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DEPARTMENT OF ENERGY,
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SECTION

**LOWER CRETACEOUS (ALBIAN) OF THE YUKON:
STRATIGRAPHY AND FORAMINIFERAL SUBDIVISIONS,
SNAKE AND PEEL RIVERS**

(Report, 4 figures and 3 tables)

E. W. Mountjoy and T. P. Chamney



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Abstract

The Lower Cretaceous Albian and Aptian (?) strata of the upper Peel River near the mouth of Snake River and Trevor Range are outlined and discussed. The Lower Cretaceous rocks of this region that form part of the Peel Plain are subdivided into three new formations: Trevor Formation composed of about 1,200 feet of sandstone; Arctic Red Formation consisting of about 2,000 feet of shale and silty shale and divisible into five members; and Martin House Formation consisting of about 600 feet of glauconitic and dark grey siltstones and silty shales, and which are divided into an upper Glauconite member and a Basal Siltstone member of questionable Aptian age. The Trevor Formation is approximately equivalent to the upper three quarters of the Arctic Red Formation and gradationally overlies the Arctic Red in the southern part of the area. The Martin House Formation includes all shales and siltstones above Devonian or Carboniferous strata and beneath the Arctic Red Formation.

The Lower Cretaceous sediments in the Peel - Snake Rivers region formed an eastward part of the Richardson - Carcajou trough or basin. Marine Aptian (?) sediments are restricted to the extreme western part of Peel Plain. Initial Albian sedimentation appears to mark a widespread, almost chronotaxial, marine boreal transgression. Predominately marine sediments were deposited in a shallow basin which extended from the Arctic to the Peace River region. During Middle and Late Albian, clastic debris derived from uplifts considerable distances to the west and southwest probably formed delta complexes along the western margin of this basin. These quartz sands grade and interfinger rapidly northeastward and northward into marine black shales. Maximum thickness of Albian sediments in the Peel - Snake region is between 2,000 and 2,500 feet. Some of the sands associated with the basal part of the Albian may form traps suitable for petroleum accumulations.

Nine biostratigraphic subdivisions of the Albian sediments are established from assemblages of Foraminifera. The most significant of these are the late Middle Albian Valvulineria loetterlei - Gaudryina subcretacea and the Early Albian Saracenaria trollopei. They represent the strongest marine environments, are correlatable over most of the western and northern sedimentary basins, and are referable to the "Joli Fou" and "Clearwater" Seas respectively. Each of these provides a datum from which the remaining depositional intervals of the Albian stage can be interpreted.

LOWER CRETACEOUS (ALBIAN) OF THE YUKON: STRATIGRAPHY AND
FORAMINIFERAL SUBDIVISIONS, SNAKE AND PEEL RIVERS

PART I

STRATIGRAPHY

by
E. W. Mountjoy

Introduction

This report summarizes some data concerning the Lower Cretaceous Albian rocks of the middle part of Peel River and adjacent lower part of Snake River. The region comprises the western part of the Peel Plain and the eastern part of Peel Plateau, the most northwesterly extension of the Interior Plains. It occurs east of the southern Richardson Mountains and north of the northwestern Mackenzie Mountains. The report is based on field work by E. W. Mountjoy during Operation Porcupine in the summer of 1962 when parts of the Arctic Red, Snake and Peel Rivers were traversed by rubber boat. The samples collected for microfossils were disintegrated, picked and studied for biostratigraphic interpretations by T. P. Chamney of the Institute of Sedimentary and Petroleum Geology, Calgary, Alberta.

The general distribution of rock units in this area is shown on a small-scale preliminary geologic map prepared in conjunction with Operation Porcupine (Norris, et al., 1963). A subsequent study of fossil collections indicated that parts of the map should be changed, and a revised map is shown in Figure 1.

The area covered by this report is illustrated in Figures 1 and 2. Descriptions of stratigraphic sections are given in Appendix I, together with pertinent macrofossil data. The microfossil data are listed in Tables 1 and 2 (see part II). Future reports will include data collected from the Lower Cretaceous Albian strata along the Arctic Red, Cranswick and upper Snake Rivers and the lower part of the Peel River.

Previous Work

The first geological study along the Peel River was made by C. Camsell in 1905 (Camsell, 1906) who found a new route from Beaver River to Wind River through Braine Pass. He studied the geology along the Wind River and in the area around Rat River and Mount Goodenough. The next important study of the Peel was undertaken in

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the summer of 1942 by geologists of the Canol project. C.R. Stelck (1944b) studied the geology along the upper part of Peel River and E.J. Foley (1944) examined the geology of the lower part of Peel River (in Hume and Link, 1945; Hume, 1954). Since then the area has been examined by several oil companies but only a small part of their information has been made available. Jeletzky (1958, 1960, 1961) reported on the Jurassic and Cretaceous rocks and faunas of the eastern flank of the Richardson Mountains.

Field Work

Sections were measured by means of Jacob- staff and correlated in the field by means of clay, siltstone or sandstone marker beds where present.

Measurement and correlation of the Lower Cretaceous sequence is made difficult by a number of factors: the lack of good marker horizons with distinct lithologies; the lack of abundant diagnostic zone macrofossils of restricted stratigraphic range; the intermittent nature of river exposures; the lack of control due to muskeg cover between rivers; and the very small angle of dip between successive outcrops. Thus the composite stratigraphic sections constructed from the small amount of data are not too reliable and, in some cases, are little more than speculative. Part of the purpose of this paper and the micropaleontological investigation is to help provide a more refined zonation of the sequence than can be achieved solely with stratigraphic and macrofossil correlations.

Acknowledgments

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Lower Cretaceous

Introduction

Lower Cretaceous rocks of Albian age are widely distributed in the general vicinity of the lower part of the Mackenzie River area in the Peel and Anderson Plains. They extend from the northern edge of the Mackenzie Mountains between the Peel River and Fort Norman northward to the Arctic Ocean (Fig. 1; see also GSC Map 30-1963, Douglas and MacLean, 1963). These strata are more or less continuous with rocks of the Fort St. John Group which outcrop to the south between Hay and Liard Rivers (Stott, 1960b), in the northern extension of the Alberta basin. (See section on correlation for a more complete discussion of equivalent units).

Previous Nomenclature

The Albian succession of this region consists of a thick sequence of shale, silty shale, and siltstone with sandstone becoming predominant near Mackenzie Mountains. Before discussing the local succession, it is important to review briefly the somewhat similar Cretaceous succession to the east near Norman Wells, which has been examined in some detail by other geologists. The nomenclature established by them (Stewart, 1945; Hume, 1954) is reviewed insofar as it might have been applicable in the present area of study.

The Cretaceous of the Norman Wells region was divided by Stewart (1945) into the Sans Sault Group, Slater River, Little Bear, and East Fork Formations, in ascending order. All Lower Cretaceous sandstone and shale between the Devonian Fork Creek or Ramparts Formations and overlying bentonitic shales of the Slater River Formation (assigned to Upper Cretaceous) were placed within the Sans Sault Group (Stewart, 1945). The Slater River Formation, consisting of 2,150 feet of dark grey to black shale, is overlain by the Little Bear Formation composed of 780 feet of sandstone, sandy shale, and some coal. The East Fork Formation consists of 850 feet of grey marine shale. All are poorly defined units and lack good lithological boundaries.

