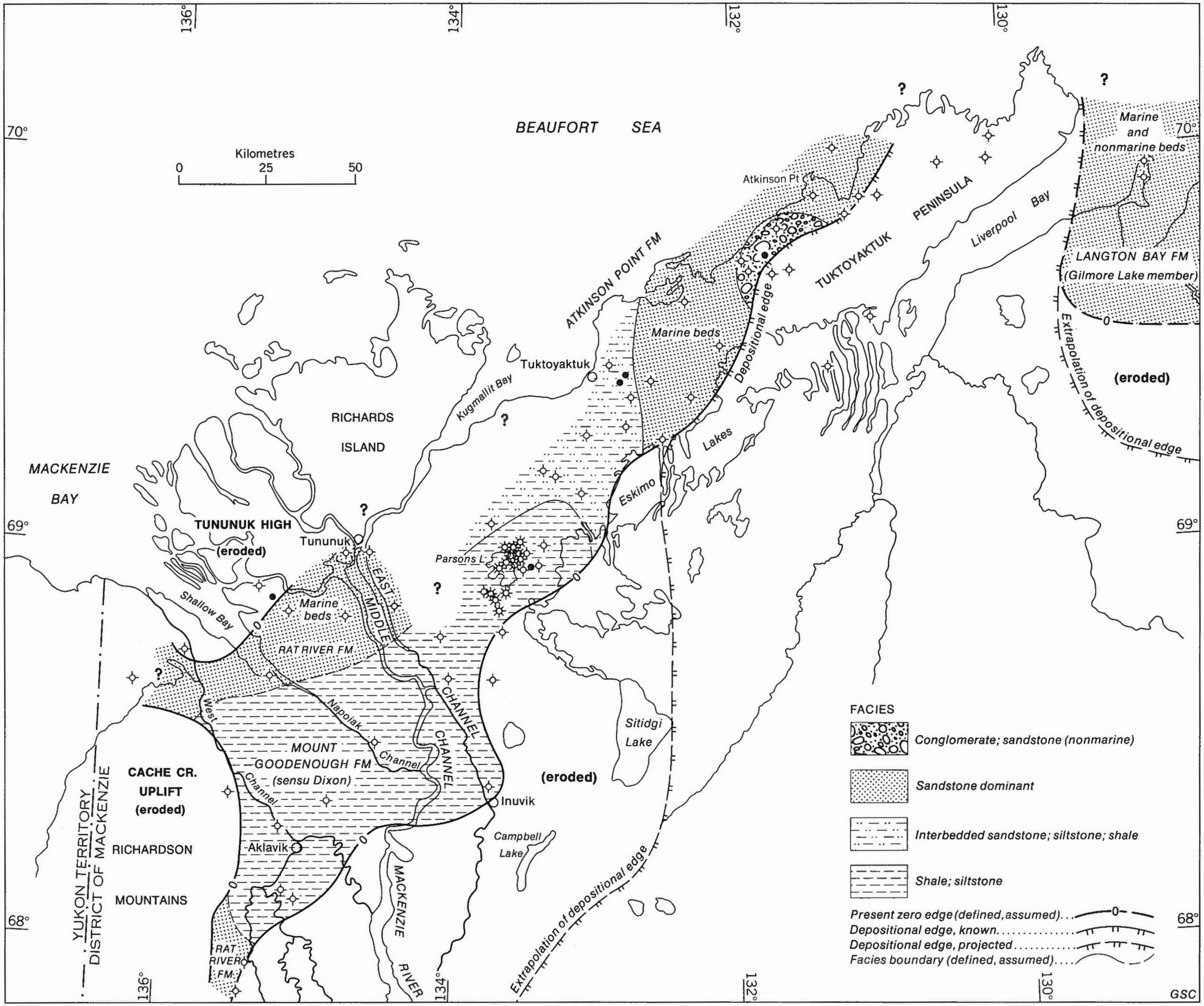


FIGURE 23. *Facies map of depositional-complex 8 (includes data from Jeletzky, 1975, Fig. 15 and Young et al., 1976, Fig. 10): approximately Aptian. Rat River, uppermost Mount Goodenough and Atkinson Point Formations.*

Depositional-episode 9

The Albian Arctic Red Formation and the laterally equivalent Horton River Formation of the Anderson Plains comprise depositional-episode 9. In Late Aptian or Early Albian time there was a major rise in sea level, probably enhanced by subsidence of the North American craton margins, and the depositional basin extended far to the southeast and east. Only in the southern Peel Plains and Norman Wells area (Tassonyi, 1969; Yorath and Cook, 1981) do shallow marine to continental sandstones become significant in the Albian succession. In the Mackenzie Delta and adjacent areas shelf shales are dominant.

During the early stages of deposition local basal sandstone beds developed (Fig. 5) on and adjacent to small topographic highs. Young et al. (1976, Fig. 11) indicated that the Eskimo Lakes Arch formed an island rimmed by a narrow belt of sand facies. Such an island was short-lived, and also the available subsurface data does not support the interpretation of a sand-rim around the Arch, rather local sandy beds developed, commonly at slightly different stratigraphic levels. For most of depositional-episode 9 middle to outer shelf conditions prevailed and deposition of mud was prevalent.

Similar conditions prevailed in the northern Richardson Mountains but where ironstones were also forming. Further to the west, turbidites were deposited in the Blow Trough (Young, 1970; Young et al., 1976; Jeletzky, 1975), apparently derived from the emerging Brooks Range Geanticline.