The upper Sans Sault sandstone, that is exposed at the rapids across the Mackenzie River, is dated as of Early to Middle Albian because of the presence in these strata at the south end of Clamshell Island of Gastrolites, Beudanticeras, Hoplites, and several types of pelecypods. McGill and Loranger (1961) suggested, from a study of Foraminifera, that the Sans Sault Formation, as interpreted by them, contained five (Albian?) markers and inferred that the younger Slater River Formation is also in part of Albian age. The age of the Slater River, Little Bear and East Fork Formations is not well established owing to the present lack of definitive paleontological data. The shales of the East Fork Formation are very similar to those of the Slater River Formation (Stewart, 1945, p. 8; Hume, 1954, p. 48). Therefore, it is possible that the shales near Bear Rock (on the north side of Mackenzie River several miles east of the Slater River Formation type section), that yielded Upper Cretaceous fossils and that were assigned to the Slater River Formation by Stelck (1944) and Hume (1954), may belong to the East Fork Formation. Even the stratigraphic relationships of these shales near Bear Rock are not known because they occur in isolated outcrops completely separated from other Cretaceous strata on the south side of the river. The age assignment of the Slater River, Little Bear and East Fork Formations is based essentially on that one Upper Cretaceous fossil locality, together with its proposed correlation with strata in the Bluefish well (about 10 miles west of Fort Norman) and with the type Slater River Formation. Thus, it is only possible to state that these formations are of Cretaceous age.

The type section of the Sans Sault Formation, outlined by Stewart, is based on an unpublished description by J.M. Parker (1944b; see Hume, 1954) in a Canol report. That section is composite, the upper part being described at Sans Sault rapids and the lower part along Mackenzie River about 4 miles upstream. The formation is reported to be 1,411 feet thick and to consist of three units; a basal sandstone (50 feet),

a middle shale (1,247 feet) and an upper sandstone (114 feet). The basal medium-grained, conglomeratic sandstone may correlate with a 1,000-foot thick interval of glauconitic and conglomeratic sandstone that occurs 40 miles to the southeast along Imperial River (Hume, 1954, p. 51).

A glauconitic sandstone at the base of the Sans Sault in the Norman Wells area may be equivalent to the Martin House Formation of the Peel and Snake Rivers region described in this report. Correlation of overlying strata is much less certain. Although only about 100 feet of sandstone occur in the upper Sans Sault in the region of Sans Sault rapids, 900 and 1,200 feet of sandstone are reported at the top of the Lower Cretaceous succession on Arctic Red and Ramparts Rivers respectively (McKinnon, in Hume, 1954, p. 52). From there this sandstone succession is easily mapped to east of Hume River (Fig. 1) and probably forms the eastern part of the Trevor Formation of this report. The upper beds of the western succession are not readily traced into the Norman Wells region but photo interpretation and the known stratigraphic relationships suggest that they occur stratigraphically above the Sans Sault Formation and it is suggested that they may be equivalent in age to the Little Bear Formation. The underlying shale succession in the west, more than 1,000 feet thick and containing Beudanticeras near the base, appears to be equivalent to some part of the Sans Sault Formation but correlation is tentative at the present time. A recent study of well data by E.J. Tassonyi (1964; personal communication) indicates that sandstones of the Sans Sault Formation have an erratic and limited distribution and cannot be traced for any distance.

It is advisable to use a different terminology for the Lower Cretaceous sequence that occurs between Hume and Peel Rivers because of the considerable doubt regarding the character of the stratigraphic succession in the region of Norman Wells. The Slater River, Little Bear, and East Fork Formations are not well dated, thereby inhibiting direct paleontological correlation with the upper part of the Peel River Succession. The present surface study and the subsurface work of Tassonyi (in press; and Open File report) show that many of the Cretaceous sandstones are of local extent and cannot be traced far, except for the distinct glauconitic sandstone near the base. It is considered advisable, therefore, to use new formational names for the Lower Cretaceous sequence that occurs between Hume and Peel Rivers.

Present Work

Most of the sections outlined in this report are almost continuously exposed. Section 1 was measured on the flank of a broad homoclinal or anticlinal structure on Peel River. Section 2 was measured at the junction of the Snake and Peel Rivers. Sections 3 and 4 were measured along the lower part of Snake River and Section 5 was measured on the east side of the Trevor Range (Fig. 2). The sequence is dated as Albian on the basis of widely scattered macrofossils and the sequential control of microfossils for the type sections.

Samples collected from the Peel River section were assigned an Early Albian to early Late Albian age by Chamney on the basis of the contained Foraminifera.

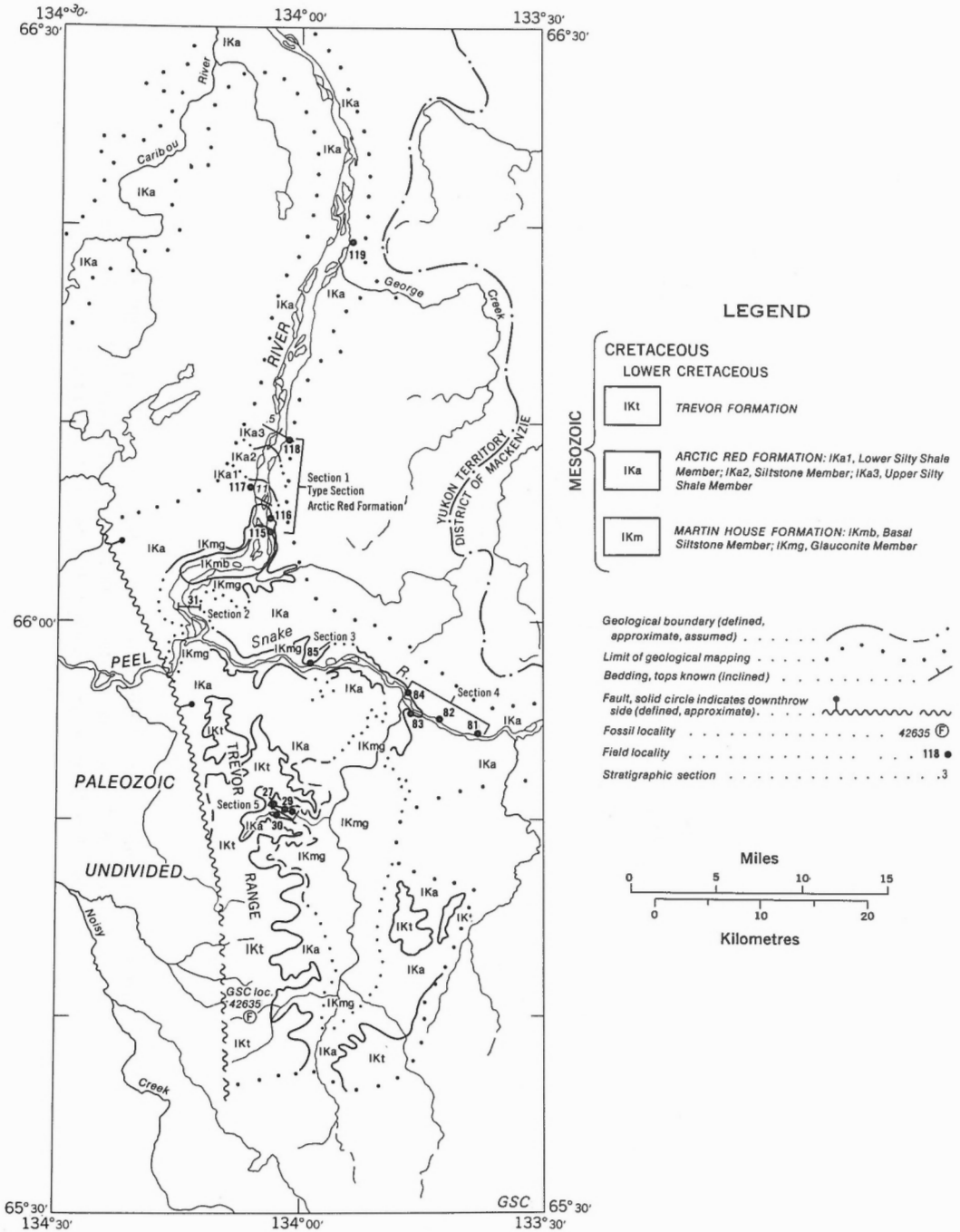


Figure 2. Geology and location of sections in the vicinity of Peel and Snake Rivers, Yukon Territory