During the Late Albian or Early Cenomanian there was uplift and erosion, resulting in the younger (Upper Cretaceous) Boundary Creek, and the equivalent Smoking Hills, Formation resting unconformably on older rocks. According to Frazier's (1974) concept of depositional-episodes this unconformity and at least part of the overlying Boundary Creek Formation may be part of depositional-episode 9. However, the Boundary Creek Formation has been interpreted as a marine deposit formed on a stagnant sea floor (Young, 1975), consequently the unconformity between these and Albian strata may also be a hiatal surface, an interpretation which I favour. The stratigraphic relationships across the unconformity have not been examined in detail and the study was curtailed at the Arctic Red-Boundary Creek Formations contact, mostly for the sake of convenience but also because the unconformity is a major feature and consequently a good boundary marker.

SUMMARY

Over 2500 m of Jurassic and Lower Cretaceous rocks are present in the subsurface, the greatest known thickness occurring in the Kugmallit Trough, and probably a similar thickness in the Canoe Depression. Strata thin towards major structural elements, the Eskimo Lakes Arch to the southeast, Tununuk High to the northwest and Cache Creek Uplift to the west. Some of the thinning is truly depositional but several erosional events have also contributed to thinning.

The subsurface geology is essentially a continuation of that seen in outcrop in the northern Richardson Mountains, consequently a similar lithostratigraphic terminology has been used wherever possible. Some modifications proposed in another publication (Dixon, in prep.) continue to be used.

Subsurface data offered a unique opportunity to undertake detailed correlations and this led to the division of the Jurassic-Lower Cretaceous succession into depositional-episodes (*sensu* Frazier, 1974). At least nine depositional-episodes are recognized, informally numbered 1 to 9, oldest to youngest. During depositional-episodes 1 to 3 (Bug Creek Group) deposition was limited to the southwestern part of the Mackenzie Delta, with a source area lying to the south and east. Depositional-episode 4 saw the expansion of deposition northeastwards. During depositional-episodes 4 to 8 (Husky, Martin Creek, McGuire, Kamik, Siku, Mount Goodenough, Rat River and Atkinson Point Formations) the basin configuration remained similar, with the strandline oscillating back and forth over the Eskimo Lakes Arch. The main source areas were to the south and east during depositional-episodes 4 to 8, but in depositional-episodes 7 and 8 an additional northerly source may have been present. A major, and apparently rapid, expansion of the basin occurred during depositional-episode 9 (Albian, Arctic Red Formation), with the basin margins extending well beyond the Mackenzie Delta area. This basin expansion was probably due to a major rise in sea level, enhanced by subsidence of the craton margin.

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APPENDIX 1

Formation Tops

Formation tops were chosen primarily from the gamma/sonic logs, although in some wells the DIL/SP logs or samples were used. Log depths are given in metres, but due to the fact that most wells were drilled when the imperial system was in use depths in feet are given in parentheses.

Imperial Cigol Akku F-14

Arctic Red Fm.	1316.1	(4318)
Atkinson Point Fm.	1321.6	(4336)
Pre-Mesozoic	1364.6	(4477)

Shell Aklavik A-37

?Arctic Red Fm.	131.1	(430)
Mount Goodenough Fm.	205.4	(674)
Parsons Grp.		
Kamik Fm.	914.4	(3000)
McGuire Fm.	965.9	(3169)
Martin Creek Fm.	996.1	(3268)
Husky Fm.	1100.9	(3612)
BugCreek Grp.		
Aklavik Fm.	1513.6	(4966)
Tongue of the Richardson Mts. Fm.	1532.5	(5028)
Aklavik Fm.	1563.0	(5128)
Richardson Mts. Fm.	1601.1	(5255)
Manuel Creek Fm.	1665.4	(5464)
Almstrom Creek Fm.	1674.0	(5492)
Murray Ridge Fm.	1739.5	(5707)
Pre-Mesozoic	1755.0	(5758)

Union Aklavik F-17

?Arctic Red Fm.	166.2	(532)
Mount Goodenough Fm.	234.7	(770)
Husky Fm.	731.5	(2400)
Aklavik Fm.	763.5	(2505)
Pre-Mesozoic	770.5	(2528)

Union Aklavik F-38

?Arctic Red Fm.	155.4	(510)
Mount Goodenough	234.1	(768)
Parsons Grp.		
McGuire Fm.	1202.1	(3944)
Martin Creek Fm.	1236.3	(4056)
Husky Fm.	1278.0	(4193)
Bug Creek Grp.		
Aklavik Fm. (Internal unconformity at 1524.6 m:5002 ft	1510.0	(4954)
Richardson Mts. Fm.	1541.7	(5058)
Manuel Creek Fm.	eroded	
Almstrom Creek Fm.	1575.8	(5170)
Murray Ridge Fm.	1608.1	(5276)
Pre-Mesozoic	1617.0	(5305)

Elf Imperial Amaguk H-16

Arctic Red Fm.	918.1	(3012)
Pre-Mesozoic	955.9	(3136)

Imperial Amorak N-44

Arctic Red Fm.	1026.6	(3368)
Pre-Mesozoic	1163.7	(3818)

IOE Atkinson A-55

Arctic Red Fm.	1862.3	(6110)
Atkinson Point Fm.	1956.2	(6418)
Pre-Mesozoic	2061.7	(6764)

IOE Atkinson H-25

Arctic Red Fm.	1689.5	(5543)
Atkinson Point Fm.	1710.0	(5610)
Pre-Mesozoic	1803.2	(5916)

IOE Atkinson M-33

Arctic Red Fm.	1669.7	(5478)
Atkinson Point Fm.	1797.1	(5896)
Pre-Mesozoic	1895.9	(6220)