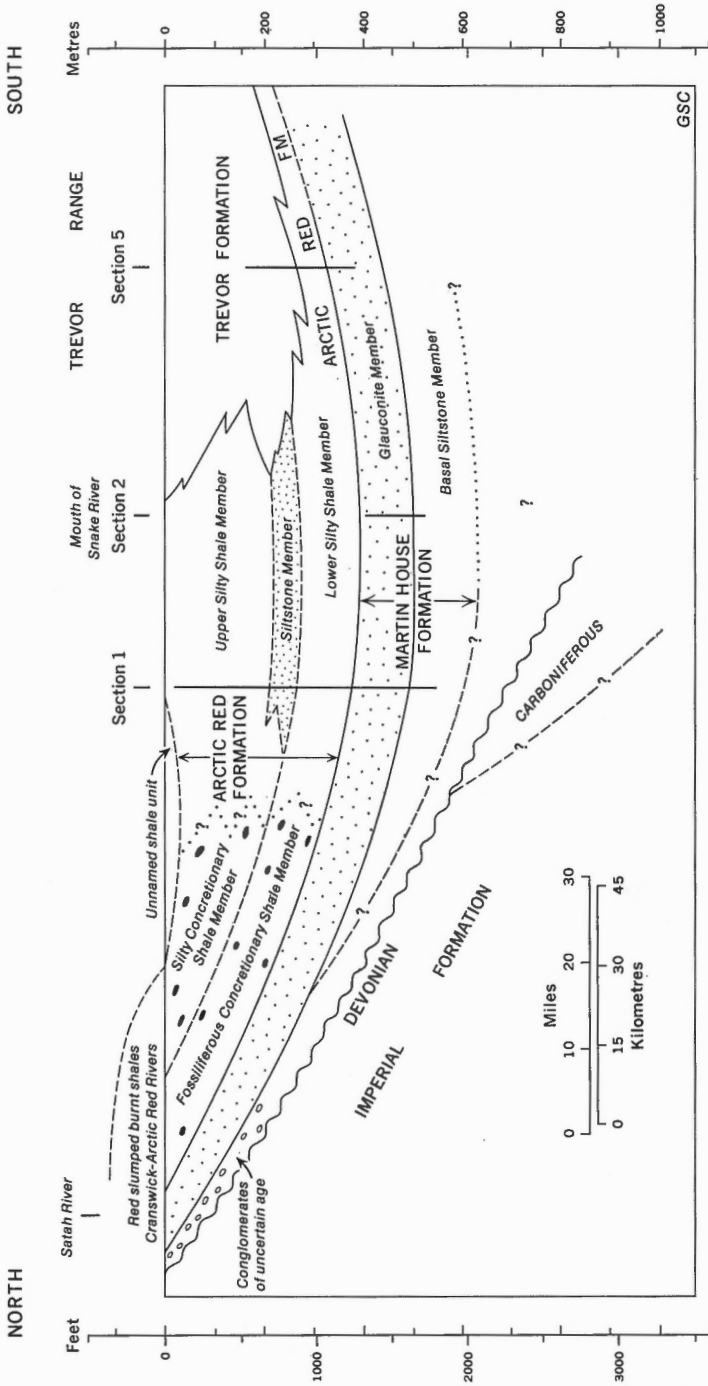


Figure 3. Schematic diagram illustrating the inferred stratigraphic relationships of Lower Cretaceous strata across the western part of the Peel Plain in the vicinity of Snake and Peel Rivers, Yukon Territory

Detailed Stratigraphy

The Peel and Snake Rivers have eroded deep channels into the soft shale, siltstone and sandstone, and in several places cliffs occur exposing between 200 and 600 feet of section. The Lower Cretaceous is divisible into three main rock units: a distinct basal glauconitic siltstone and shale herein named the Martin House Formation; a thick (1,300 feet) shale unit with considerable siltstone present near the top, herein called the Arctic Red Formation; and a sandstone forming mesa-like hills in front of the Mackenzie Mountains, called the Trevor Formation. The latter sandstone unit thins northward and grades into shales of the Arctic Red Formation (Figs. 3 and 4). The Martin House Formation is divisible into the following two members in ascending order:

- 1) Basal Siltstone member (more than 300 feet thick)
- 2) Glauconitic member (350 feet thick)

The Arctic Red Formation in the Peel and Snake River region is divisible into the following three members in ascending order:

- 1) Lower Silty Shale member (600 feet)
- 2) Siltstone member (240 feet)
- 3) Upper Silty Shale member (more than 400 feet)

Two other members, the Fossiliferous Concretionary Shale member and the Silty Concretionary Shale member occur above the Martin House Formation to the north and east (Arctic Red River region) near the erosional edge of the Lower Cretaceous outcrops (Figs. 3 and 4). The Fossiliferous Concretionary Shale member is probably a facies of the Arctic Red Formation. The overlying Silty Concretionary Shale member is considerably different from the underlying Fossiliferous Concretionary Shale member. Additional study is required for age dating and stratigraphic assignment especially of the upper part.

These members are not laterally extensive and, therefore, can only be recognized in a rather limited local area. The Martin House Formation, in contrast, forms a widespread, readily recognizable formation. Members of the silty facies of the Arctic Red Formation were recognized only in the lower reaches of the Snake River and downstream from the mouth of the Snake to below section 1 (Fig. 2). The concretionary shale members are restricted to the northern part of the study-area and extend from the Peel River to the Arctic Red River, a distance of about 50 miles, and may extend eastward to the Mackenzie River.

Distribution of the Trevor Formation on air photographs and in the field, clearly indicates that most of the Cretaceous succession is essentially flat-lying over extensive areas, except for very gentle warping which has resulted in dips of less than half a degree. The most prominent structural feature is the anticline or monocline that occurs on Peel River about 14 miles south of the mouth of George Creek. Section 1 (Appendix; Figure 2, field stations 115, 116, 117, 118) was measured across this structure which exposes more than 1,600 feet of strata. Downstream adjacent to the anticline? is a very broad, open syncline.

The microfauanal content of the Trevor sandstone suggests that the formation grades northward and northeastward into silty shales of the Arctic Red Formation exposed on Peel River (Figs. 1 and 2). Siltstone and sandstone marker beds in the Glauconite member of the Martin House Formation as well as microfossils have been used to correlate the sections measured in the Trevor Range with those near the mouth of Snake River. The approximate distribution of two of the prominent siltstone units is shown on Figure 2.

Martin House Formation

Distribution and Lithology

The name Martin House Formation is proposed for the distinctive, generally glauconitic, shales and siltstones at the base of the recessive Lower Cretaceous (mostly Albian) shale succession of the Peel Plain. These rocks rest unconformably on Devonian or Carboniferous strata and are overlain gradationally by the Arctic Red Formation. They are well exposed along the erosional edge of the formation in the northern part of the region, especially along the lower parts of the Peel and Arctic Red Rivers. The lower part of the Martin House Formation is at present known to occur only along the Peel River below the junction with Snake River (Fig. 2).

The type section is located on the east side of Peel River approximately 10 miles downstream from the mouth of Snake River (Appendix, section 1; Fig. 2). The exposures along the lower part of Peel River near the mouth of Satah River (Fig. 1), although they lack the Lower Siltstone member, are considered as a supplemental type section.

The Martin House Formation is divisible into a Basal Siltstone member of questionable Aptian age and an upper Glauconite member of early Albian age. The lower member is more than 70 feet thick (base not exposed) and the upper member is about 500 feet thick. Descriptions of these two members follow.

Basal Siltstone member

The base of this member is not exposed in the study-area but is thought to be a short distance below the surface near the mouth of Snake River. This member is known to occur only on the Peel River (section 1) about 10 miles downstream from the mouth of Snake River (Fig. 2).

The Basal Siltstone member at section 1 consists of siltstone alternating with silty, recessive shales in units 5 to 20 feet thick. These strata are more than 73 feet thick (base not exposed), and are non-calcareous, medium to dark brownish grey and light brown-weathering. Scattered beds and individual concretions of reddish brown-weathering siltstone occur at the base and top of the exposed section.

The contact with the overlying Glauconite member is indistinct and gradational. The contact may represent a disconformity but present microfossil data indicate that a more or less complete sequence is present. On Peel River near Satah Creek and along the lower part of the Arctic Red River the Glauconite member rests directly on Paleozoic strata and, therefore, the depositional edge of the Basal Siltstone member is buried beneath the Glauconite member somewhere north and northeast of section 1 and north of the Snake River (Fig. 1, 2 and 3).

The Basal Siltstone member is tentatively dated as Aptian? on the basis of microfossil determinations by Chamney (see part II). These microfossils are referred to the *Pyruilina* cf. *P. cylindroides* assemblage subzone. The lower half of the overlying Glauconite member may be also of Aptian age but is provisionally assigned by Chamney to an Albian-Aptian transition interval.

Glauconite Member

The Glauconite member consists of grey, fine-grained sandstone, siltstone, and silty shale with varying amounts of glauconite giving these strata a greenish colour. Scattered bentonite layers and siltstone concretions are also present throughout the member. The silt and sand content is most abundant in sections 1, 2 and 3, presumably because of proximity to the source area. The content of silt and sand gradually decreases northward and eastward so that along the northern erosional edge of the formation this member consists mainly of dark grey to black silty shale with abundant glauconite at the base.

A composite section of the Glauconite member, 340 feet thick, was measured on Peel River just upstream from Satah Creek. These strata occur above a distinctive conglomerate (see below) and consist predominantly of fine-grained sandstone alternating with dark grey, silty shale, both of which contain varying amounts of glauconite. The uppermost beds (a few feet) of the Glauconite member may be missing in this section because the contact with overlying black, fissile shales is not exposed. Abundant pelecypods as well as brittle starfish occur in some beds. The pelecypods can be dated only as post Paleozoic. Presumably this is part of the same section as that described by Foley (Hume, 1954, p. 52).

Upstream on Peel River near the junction with Snake River (sections 1 and 2) laterally equivalent beds contain less glauconite. In section 1 only the upper half of this member contains glauconite. It also contains abundant siltstone and fine-grained sandstone. At the mouth of Snake River (section 2), about 12 miles farther upstream, the lower part of the Glauconite member is again different; there it is much more argillaceous and contains no noticeable glauconite. Correlation was made on the basis of microfossils and its stratigraphic position below the Lower Silty Shale member. Section 2 (see Appendix) consists mainly of non-calcareous shale and silty shale with interbedded layers of reddish brown-weathering siltstone concretions that become more numerous towards the top. The shales lack fissility and weather light to medium grey or brown. A few thin, intercalated beds of light grey bentonite (?) occur throughout. Rare lignite is present near the base.

Strata occurring on Snake River about 8 miles upstream from its mouth (section 3, Fig. 2) are tentatively assigned, on the basis of lithological correlation in the field, to the upper part of the Glauconite member. These rocks are again coarser grained and contain glauconite. The glauconitic sands and silts of sections 1 and 3 probably represent a more shoreward facies of this member whereas the more argillaceous succession of section 2 represents somewhat deeper water and more seaward conditions.

Microfossils indicate that the basal 100 feet or more of section 5 is equivalent in age to the top of the Glauconite member. This section is more argillaceous and lacks glauconite, again suggesting somewhat deeper water westward of the near shore silts and sands.

Initially section 2 at the mouth of Snake River was believed to contain stratigraphically older beds than section 1 because the upper sandstone portion of the Glauconite member is missing. A preliminary examination of Foraminifera by T.P. Chamney shows that the basal 150 feet of section 2 contain a microfauna similar to the Textularia assemblage zone and the upper 350 feet a fauna similar to the Saracenaria trollopei zone. Both of these zones occur in the Glauconite member of section 1 above the Basal Siltstone member and contain Pyrulina cf. P. cylindroides (see part II, Table 2).

Along Arctic Red River, ammonites identified as Beudanticeras sp. by Jeletzky (1964) were collected from the top of the Glauconite member and from the base of the overlying Arctic Red Formation. In section 5, on the east side of the Trevor Range, Lemuroceras sp. and Cleoniceras sp. occur about 200 feet below the top of the Glauconite member (see Appendix).

The base of the Glauconite member, as noted above, contains the Textularia spp. — Bathysiphon cf. B. brosgiei assemblage zone which Chamney considers to be transitional in age between ?Aptian and Early Albian. The Glauconite member also contains the lower Lenticulina erecta assemblage subzone of the Saracenaria trollopei zone. The L. erecta assemblage subzone, according to Chamney, is of earliest Albian age. Microfossils from the Glauconite member of section 1 (see part II of this report) have been assigned to the Saracenaria trollopei Zone (upper half) and the Textularia spp. — Bathysiphon cf. B. brosgiei assemblage zone (lower half), and dated as Early Albian and ?Aptian and Early Albian transition respectively. The upper half of the Glauconite member is, therefore, the same age as the Clearwater and lower Moosebar Formations in northeastern British Columbia and adjoining parts of Alberta.

As a result of reconnaissance studies by the writer along Trail River and lower Vittrekwa River, between 300 and 700 feet of strata are assigned to the Martin House Formation. The outcrop pattern indicates a broad, faulted syncline immediately east of the fault that borders the Richardson Mountains (Fig. 1).

The lower contact of the glauconitic sandstones is reasonably well exposed on Peel River at the mouth of Satah River (about 25 miles south of Fort McPherson) where they overlie a conglomerate about 50 feet thick and of uncertain age. Plant fragments from the conglomerate cannot be dated (McGregor, personal communication, 1966). Jeletzky (personal communication, 1964), however, considers the conglomerate on Peel River near Satah River to be of Upper Devonian or ?Lower Mississippian age on the basis of plant fragments and fossil wood collected from immediately underlying beds. A similar pebble-conglomerate occurs on Arctic Red River about one mile downstream from Martin House (Fig. 1). About 2 miles upstream from Martin House between 30 and 40 feet of fine-grained, calcareous, grey sandstone, in part glauconitic, is exposed and is the same Glauconite member that occurs on Peel River. Conglomerates also occur elsewhere at the base of the Albian sequence. In the Stony Creek area, for example, a pebble-conglomerate of varying thickness fills depressions in older Cretaceous rocks (Jeletzky, 1961, p. 540).

Conglomerates have been observed also at the base of the Albian on Arctic Red River and in the Norman Wells area at the base of the Sans Sault Group (Hume, 1954). To the south in the region of lower Liard River, about 30 feet of similar conglomerate occurs at the base of the Buckinghorse Formation (Stott, 1960b, p. 9).

Thus, the widespread occurrence of conglomerates at the base of the Albian sequence suggests that they represent an initial deposit of the Lower Cretaceous transgression at least in the northern and northeastern part of the study-area. These conglomerates may include older reworked residual material. They form a distinct unit and perhaps should be given member status.