Shell Beaverhouse Creek H-13

Mount Goodenough Fm.	surface	
Parsons Grp.		
Kamik Fm.	361.5	(1186)
McGuire Fm.	403.9	(1325)
Martin Creek Fm.	432.8	(1420)
Husky Fm.	502.9	(1650)
	Incomplete section due to faulting.	
Bug Creek Grp.		
Aklavik Fm.	769.0	(2523)
Richardson Mts. Fm.	790.0	(2592)
Manuel Creek Fm.	969.3	(3180)
Almstrom Creek Fm.	999.1	(3278)
Murray Ridge Fm.	1128.7	(3703)
Pre-Mesozoic	1147.3	(3764)

Gulf East Reindeer A-01

Mount Goodenough Fm. - fault contact	1462.2	(4810)
Siku Fm.	1980.6	(6498)
Parsons Grp.		
Kamik Fm.	2080	(6824)
McGuire Fm.	2505.5	(8220)
Martin Creek Fm.	2529.8	(8300)
Husky Fm.	2567.9	(8425)
Pre-Mesozoic	2822.4	(9260)

Gulf East Reindeer C-38

Mount Goodenough Fm.	983.3	(3226)
Husky Fm.	1170.4	(3840)
Pre-Mesozoic	1280.2	(4200)

Gulf East Reindeer G-04

Arctic Red Fm.	1615.4	(5300)
Mount Goodenough Fm.	1928.2	(6326)
Siku Fm.	2715.2	(8908)
Parsons Grp.		
Kamik Fm.	2806.6	(9208)
McGuire Fm.	3241.2	(10 634)
Martin Creek Fm.	3263.8	(10 708)
Husky Fm.	3369.3	(11 054)
Pre-Mesozoic	3591.8	(11 784)

Gulf East Reindeer P-60

Mount Goodenough Fm.	430.4	(1412)
Husky Fm.	920.5	(3020)
Pre-Mesozoic	969.9	(3182)

IOE Eskimo J-07

Arctic Red Fm.	804.1	(2638)
Atkinson Point Fm.	821.4	2695)
Pre-Mesozoic	827.2	(2714)

Chevron et al. Fish River B-60

Lower Cretaceous and Jurassic rocks are present in this well but faulting is so extensive that a satisfactory stratigraphy has not been resolved.

Gulf Ikhil I-37

Mount Goodenough Fm. - in fault contact with younger rocks	2258.6	(7410)
Siku Fm.	2912.7	(9556)
Parsons Grp.		
Kamik Fm.	3173.0	(10 410)
McGuire Fm.	3970.0	(13 025)
Martin Creek Fm.	?4036.2	(13 242)
Husky Fm.	?4267.2	(14 000)

Dome Imnak J-29

Arctic Red Fm.	2584.1	(8478)
Atkinson Point Fm.	2720.3	(8925)
Mount Goodenough Fm.	2762.1	(9062)
Siku Fm.	2862.1	(9390)
Parsons Grp.		
Kamik Fm.	2916.9	(9570)
McGuire Fm.	3045.0	(9990)
Martin Creek Fm.	3070.0	(10 072)
Husky Fm. - minor faulted contact with Martin Creek Fm.	3131.0	(10 272)
Pre-Mesozoic	3304.0	(10 840)

Amoco Ulster Scurry Inuvik D-54

Arctic Red Fm.	surface	
Mount Goodenough Fm.	?161.5	(530)
Husky Fm.	?274.3	(900)
Pre-Mesozic	320.0	(1050)

Husky Fm. chosen on basis of paleontology (Chamney, 1974) and sample descriptions.

Gulf Mobil Kamik D-48

Arctic Red Fm.	1825.8	(5990)
Mount Goodenough Fm.	?2215.9	(7270)
Fault zone	2738.6	(8985)
Parsons Grp.		
Kamik Fm.	2831.6	(9290)
McGuire Fm.	2920.0	(9580)
Martin Creek Fm.	2938.9	(9642)
Husky Fm.	3017.5	(9900)

Gulf Mobil Kamik D-58

Arctic Red Fm.	1839.5	(6035)
Mount Goodenough Fm.	2144.3	(7035)
Siku Fm.	2706.6	(8880)
Parsons Grp.		
Kamik Fm.	2801.7	(9192)
McGuire Fm.	3063.2	(10 050)
Martin Creek Fm.	3082.1	(10 112)
Husky Fm.	3160.8	(10 370)

Gulf Mobil Kamik F-38

Arctic Red Fm.	1783.1	(5850)
Mount Goodenough Fm.	?2239.7	(7348)
Siku Fm.	2921.5	(9585)
Parsons Grp.		
Kamik Fm.	3006.5	(9864)
McGuire Fm.	3236.4	(10 618)
Martin Creek Fm.	3261.4	(10 700)
Husky Fm.	3339.1	(10 955)

Gulf Mobil Kamik L-60

Arctic Red Fm.	2180.0	(7152)
Mount Goodenough Fm.	?2372.6	(7784)
Siku Fm.	2868.2	(9410)
Parsons Grp.		
Kamik Fm.	2954.1	(9692)

Imperial Kanguk F-42

Arctic Red Fm.	1333.2	(4374)
Atkinson Point Fm.	1437.1	(4715)
Pre-Mesozoic	1469.1	(4820)

IOE Kanguk I-24

Arctic Red Fm.	1269.2	(4164)
Atkinson Point Fm.	1375.0	(4511)
Pre-Mesozoic	1390.8	(4563)

Imperial Kannerk G-42

Arctic Red Fm.-fault contact	?2179.3	(7150)
Atkinson Point Fm.	2293.9	(7526)
Pre-Mesozoic	2388.4	(7836)

Imperial Kapik J-39

Arctic Red Fm.	1120.4	(3676)
Atkinson Point Fm.	1206.4	(3958)
Pre-Mesozoic	1232.9	(4045)

Elf Kiligvak I-29

Upper Cretaceous Boundary Creek Fm. rests directly on Paleozoic rocks.

IOE Kimik D-29

Arctic Red Fm. - in fault contact with younger rocks	2344.2	(7691)
Atkinson Point Fm.	2415.5	(7925)
Husky Fm.	2509.1	(8232)
Pre-Mesozoic	2581.7	(8470)

Shell Kipnik O-20

Arctic Red Fm. - in fault contact with younger rocks	981.5	(3220)
Rat River Fm.	1231.4	(4040)
Mount Goodenough Fm.	1362.5	(4470)
Siku Fm.	1866.7	(6124)
Parsons Grp.		
Kamik Fm.	2137.9	(7014)
McGuire Fm.	3073.0	(10 082)
Martin Creek Fm.	3179.1	(10 430)
Husky Fm.	3307.7	(10 852)

Shell Kugpik L-24

Upper Cretaceous Boundary Creek Fm. rests directly on Paleozoic strata at 2225 m (7300 ft).

Shell Kugpik O-13

Parsons Grp.		
Kamik Fm.	2173.2	(7130)
McGuire Fm.	2372.9	(7785)
Martin Creek Fm.	2436.0	(7992)
Husky Fm.	2532.9	(8310)
Pre-Mesozoic	3090.7	(10 140)

The Upper Cretaceous Boundary Creek Fm. rests directly on a partially eroded Kamik Fm.

Imperial Louth K-45

Arctic Red Fm.	1916.0	(6286)
Atkinson Point Fm.	2012.3	(6602)
Pre-Mesozoic	2118.4	(6950)

IOE Magak A-32

Arctic Red Fm.	1434.7	(4707)
Atkinson Point Fm.	1453.9	(4770)
Pre-Mesozoic	1522.8	(4996)

IOE Mayogiak J-17

Fault zone	2625.9	(8615)
Husky Fm.	2633.5	(8640)
Pre-Mesozoic	2856.0	(9370)

IOE Mayogiak L-39

Arctic Red Fm.	3780.7	(12 404)

Stratigraphy between Arctic Red Fm. and top of Paleozoic at 4425.8 (14 517) is not readily distinguished but may include equivalents of the Mount Goodenough and Husky Fm. in fault contact.

Esso Mayogiak M-16

?Arctic Red Fm.	2282.0
Fault zone	?2571.0
Husky Fm.	2608.5
Pre-Mesozoic	2871.0

The stratigraphy of this well, like J-17 and L-39 is complicated by faulting. The section between 2282-2608.5 m is believed to be Arctic Red Fm. but may involve other Lower Cretaceous strata. Between 2608.5-2871 m the strata is definitely Husky Fm.

Esso Pex Napartok M-01

Mount Goodenough Fm. - in fault contact with younger rocks	992.0
Siku Fm.	1242.0
Parsons Grp.	
Kamik Fm.	1320.0
McGuire Fm.	1448.4
Martin Creek Fm.	1458.0
Husky Fm.	1548.0
Pre-Mesozoic	1798.0

Shell Napoiak F-31

Arctic Red Fm.	115.8	(380)
Mount Goodenough Fm.	237.7	(780)
Parsons Grp.		
Kamik Fm.	823.0	(2700)
McGuire Fm.	841.9	(2762)
Martin Creek Fm.	866.2	(2842)
Husky Fm.	929.0	(3048)
Bug Creek Grp.		
Aklavik Fm.	1158.9	(3802)
Richardson Mts. Fm.	1168.6	(3834)
Manuel Creek Fm.	eroded	
Almstrom Creek Fm.	1210.7	(3972)
Murray Ridge Fm.	1258.2	(4128)
Pre-Mesozoic	1264.3	(4148)

IOE Natagnak H-50

Arctic Red Fm. - fault contact	?1774.9	(5823)
Atkinson Point Fm.	1820.9	(5974)
Pre-Mesozoic	1929.4	(6330)

IOE Natagnak K-23

Arctic Red Fm.	1310.0	(4298)
Pre-Mesozoic	1469.1	(4820)

IOE Natagnak K-53

Arctic Red Fm.	1624.6	(5330)
Pre-Mesozoic	1691.0	(5548)

Texcan Nicholson N-45

Horton River Fm.	378.0	(1240)
Langton Bay Fm.	617.2	(2025)

Imperial Nuna A-32

Arctic Red Fm.	2228.1	(7310)
Mount Goodenough Fm.	?2676.1	(8780)
Siku Fm.	3115.7	(10 222)
Parsons Grp.		
Kamik Fm. - sample depth	?3237.0	(10 620)
(faulted section Kamik Fm.)		
McGuire Fm. - estimated	?3319.3	(10 890)
Martin Creek Fm.		
- sample depth	3337.6	(10 950)
Husky Fm. - sample depth	3395.5	(11 140)

IOE Nuvorak O-09

Arctic Red Fm.	983.0	(3225)
Pre-Mesozoic	1043.6	(3424)

Gulf Mobil Ogruknang M-31

Arctic Red Fm. - fault contact	2845.3	(9335)
Rat River Fm.	3284.2	(10 775)
Mount Goodenough Fm.	3426.0	(11 240)
Parsons Grp.		
McGuire Fm. - ?fault contact	3843.5	(12 610)
Martin Creek Fm.	?3903.3	(12 806)
Husky Fm.	4066.0	(13 340)

Gulf Mobil Parsons A-44

Arctic Red Fm.	1786.1	(5860)
Mount Goodenough Fm.	2112.3	(6930)
Siku Fm.	2776.1	(9108)
Parsons Grp.		
Kamik Fm.	2904.7	(9530)
McGuire Fm.	3197.4	(10 490)
Martin Creek Fm.	3215.6	(10 550)
Husky Fm.	3281.2	(10 765)
Pre-Mesozoic	3450.3	(11 320)

Gulf Mobil Parsons D-20 (taken from true vertical depth [TVD] logs)