Outcrops of the Martin House Formation occur in a broad, faulted, synclinal structure immediately east of and adjacent to the fault that borders the Richardson Mountains. This structure has been generalized on the geological map as a simple syncline (Fig. 1) which has a gentle regional southeast plunge.

The distribution and age of strata underlying the Cretaceous beds is not well established owing to the lack of subsurface information and fossiliferous strata. The Devonian Imperial Formation outcrops north and northeast of the Cretaceous outcrops in the Peel Plain. To the west of the Cretaceous outcrop belt Lower Carboniferous plant fossils (on Caribou River) were collected from a sandstone-shale sequence. Similar clastic strata occur immediately south of the Cretaceous outcrops between Snake River and Trevor Range and are tentatively assigned to the Carboniferous. Presumably these Carboniferous strata extend some distance beneath Cretaceous strata occurring on the Peel Plain.

The presence of Aptian? strata in Peel River outcrops suggests that older Mesozoic clastics may occur also in the southwestern corner of the Peel Plain and might be confused with Paleozoic rocks having similar lithology.

Age and Correlation

The age of the Martin House Formation ranges from Aptian? or earliest Albian to late Early Albian (Fig. 4) as indicated in the above discussion concerning each member.

Aptian strata, in part equivalent to the Basal Siltstone member of section 1, are restricted in northern Canada but are represented by the Upper Sandstone Division of Jeletzky (1958, 1960, 1961) on the eastern flank of the northern Richardson Mountains. To the south some portion of the Gething Formation (Stott, 1967) appears to be equivalent.

Strata of Early Albian age are widely distributed in northern Canada (Fig. 4, and Stelck, 1958), and Albian strata extend northward to a point just north of Stony Creek and west of Fort McPherson (Jeletzky, 1960). These beds, which are equivalent, in part, to the Martin House Formation and lower part of the Arctic Red Formation were tentatively referred to the Sans Sault Group by Jeletzky (1961, Fig. 1, p. 534). The Albian shale-siltstone division of Jeletzky is a northern extension of the Martin House Formation and lower part of the Arctic Red Formation. According to Jeletzky (1960, Fig. 2) these units end a few miles north of Stony Creek. They appear to have been eroded from the Rat River area (just 15 miles north of Stony Creek) and regions to the north because there Upper Cretaceous Cenomanian strata rest directly on Barremian and Aptian sandstones. Early Albian strata are known to occur also east of the Mackenzie delta at Toker Point (Jeletzky, 1960, p. 19) and along the Anderson River in the Anderson Plain where they have been referred to the Sans Sault Group by McGill and Loranger (1961, p. 517).

A much thinner Early Albian succession occurs on the Porcupine River (Jeletzky, 1960, p. 19), and throughout much of the Eagle Plains. Recent reconnaissance studies indicate that this unit decreases in thickness and is no longer present near the head of Peel River and west of Eagle River (Norris *et al.*, 1963; Mountjoy, 1967, and unpublished). Farther north one collection of the early Albian ammonite *Sonneratia* (*s. lato*) sp. indet. has been made by geologists of Texaco Exploration Co. from an eastern tributary of Blow River 12 miles east of Mount Fitton. The work of Operation Porcupine indicates that these rocks continue northward and outcrop along much of the lower part of Blow River.

In Alaska (Fig. 4) Early Albian shales and sandstones are widespread on the central Arctic slope north of the Brooks Range (Detterman *et al.*, 1963; Tappan, 1962). These formations are discussed more fully under the Arctic Red Formation.

The Glauconite member of the Martin House Formation is one of the most distinct and widespread units. Not only does the Martin House Formation form a well-defined unit within the Peel Plain but it also appears to be a distinct and nearly chronotaxial unit that extends as far south as the Alberta basin. Glauconite has been reported from the basal and upper sands of the Sans Sault in the type area (Parker, 1944b). In the subsurface of the Norman Wells area, Tassonyi (personal communication, June 1966) demonstrated that glauconite is conspicuous also in the first and

second sandy members of the Sans Sault Formation and, although present in the immediately overlying shales, is relatively inconspicuous. In the Fort Liard region (Stott, 1960b, 1967) the Buckingham Formation contains glauconite in the basal 150 feet as well as in sands and silts 800 to 1,200 feet above the base. Immediately to the south in the Tetsa-Peace region Stott (1967, p. 14) reported silty sandstones containing much glauconite at the top of the Gething Formation, which is gradational with the Buckingham Formation. In the Peace River area some glauconitic, argillaceous siltstones occur near the base of the equivalent Moosebar Formation (Stott, 1963, p. 9). Stott (1967) suggested that the glauconitic sands at the top of the Gething Formation may represent some part of the Bluesky Formation in the subsurface of the Peace River Plains. Mellon (1967, p. 80) concluded that the base of these marine successions marks a time-datum plane in most of northern and central Alberta and adjoining British Columbia. This zone is equivalent to the base of the Beaver Mines and Fort Augustus Formations of the middle part of the Blairmore Group (ibid. op.cit., p. 80).

In a regional survey of the Lower Cretaceous, Rudkin (1965, p. 160) concluded that in the shelf areas the glauconite-bearing sands represent a marine incursion following a time of essentially non-marine sedimentation except in the extreme northwestern part of the region where sedimentation was more continuous. At many places the upper part of the glauconite sands either contains or is overlain by shales that contain ammonites representative of the Beudanticeras affine faunal zone. As pointed out by Rudkin (1965, p. 163) these glauconitic sands appear to mark the beginning of a major transgression by the boreal sea from the north. The above data suggest that this transgression was rapid and, in terms of geological time, is close to being chronotaxial in a large part of northwestern Canada. It is clear, however, that this transgression began in the north and extended southward. A distinct series of environmental facies was developed from north to south; essentially marine north of latitude 57 degrees, mixed marine and non-marine between latitudes 53 and 57 degrees, and essentially non-marine south of latitude 53 degrees (Rudkin, 1965). It may be that in areas to the west marine conditions either began earlier or continued from earlier Lower Cretaceous time (section 1, Jeletzky, 1960, 1961; Stott, 1963, 1967). The glauconite sands and shales are thought to mark a major encroachment of the sea eastward and southeastward over a shelf that had remained land for a considerable period of time.

Arctic Red Formation

Lithology and Distribution

The name Arctic Red Formation is proposed for all recessive Lower Cretaceous shales and siltstones that occur beneath the Trevor sandstones and above the Martin House Formation, and which outcrop extensively along the lower parts of the Peel, Snake, Cranswick and Arctic Red Rivers. Where the Trevor Formation grades laterally into shales and can no longer be distinguished as a mappable unit, as on the lower parts of the Peel and Arctic Red Rivers, the entire shale succession is assigned to the Arctic Red Formation. The type section is located along both sides

of Peel River (section 1, Fig. 1) and is named after the Arctic Red River. The exposures along Cranswick River can be considered as supplemental to the type section (section 1) as are those on the adjoining middle part of the Arctic Red River.

The Peel, Cranswick and Arctic Red Rivers provide almost continuous exposures of the Arctic Red Formation. However, the very small angle of dip and lack of markers make correlation difficult. It is impractical, moreover, to assemble a meaningful composite type section especially with respect to thickness. At its maximum development the Arctic Red Formation is over 1,900 feet thick and may be as much as 2,400 feet thick.

Two gross facies are recognizable in the Arctic Red Formation, a silty shale facies and a concretionary shale facies (Fig. 3). The concretionary shale facies occurs in the northern part of the study-area along the eroded edge of the formation. Southward the silt content and grain size gradually increases resulting in a distinct silty shale facies between the Trevor Formation and the concretionary shales (Fig. 3). The boundaries between these facies are completely gradational and are difficult to distinguish.