Arctic Red Fm.	1894.3	(6215)
Mount Goodenough Fm.	2079.7	(6823)
Siku Fm.	2619.8	(8595)
Parsons Grp.		
Kamik Fm.	2731.9	(8963)
McGuire Fm.	2956.0	(9698)
Martin Creek Fm.	2980.9	(9780)
Husky Fm.	3063.2	(10 050)
Pre-Mesozoic	3252.2	(10 670)

Gulf Mobil Parsons F-09

Arctic Red Fm.	1811.1	(5942)
Mount Goodenough Fm.	2017.8	(6620)
Siku Fm.	2601.5	(8535)
Parsons Grp.		
Kamik Fm.	2698.1	(8852)
McGuire Fm.	2980.9	(9780)
Martin Creek Fm	3004.7	(9858)
Husky Fm.	3081.5	(10 110)
Pre-Mesozoic	3313.2	(10 870)

Gulf Mobil Parsons L-37 (taken from true vertical depth logs)

Arctic Red Fm.	1966.0	(6450)
Mount Goodenough Fm.	2103.1	(6900)
Siku Fm.	2624.6	(8611)
Parsons Grp.		
Kamik Fm.	2709.7	(8890)
McGuire Fm.	3054.1	(10 020)
Martin Creek Fm.	3073.0	(10 082)
Husky Fm.	3145.5	(10 320)

Gulf Mobil Parsons L-43

Arctic Red Fm.	1728.2	(5670)
Mount Goodenough Fm.	2030.6	(6662)
Siku Fm.	2580.1	(8465)
Parsons Grp.		
Kamik Fm.	2712.1	(8898)
McGuire Fm.	3019.0	(9905)
Martin Creek Fm.	3036.4	(9962)
Husky Fm.	3128.8	(10 265)
Pre-Mesozoic	3279.6	(10 760)

Gulf Mobil Parsons N-10

Arctic Red Fm.	2017.8	(6620)
Mount Goodenough Fm.	2083.6	(6836)
Siku Fm.	2527.4	(8292)
Parsons Grp.		
Kamik Fm.	2618.2	(8590)
McGuire Fm.	2872.3	(9276)
Martin Creek Fm.	2848.7	(9346)
Husky Fm.	2892.9	(9491)
Pre-Mesozoic	3077.0	(10 095)

Gulf Mobile Parson N-17 (depths corrected to true vertical depth using a depth correction curve; log depths and TVD are given)

Arctic Red Fm.		
log depth	2030.0	(6660)
TVD	1973.6	(6475)
Mount Goodenough Fm.		
log depth	2267.7	(7440)
TVD	2205.2	(7235)
Siku Fm.		
log depth	2810.3	(9220)
TVD	2728.0	(8950)
Parsons Grp.		
Kamik Fm.		
log depth	2916.9	(9570)
TVD	2828.5	(9280)
McGuire Fm.		
log depth	3238.5	(10 625)
TVD	3150.7	(10 337)
Martin Creek Fm.		
log depth	3265.9	(10 715)
TVD	3179.4	(10 431)

Gulf Mobil Parsons O-27 (taken from true vertical depth logs)

Arctic Red Fm.	?1908.0	(6260)
Mount Goodenough Fm.	?2212.8	(7260)
Siku Fm.	2788.9	(9150)
Parsons Grp.		
Kamik Fm.	2908.4	(9542)
Husky Fm. - fault contact	3054.7	(10 022)
Pre-Mesozoic	3221.7	(10 570)

APPENDIX 1 (cont'd)

Gulf Mobil Parsons P-41

Arctic Red Fm. - ?fault contact	1679.4	(5510)
Mount Goodenough Fm.	2204.3	(7232)
Siku Fm.	2744.4	(9004)
Parsons Grp.		
Kamik Fm.	2874.3	(9430)
McGuire Fm	3216.9	(10 554)
Martin Creek Fm.	3231.5	(10 602)
Husky Fm.	3320.0	(10 892)

Gulf Mobil Parsons P-53

Arctic Red Fm.	1713.0	(5620)
Mount Goodenough Fm.	2025.4	(6645)
Siku Fm.	2740.2	(8990)
Parsons Grp.		
Kamik Fm.	2856.6	(9372)
Husky Fm. - fault contact	3066.3	(10 060)
Pre-Mesozoic	3185.2	(10 450)

IOE Pikiolik E-54

Arctic Red Fm. - fault contact	1989.1	(6526)
Atkinson Point Fm.	2448.2	(8032)
Mount Goodenough Fm.	2522.5	(8276)
Parsons Grp.		
Martin Creek Fm.	2593.2	(8508)
Husky Fm.	2618.2	(8590)
Pre-Mesozoic	2738.6	(8985)

IOE Pikiolik M-26

Lower Cretaceous strata is in fault contact with younger rocks at 1659 (5443) and rests on Pre-Mesozoic strata at 1709.3 (5608). Chamney (in Brideaux, 1974) dated foraminifera from core as Barremian to Aptian, indicating a possible Mount Goodenough Fm. equivalence.