Silty Shale Facies

The silty shale facies is divisible into three members, two silty shale members separated by a middle siltstone member (Figs. 3 and 4).

Lower Silty Shale member: This member consists of thin-bedded, dark grey to brown, silty shales with thin siltstone concretions and rare siltstone beds. The siltstone concretions tend to be most abundant in the upper part. A few clay (bentonite?) layers are present in most exposures. These rocks weather light to medium grey and, in comparison to the overlying member, are moderately resistant to erosion. The Lower Silty Shale member is best exposed along the Peel River (section 1, station 116) below the mouth of Snake River. It also outcrops extensively along the lower reaches of the Snake River (section 4) and the lower part of the member occurs below the Trevor Formation on the east side of the Trevor Range (section 5) just north of the Mackenzie Mountain Front (Fig. 2).

The Lower Silty Shale member is 616 feet thick in section 1 along the Peel River. Elsewhere, because of the absence of the overlying Siltstone member or underlying Glauconite member, it is impossible to determine the thickness of this member. However the same order of thickness was obtained from these outcrops as from those measured in the Peel River section.

Nearly 1,200 feet of strata occur at section 4, above 305 feet of siltstones tentatively assigned to the Martin House Formation. At section 1 the combined thickness of the three members of the silty shale facies is more than 1,300 feet. Thus, the strata of section 4 presumably represent all three of these members unless rapid thickness variations have occurred. No prominent siltstone member occurs,

however, other than a silty development in the shales of unit 6, (Appendix), so that it is not possible to divide this sedimentary sequence into members. It is simply referred to the upper part of the Arctic Red Formation. From a preliminary examination of microfossils from these strata in section 4, T.P. Chamney reported that both Middle and Late Albian microfaunas are present.

Lateral equivalents of the Lower Silty Shale member also occur in the 357-foot gradational interval beneath the Trevor Formation. Chamney reported that microfossil representatives of the Ammodiscus mangusi assemblage zone occur in these beds. This zone occurs in the lower portion of the Lower Silty Shale member in section 1 (Part II, Table 2):

Few macrofossils were found in this member except for a few pelecypods which occur in concretions. The shales are generally too deeply weathered to obtain good fossil impressions. On the basis of microfossils determined by Chamney (see part II) this member is dated as late Early Albian to early Middle Albian.

Microfossils from the Lower Silty Shale member of section 1 and adjacent sections have been identified by Chamney (see part II of this report) and assigned to the following two foraminiferal assemblage zones and one subzone (Fig. 4, Plate 2): Gaudryina canadensis assemblage zone; Ammodiscus n. sp. 1 - Ammodiscus mangusi assemblage zone; and the upper Marginulinopsis collinsi assemblage subzone of the S. trollopei zone.

The Ammodiscus and M. collinsi assemblage zones are dated as Early Albian and the G. canadensis assemblage zone is dated as early Middle Albian by Chamney.

No ammonites were collected from section 1 but Beudanticeras sp. is abundant in the lower part of the laterally equivalent Fossiliferous Concretionary Shale member to the north. Foraminifera representative of the Marginulinopsis collinsi assemblage subzone appear to range downward into the Martin House Formation in section 5 on the east side of the Trevor Range (Chamney, personal communication).

The Lower Silty Shale member is equivalent to parts of the Fort St. John Group including the Moosebar and Spirit River Formations and lower part of the Buckingham Formation (Fig. 4).

Siltstone member: This member is well exposed along Peel River (unit 16, section 1). It consists of 240 feet of argillaceous, medium to dark grey siltstone with intercalated concretionary layers spaced about 5 to 15 feet apart. A few clay (bentonite?) layers occur throughout and form distinct markers within the member. The siltstones weather light grey and form a prominent resistant cliff that can be traced for a number of miles along both sides of the river. Toward the top this member is less resistant to weathering.

To the north and northeast, downstream on Peel River and Arctic Red River, similar siltstones do not occur at this stratigraphic level and presumably grade in this direction into silty shales (Fig. 3). The base of this member appears to be approximately equivalent to a horizon about the middle of the lower half of the Trevor Formation.

No macrofossils were collected from this member and microfossil recovery was poor. These microfossils are referred by Chamney to the Marsonella spp. assemblage subzone, (the lower portion of the Ammobaculites fragmentarius assemblage zone) of the Middle Albian (part II, Table 2).

Upper Silty Shale member: The Upper Silty Shale member is well exposed along Peel River at section 1 and downstream at least to George Creek and possibly as far as immediately south of Trail River. It consists of a sequence of recessive and brownish grey-weathering, silty shales. Several 2- to 5-foot thick, intercalated siltstone beds and concretionary layers form thin, resistant bands in the shales. Light grey clay (bentonite?) layers are scattered throughout. It has a minimum thickness of 400 feet and may be as much as 800 feet thick.

Near George Creek, farther downstream from section 1, overlying but unnamed shales are exposed (Fig. 3). These consist of dark bluish grey shales with 1- to 4-inch thick, light brown, concretionary siltstone layers spaced 2 to 10 feet apart. The amount of siltstone gradually decreases upward. A few pelecypods were collected but these were too poorly preserved for identification.

Stratigraphic relationships observed in the area indicate that the Upper Silty Shale member grades toward the north and northeast into the Silty Concretionary Shale member and is in part the lateral equivalent of the Trevor Formation (Fig. 3). The top of the member is not present in this region.

A few pelecypods and ammonites were collected. The only collection suitable for identification was that from a locality about 2 miles upstream from the mouth of Caribou River and which contained Inoceramus cf. anglicus Woods and a gastropodid ammonite, dated as early to late Middle Albian by Jeletzky (GSC loc. 52746).

This member contains abundant microfossils especially in the lower part. The Foraminifera are divided by Chamney (see part II) into two zones; an upper Psammimopelta subcircularis - Verneuilioides borealis assemblage zone of Late Albian age, and a lower Valvulineria loetterlei - Gaudryina subcretacea assemblage subzone (upper part of Ammobaculites fragmentarios (assemblage zone) of late Middle Albian age.

As noted above under the Lower Silty Shale member the thick sequence measured on the Snake River at section 4 presumably includes some portion of the Upper Shale member but, because the succession lacks a distinct siltstone member, these beds can be only assigned to the upper Arctic Red Formation. Late Albian Foraminifera have been tentatively identified by T. P. Chamney from the upper part of section 4, thus verifying that these strata are time equivalents of the Upper Silty Shale member.

The Upper Silty Shale member appears to be equivalent in age to portions of the upper Fort St. John Group, i. e. the Sikanni and Goodrich Formations and the upper part of the Buckingham and the Hasler Formations of northeastern British Columbia and northwestern Alberta.

Concretionary Shale Facies

The concretionary shale facies of the Arctic Red Formation consists of dark grey to black shales containing numerous concretions which, near the base, contain abundant ammonite fragments. This facies is divisible into two members, based on these fossiliferous concretions and the generally greater silt content of the upper part; an upper Silty Concretionary Shale member and a lower Fossiliferous Concretionary Shale member.

Fossiliferous Concretionary Shale member: This member is the lateral equivalent (northern and less silty facies) of the Lower Silty Shale member, because it occurs above the recognizable Martin House Formation and contains abundant Beudanticeras and associated fossils (Fig. 3). The member is a more open marine and presumably a deeper water shale equivalent of the Lower Silty Shale member (Fig. 3).