Banff Rat Pass K-35

Mount Goodenough Fm. - overlain by Recent and/or Tertiary sediment	189.0	(620)
Husky Fm.	539.5	(1770)
Aklavik Fm.	576.1	(1890)
Pre-Mesozoic	590.7	(1938)

Imperial Russell H-23

Arctic Red Fm.	1017.4	(3338)
Atkinson Point Fm.	1094.2	(3590)
Pre-Mesozoic	1100.9	(3612)

Gulf Mobil Siku A-12

Mount Goodenough Fm. - probably a fault contact	2179.3	(7150)
Siku Fm	2575.6	(8450)
Parsons Grp.		
Kamik Fm.	2658.5	(8722)
McGuire Fm.	2971.8	(9750)
Martin Creek Fm.	2991.9	(9816)
Husky Fm.	3066.3	(10 060)
Pre-Mesozoic	3234.5	(10 612)

Gulf Mobil Siku C-11

Arctic Red Fm.	1949.2	(6395)
Mount Goodenough Fm.	?2129.0	(6985)
Siku Fm.	2657.9	(8720)
Parsons Grp.		
Kamik Fm.	2791.4	(9158)
McGuire Fm.	3015.7	(9894)
Martin Creek Fm.	3037.6	(9966)
Husky Fm. - fault contact	3072.4	(10 080)
Pre-Mesozoic	3182.1	(10 440)

Gulf Mobil Siku C-55

Arctic Red Fm.	2965.7	(9730)
Mount Goodenough Fm.	3447.9	(11 312)
Siku Fm.	4020.3	(13 190)
Parsons Grp.		
Kamik Fm.	4145.3	(13 600)

Gulf Mobil Siku E-21

Arctic Red Fm.	2109.2	(6920)
Mount Goodenough Fm.	2160.4	(7088)
Siku Fm.	2697.5	(8850)
Parsons Grp.		
Kamik Fm.	2796.5	(9175)
McGuire Fm.	3146.1	(10 322)
Martin Creek Fm.	3169.9	(10 400)
Husky Fm.	3227.2	(10 588)
Pre-Mesozoic	3393.9	(11 135)

Banff Treeless Creek I-51

Mount Goodenough Fm. - overlain by a thin cover of Recent and/or Tertiary sediment	44.2	(145)
Husky Fm.	304.8	(1000)
Aklavik Fm.	326.1	(1070)
Pre-Mesozoic	350.5	(1150)

IOE Tuk F-18

Arctic Red Fm.	2621.9	(8602)
Atkinson Point Fm.	2868.2	(9410)
Mount Goodenough Fm.	2884.3	(9463)
Siku Fm.	2971.8	(9750)
Parsons Grp.		
Kamik Fm.	3018.1	(9902)
McGuire Fm.	3121.5	(10 241)
Martin Creek Fm.	?3139.4	(10 300)

IOE Tuktu O-19

Arctic Red Fm.	1644.1	(5394)
Atkinson Point Fm.	1965.4	(6448)
Mount Goodenough Fm.	2003.1	(6572)
Parsons Grp.		
Martin Creek Fm.	2083.0	(6834)
Husky Fm.	2101.6	(6895)
Pre-Mesozoic	2199.4	(7216)

Shell Tullugak K-31

Arctic Red Fm. - fault contact	1097.3	(3600)
Rat River Fm.	1196.6	(3926)
Mount Goodenough Fm.	1347.2	(4420)
Siku Fm.	1825.8	(5990)
Parsons Grp.		
Martin Creek Fm. - fault contact	1986.1	(6516)
Husky Fm. - fault contact	2066.5	(6780)
Bug Creek Grp.		
Aklavik Fm.	faulted out	
Richardson Mts. Fm. - fault contact	2562.1	(8406)
Manuel Creek Fm.	?2664.0	(?8740)
Almstrom Creek Fm.	2715.8	(8910)
Murray Ridge Fm.	2862.1	(9390)
Pre-Mesozoic	2883.4	(9460)

Gulf Tununuk F-30 (tentative stratigraphy)

Arctic Red Fm. - fault contact	?1615.4	(5300)

IOE BA Tununuk K-10 (tentative stratigraphy)

Arctic Red Fm.	2593.2	(8508)
Rat River Fm.	2927.3	(9604)
Mount Goodenough Fm.	3048.0	(10 000)
?Husky Fm. (could be Siku Fm.) - fault contact	3541.8	(11 620)

Shell Ulu A-35

Arctic Red Fm.	2099.2	(6887)
Bug Creek Grp.	fault contact	
Aklavik Fm.	faulted out	
Richardson Mts. Fm.	faulted out	
Manuel Creek Fm.	faulted out	
Almstrom Creek Fm.	2420.1	(7940)
Murray Ridge Fm.	2709.1	(8888)
Pre-Mesozoic	2771.9	(9094)

Shell Unak B-11

Arctic Red Fm.	240.8	(790)
Rat River Fm.	506.0	(1660)
Mount Goodenough Fm	594.4	(1950)
Siku Fm.	1222.9	(3912)
Parsons Grp.		
Kamik Fm	1324.4	(4345)
McGuire Fm.	1607.8	(5275)
Martin Creek Fm.	1670.3	(5480)
Husky Fm.	1818.4	(5966)
Husky Fm. is faulted, giving an anomalously thin section.		
Bug Creek Grp.		
Aklavik Fm.	2123.2	(6966)
Richardson Mts. Fm.	2153.1	(7064)
Manuel Creek Fm.	2376.2	(7796)
Almstrom Creek Fm.	2435.4	(7990)
Murray Ridge Fm.	faulted out	
Pre-Mesozoic - fault contact	2493.3	(8180)

Imperial Wagnark C-23

Arctic Red Fm.	3049.8	(10 006)
Atkinson Point Fm.	3280.6	(10 763)
Mount Goodenough Fm.	3452.2	(11 326)
Siku Fm.	3657.0	(11 998)
Parsons Grp.		
Kamik Fm.	3744.2	(12 284)
Fault zone	3914.2	(12 842)
Husky Fm.	3936.8	(12 916)
Pre-Mesozoic	4179.4	(13 712)

Imperial Wagnark G-12

Arctic Red Fm.	2952.9	(9688)
Atkinson Point Fm.	3096.8	(10 160)
Mount Goodenough Fm.	3384.8	(11 105)

APPENDIX 2

Cored Intervals in Jurassic and Lower Cretaceous Strata

Core depths, given in metres and feet (in parenthese), are those reported in the well history reports. However, some cores did not appear to correspond with the log character at the given depth and adjusted depths are also given. All core material is available for inspection at the Institute of Sedimentary and Petroleum Geology, Calgary.

Shell Aklavik A-37

1585.6-1593.5 (5202-5227.9) Aklavik Fm. (Bug Creek Group)

Elf Imp. Amaguk H-16

944.3-947.3 (3098-3108) Arctic Red Fm.

IOE Atkinson A-55

2016.6-2047 (6616-6716) Atkinson Point Fm.

IOE Atkinson H-25

1742.5-1803.5 (5717-5917) Atkinson Point Fm./Proterozoic strata

IOE Atkinson M-33

1823.3-1893.7 (5982-6213) Atkinson Point Fm.

Gulf Mobil East Reindeer A-01

2299.4-2310.1 (7544-7579) Kamik Fm.

Gulf East Reindeer C-38

1195.4-1204.3 (3922-3951) Husky Fm. (lower member)

Gulf Mobil East Reindeer G-04

1912-1915.5 (6273-6284.5) Arctic Red Fm.
2306.1-2316.5 (7566-7600) Mount Goodenough Fm.
2720.3-2731 (8925-8960) Siku Fm.
2920-2929.4 (9580-9611) Kamik Fm. Adjusted to log depths 2915.4-2924.9 (9565-9596)
2930.6-2940.4 (9615-9647) Kamik Fm. Adjusted to log depths 2926.1-2935.8 (9600-9632)

Gulf Mobil Ikhil I-37

3908.8-3912.7 (12824-12837) Kamik Fm.

IOE Kanguk I-24

1390.2-1404.2 (4561-4607) Atkinson Point Fm./Paleozoic strata

Imperial IOE Kimik D-29

2579.5-2585.3 (8463-8482) Husky Fm. (lower member)

Shell Kipnik O-20

1791-1798.3 (5876-5900) Mount Goodenough Fm.

Shell Kugpik O-13

2938.3-2956.6 (9640-9700) Husky Fm. (lower member)

IOE Mayogiak J-17

2687.7-2699.9 (8818-8858) Husky Fm. (lower member)
2731-2760 (8960-9055) Husky Fm. (lower member)
2854.8-2859.9 (9366-9383) Husky Fm. (lower member)/Paleozoic strata

Shell Napoiak F-31

689.2-698.9 (2261-2293) Mount Goodenough Fm.
1237.8-1259.4 (4061-4132) Almstrom Creek Fm. (Bug Creek Grp.)

IOE Natagnak H-50

1719.7-1728.5 (5642-5671) Arctic Red Fm.
1829.1-1841.3 (6001-6041) Atkinson Point Fm.
1878.2-1897.4 (6162-6225) Atkinson Point Fm.

IOE Natagnak K-23

1387.5-1400 (4552-4592) Arctic Red Fm.

Gulf Mobil Ogruknang M-31

4028.4-4038 (13 126-13 248) ?Martin Creek Fm. Adjusted to log depths 4046.5-4056.3 (13 276-13 308)

Gulf Mobil Parsons F-09

2845.9-2864.2 (9337-9397) Kamik Fm.
2991.3-3001.7 (9814-9848) McGuire Fm.

Gulf Mobil Parsons L-43

2772.5-2790.8 (9096-9156) Kamik Fm. Adjusted to log depths 2768.2-2786.5 (9082-9142)
2849.3-2858.4 (9348-9378) Kamik Fm. Adjusted to log depths 2846.2-2855.4 (9338-9368)
2932.8-2945.9 (9622-9665) Kamik Fm. Adjusted to log depths 2929.7-2942.8 (9612-9655)

Gulf Mobil Parsons N-10

2750.8-2765.2 (9025-9072) Kamik Fm.
2795.6-2804.8 (9172-9202) Kamik Fm.
2842.3-2899.3 (9325-9512) McGuire, Martin Creek and Husky (upper member) Fms.

Gulf Mobil Parsons P-41

2961.7-2980.3 (9717-9778) Kamik Fm. Adjusted to log depths 2959.6-2978.2 (9710-9771).

Imperial IOE Pikiolik E-54

2383.8-2393 (7821-7851) Arctic Red Fm.
2468.3-2476.5 (8698-8215) Atkinson Point Fm.
2590.2-2593.5 (8498-8509) Mount Goodenough/Martin Creek Fms.
2685.9-2704.2 (8812-8872) Husky Fm. (lower member)

IOE Pikiolik M-26

1690.4-1699.6 (5546-5576) ?Mount Goodenough Fm.

Gulf Mobil Siku A-12

2713-2731.3 (8901-8961) Kamik Fm. Adjusted to log depths 2701.9-2729.2 (8894-8954)
2804.2-2822.4 (9200-9260) Kamik Fm. Adjusted to log depths 2802.6-2820.9 (9195-9255)

Gulf Mobil Siku E-21

2865.4-2867.6 (9401-9408) Kamik Fm. Adjusted to log depths 2861.8-2863.9 (9389-9396)
2953.5-2971.8 (9690-9750) Kamik Fm. Adjusted to log depths 2949.2-2967.5 (9676-9736)
3045-3054.7 (9990-10 022) Kamik Fm. Adjusted to log depths 3045.6-3055.3 (9992-10 024)

IOE Tuk F-18

2780.7-2795.9 (9123-9173) Arctic Red Fm.
2870.9-2876.4 (9419-9437) Atkinson Point Fm.
2881.6-2885.9 (9454-9468) Mount Goodenough Fm. Adjusted to log depths 2884.6-2888.9 (9464-9478)
3023.6-3033.7 (9920-9953) Kamik Fm. Adjusted to log depths 3021.5-3031.5 (9913-9946)
3066.6-3070 (10 061-10 072) Kamik Fm. Adjusted to log depths 3068.1-3071.5 (10 066-10 077)

IOE Tuktu O-19

1985.2-1994.3 (6513-6543) Atkinson Point Fm.
2097.9-2107.1 (6883-6913) Martin Creek and Husky (upper member) Fms.