On Arctic Red River the Fossiliferous Concretionary Shale member extends upstream from Martin House, near the mouth of Lower Beaver River, to approximately 2 miles above the mouth of Weldon Creek. On Peel River this member extends from a large, prominent bend about 5 miles upstream from the mouth of Satah River to the area just upstream from the mouth of Trail River. The contact with the overlying Silty Concretionary Shale member is essentially gradational and has been drawn arbitrarily where silty shales and siltstone concretions predominate and fossiliferous concretions are rare or lacking.

The Fossiliferous Concretionary shales are dark grey to black, fissile, generally non-calcareous and contain scattered concretions as much as 4 feet in diameter which increase in abundance and size toward the base of the member. A few silty shale intervals occur in the upper part of the member. Most of the concretions when broken open contained ammonite fragments. Many of the river outcrops are soft and deeply weathered and a great number have slumped into the river. These shales weather dark grey to reddish brown. Essentially similar, abundantly fossiliferous concretionary shales, occur along Peel River below the mouth of Road River. Upstream from Road River similar shales occur but lack abundant fossil-bearing concretions.

The thickness of this member on both the Peel and Arctic Red Rivers is extremely difficult to determine because of low dips, discontinuous outcrops and lack of marker beds. The low cliff exposures along the Arctic Red River indicate that it is over 200 feet thick. The Peel River is more deeply eroded and there exposures of this member are in the order of 300 to 400 feet thick. These are comparable in thickness to the Lower Silty Shale member farther upstream which is a little more than 600 feet thick (section 1). This member may be as much as 500 feet thick.

Ammonites are particularly abundant in concretions from the Arctic Red River exposures especially in the lower part of this member from which were collected Beudanticeras cf. affine, B. cf. glabrum, Lemuroceras sp. and Cleoniceras sp. These fossils represent the early Albian Lemuroceras or Beudanticeras affine faunal zone, according to Jeletzky. Numerous specimens of Lemuroceras and Beudanticeras were collected also from the Peel River outcrops.

Silty Concretionary Shale member: The Fossiliferous Concretionary Shale member grades upward into a less fossiliferous sequence of shales with thin, intercalated siltstone beds that comprise the Silty Concretionary Shale member. Unlike the sequence to the south, the Siltstone member of section 1 is not recognized in outcrops along the lower Peel and Arctic Red Rivers. It may grade northward into argillaceous rocks and, if so, lateral equivalents of these could occur in the lower part of the Silty Concretionary Shale member (Fig. 3). The hypothesis is supported by the much smaller silt content in the northern concretionary shale facies, the stratigraphic relationships and the age of the various members.

The shales are generally silty, dark greyish brown to dark grey, and locally contain abundant thin clay (bentonite?) and thin, brown siltstone layers or siltstone concretions. These shales weather dark grey to reddish grey, are somewhat lighter coloured than those of the underlying member and are generally more resistant to erosion. Some of the concretions are as much as 2 feet thick. Small amounts of lignite are associated with the clay layers and some of the concretions contain wood fragments. Some sulphur and gypsum (epsomite) crystals occur throughout the shales.

Along Arctic Red River for about 5 to 10 miles downstream and upstream from the mouth of the Cranswick River, outcrops of the uppermost beds of this member weather to a prominent bright red colour, from which the Arctic Red River derives its name. These shales have been burned and some of the outcrops above the Cranswick River are still burning. It was not possible to identify the material that is burning but it is probably a combination of lignite, coal or bituminous matter which has been observed elsewhere within this rock unit. Similar combustion phenomena have been reported from beds occurring in what is assumed to be approximately the same stratigraphic horizon in the "Bituminous Zone" of the Arctic Coastal Plains and, also, in the upper white speckled shale of the Vermilion River Formation (Boyne and Morden Members) in the potash shafts of Saskatchewan in the shelf area of the Williston Basin (personal communication from L.L. Price). The assumption of stratigraphic equivalence is based on the physical evidence of similar combustion phenomena resulting in the red coloured shale. Micropaleontological evidence for correlation of the Upper

Vermilion River Formation and the 'Bituminous Zone' is based on the common taxa of Globigerina aspera, Dictyometra sp. and ? Chalmasia sp. (Chamney, personal communication). These in turn are associated with macrofossils identified by J.A. Jeletzky from the potash shafts of Saskatchewan as the Inoceramus ex gr. lobatus, I. cf. I. lamarki and Scaphites cf. S. depressus (L.L. Price, personal communication). These fauna indicate the Coniacian stage of the Upper Cretaceous series. In addition, these red-weathering shales on the Anderson-Horton Rivers (Bituminous Zone) and on the Arctic Red River of this report are both underlain by shales and silty shales of Albian age. In the Anderson Plains area the general Middle Albian age of the underlying shales (Bentonitic Zone) is based on the foraminiferal Glomosphirella sp. assemblage (Chamney, 1967b). The beds overlying the red-weathering shale of the Anderson Plains are also dated as early Senonian by Chamney (in Russell, 1967). It is of interest to note in the upper white speckled shale beds in the potash shafts of Saskatchewan that combustion does not occur until some time after the shale has been removed from the mines and deposited above ground. It requires oxidation by aeration of the slumped or crumbled fragments, possibly in association with water. The lithologic content of the shales at these three reported locations is quite similar with respect to the abnormally large accumulation of red-brown and vari-coloured iron oxides, sulphides, and sulphates including jarosite, alum, gypsum and even free sulphur. Much pure bentonite is present in beds 2 to 3 inches thick with some unaltered fragments of volcanic tuff.

It is most difficult, except by the use of colour, to separate the Silty Concretionary Shale member from the uppermost red-weathering "smoking shales" on the Arctic Red River owing to their similar lithologies and because of poor, scattered outcrops. But, based on the age of the stratigraphic equivalents, an unconformity could be present in the upper portion of the Arctic Red Formation separating the "smoking shales" from the underlying silty and concretionary beds.

Thickness estimates for the Silty Concretionary Member are even more difficult to determine because the upper beds have been eroded. It is estimated to be more than 500 feet thick, and may be as much as 1,000 feet thick. Only a few poorly preserved fragments of pelecypods and ammonites have been observed in these shales and none of those collected were useful for dating purposes. Unfortunately, sample material from this unit was not submitted for micropaleontological study. The Silty Concretionary Shale member is tentatively assigned to the Middle to Late Albian because it occurs stratigraphically above the Fossiliferous Concretionary member and because stratigraphic relationships suggest that it is a lateral equivalent of the late Middle Albian and Late Albian Upper Silty Shale member (Figs. 3 and 4). As noted above the uppermost red coloured "smoking shales" unit may be as young as Coniacian (Upper Cretaceous).

Age and correlation

The main fossil collections have been mentioned above in connection with the individual members. In part II of this report microfaunal data are reported for section 1 on the Peel River and are interpreted as being of Albian age. Regionally, where the more argillaceous facies persists, the basal sediments could be of Early Albian age. The upper boundary is affected in some areas by the post-Turonian unconformity but, in general, Late Albian sediments are preserved in the Snake and Peel River area. The red-weathering and smoking shales, where included in the Arctic Red Formation as a mappable field unit, could then represent post-Turonian deposition and it would then be necessary to include an Upper Cretaceous age for this portion of the Arctic Red Formation.

As noted above, Albian strata are widely distributed in northern Canada and adjacent regions (Fig. 4, and Stelck, 1958). These strata extend eastward to Fort Norman and northeastward to the Horton and Anderson Rivers. The Arctic Red Formation embraces strata equivalent to the upper part of the Sans Sault Group and possibly part of the Slater River and Little Bear Formations, depending on the age of strata assigned to the latter two units (see discussion under previous nomenclature). The Arctic Red Formation is also equivalent to the Buckingham and Sikanni Formations of the Fort Liard area (Stott, 1960b) and to the interval including the Moosebar, Gates, Hasler and Goodrich Formations of the Peace River Foothills (Fig. 4).