Shell Tullugak K-31

2009.9-2026.6 (6594-6649) Martin Creek Fm.

IOE BA Tununuk K-10

2810.3-2825.5 (9220-9270) Arctic Red Fm.
3115.4-3126.9 (10 221-10 259) Mount Goodenough Fm.
3355.5-3359.8 (11 009-11 023) Mount Goodenough Fm.
3441.2-3450.6 (11 290-11 321) Mount Goodenough Fm.
3529.6-3531.4 (11 580-11 586) Mount Goodenough Fm.
3536.6-3543.3 (11 603-11 625) Mount Goodenough and Husky Fms.
3565.2-3574.1 (11 697-11 726) ?Husky Fm. (or Siku Fm.)
3706.7-3711.5 (12 161-12 177) ?Husky Fm. (or Siku Fm.)

Shell Unak B-11

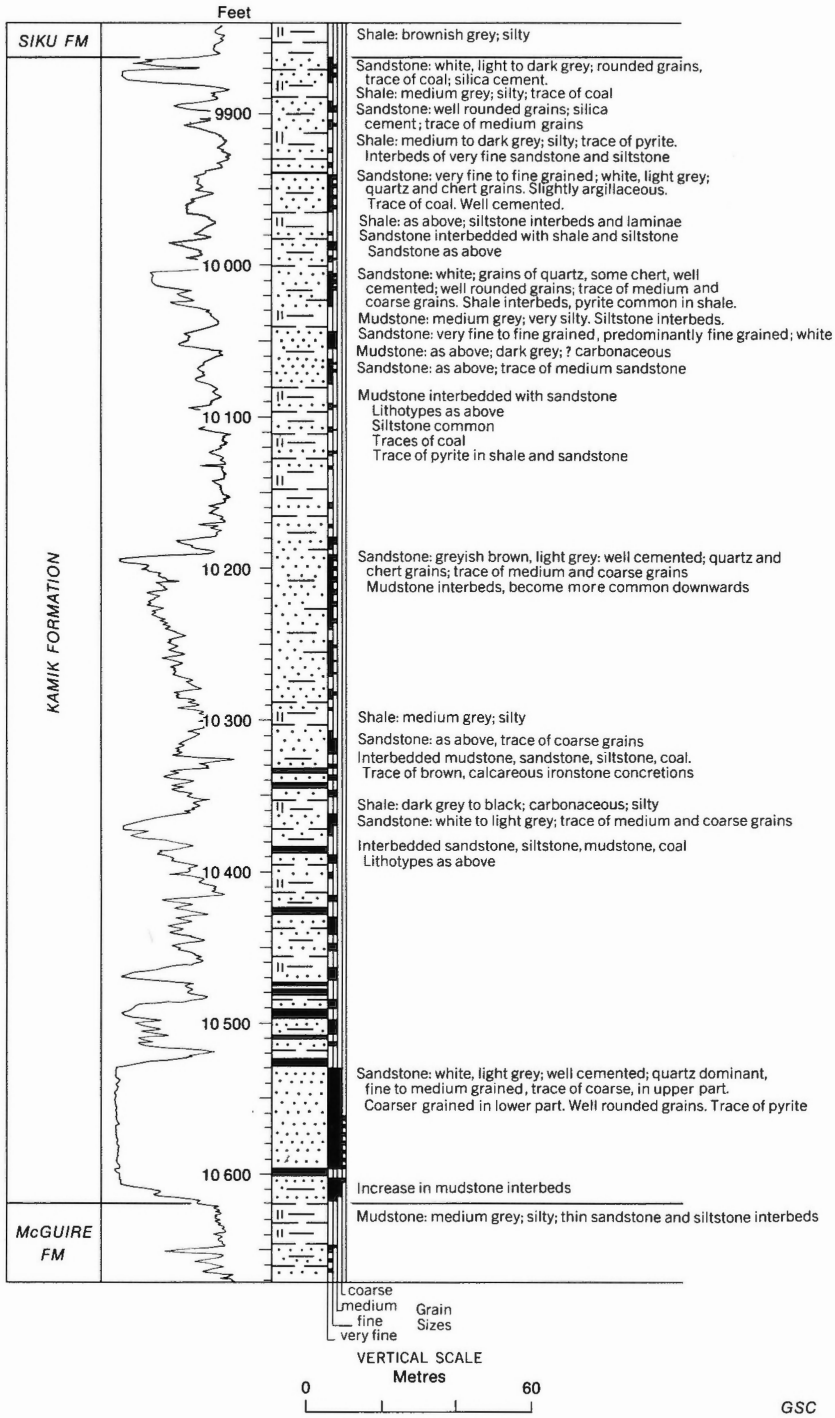
1195.4-1204 (3922-3950) Mount Goodenough Fm.
1338.1-1344.8 (4390-4412) Kamik Fm. (very little recovered)
1521.9-1530.1 (4993-5020) Kamik Fm. (very little recovered)
2133.6-2137 (7000-7011) Aklavik Fm. (Bug Creek Grp.)

Esso Wagnark C-23

3780-3790 (12 404-12 434) Kamik Fm. 3844.4-3884.7 (12 613-12 627) Kamik Fm.

APPENDIX 3

Description and gamma-ray log character of the Kamik Formation in the type well at Gulf Mobil Kamik F-38



APPENDIX 4

Description and gamma-ray log character of the Siku Formation in the type well at Gulf Mobil Siku A-12