In Alaska (Fig. 4) Albian shales and sandstones are widespread on the central Arctic slope north of the Brooks Range (Detterman et al., 1963; Tappan, 1962) and extend as far east as the Shavirovik and Sagavanirktok Rivers region (Keller et al., 1961). There is a complex, thick succession of interfingering shales and sandstones ranging from 4,000 to more than 12,000 feet thick. In the southern Arctic Foothills Province these sediments are predominantly non-marine sandstone and conglomerates. They change facies northward, first into marine sandstones and siltstones, and then into deeper water marine siltstones and shales of the Arctic Coastal Plain. The Tuktuk-Topogorok Formations in particular are similar in stratigraphic position and in lithology to the lower portion of the Trevor-Arctic Red Formations, and represent a shaly marine siltstone and sandstone facies grading into a marine silty shale and shale. The Killik-Grandstand Formations, in turn, can be compared with a similar facies gradation of the upper portion of the Trevor-Arctic Red Formations. The "Unnamed Shales" overlying the Trevor Formation (section 1) may have been deposited during the "Grandstand" marine incursion over the region. The Martin House Formation equivalent can be accommodated within the upper portion of the Fortress Mountain - Torok Formations with the Torok Formation representing a much better marine, argillaceous environment than that of the Yukon region.

The stratigraphic relationships between these formations are much more complex than the above brief outline indicates and the interested reader is referred to publications of the United States Geological Survey for additional details.

In the Arctic Islands, the Christopher Formation (Tozer, 1960; Douglas, et al., 1963) is a time equivalent of the Arctic Red Formation. The nearest outcrops occur on northern Banks Island (Tozer, 1960; Douglas and MacLean, 1963).

Trevor Formation

Distribution and Lithology

The prominent resistant sandstones forming mesa-like hills immediately north of the Mackenzie Mountains and occurring above the recessive shales, silty shales and shales of the Arctic Red Formation are herein named the Trevor Formation. These beds form an easily recognized unit that extends from the Trevor Range to the Hume River (Fig. 1). They grade downward and laterally (Fig. 3) northward and northeastward into siltstones, silty shales and sandstones of the Arctic Red Formation. The base of the formation is designated as the base of the first thick, massive, resistant sandstone. These sandstones appear to be overlain by recessive dark shales (Unnamed Shales) just east of the Trevor Range (133° 40', 65° 35').

The type area is designated as the Cranswick River, near west longitude 132° 05' and north latitude 65° 40', where more than 1,000 feet of continuous section is exposed. No continuous section description is available for the type area. The formation is named after the Trevor Range which is located just south of the junction of the Snake and Peel Rivers. The exposures in the Trevor Range are considered to be a supplemental type section in which only the lower half of the formation is present. The base of the formation on the east side of the Trevor Range is described in section 5. The following observations are compiled from data recorded from isolated outcrops.

The sandstones are generally fine-grained, light greyish brown, in part calcareous, and light yellow-brown weathering; they occur as resistant beds up to one foot thick. Thin, covered intervals separate each unit. Some chert pebbles are present near the base and some plant fragments occur throughout. The sandstones contain considerable amounts of dark minerals.

Exposures on the west side of the Trevor Range indicate that the Trevor Formation is more than 1,200 feet thick. About 1,000 feet of beds occur along the Cranswick River.

Age and Correlation

Macrofossils were collected only from the basal beds on the east side of the Trevor Range (Appendix, section 5, unit 19). J.A. Jeletzky identified these as Posidonia cf. nahwisi McLearn s. lato. and Inoceramus ex. gr. anglicus but, because of poor preservation, could not be given a definite age. Usually these fossils suggest a Late Albian age, although Posidonia cf. nahwisi ranges down into the upper part of the Gastroplites zone (Table 1, Jeletzky, 1964). A collection of considerable importance was made by geologists of Chevron Standard Company about 12 miles south of section 5, near the south end of the Trevor Range at west longitude 134° 04' and north latitude 65° 39.5' (Fig. 2). In the collection (GSC loc. 42635) Jeletzky identified Gastroplites (s. lato) nov. sp. ex aff. G. liardense (Whiteaves) and considers it to be

of Late Albian age. This fossil was collected from the bank of an eastward flowing stream near the crest of Trevor Range at an elevation of about 2,200 feet, and the locality is estimated to occur between 700 and 1,000 feet above the base of the Trevor Formation by using air photographs to project the base of the formation southward. Although the faunal zones appear to be inverted, GSC loc. 42635 is more reliable and is here used to indicate tentatively that the base of the Trevor Formation in this area is of Middle Albian age. Alternately, the base of the Trevor Formation might be considered to be diachronous, becoming older southward. The base of the Trevor Formation is not well exposed but present lithological and paleontological evidence indicates that it is not strongly diachronous in the Trevor Range, although it is obviously diachronous northward (Figs. 3 and 4). The Middle Albian age of the base is supported by the age of the microfauna occurring in the underlying strata. The 357-foot thick siltstone and sandstone unit that forms a transitional zone at the base of the Trevor Formation (units 14 through 18, section 5) contains microfossils representative of the upper portion of the Saracenaria trollopei zone (T.P. Chamney, report C 3/67, June, 1967a) which occurs also in the basal zone of the Lower Silty member of Arctic Red Formation in section 1. The upper part of the Trevor Formation is not reliably dated to the east and may possibly include Upper Cretaceous strata. The Trevor sandstones apparently grade northward into Middle to Late Albian silty shales and siltstones of the Arctic Red Formation on the Peel River (Fig. 2) and correlate with units 12 through 18 of section 1.

Equivalent rocks appear to be absent to the north in the vicinity of the Rat River (Jeletzky, 1961). In the Eagle Plains the basal part of the Eagle Plain Formation (thick non-marine and marine sandstones and shales) and the underlying unnamed argillaceous unit (Fig. 4, Mountjoy, 1967), may be of equivalent age to the Trevor Formation. Plant fossils from an interval 500 to 1,000 feet above the base (middle to upper part of Eagle Plain Formation) have been dated as Cenomanian by W.A. Bell. Unnamed shales, silty shales and sandstones beneath the Eagle Plain Formation (Fig. 4) contain Beudanticeras. Either a depositional hiatus occurs between the two sequences and Late Albian strata are absent in the Eagle Plains or the lower portion of the Eagle Plain Formation was deposited during Middle to Late Albian time. The Trevor Formation may correlate with most of the Grandstand and Topoguruk Formations of the northern foothills of the Alaska Brooks Range (Tappan, 1962; Detterman et al., 1963). To the southeast the Trevor Formation may be, in part, equivalent to the Sikanni Formation near Fort Liard and to the Goodrich Formation of the Peace River foothills (Fig. 4).

The Trevor Formation is similar in thickness and lithology to the Little Bear Formation, except that the Little Bear Formation contains lignite and coal seams. Until a more reliable age is obtained for the Little Bear Formation, correlations with these strata in the Norman Wells area can only be considered speculative.

Unnamed Shale Unit

A study of air photographs suggests that poorly exposed shales occur above the Trevor Formation at a few localities. Shales appear to overlie the Trevor Formation west of the middle part of the Snake River near west longitude 133° 40' and north latitude 65° 35'. Dark recessive strata assumed to be shales also occur above the Trevor Formation east of Arctic Red River. Shales believed to be equivalent to those above the Trevor Formation may occur above the top of section 1 (unit 18) on the Peel River (Fig. 3). The shales on Peel River are of Late Albian or younger age since they occur above shales that contain microfossils dated as Late Albian by T.P. Chamney (see part II of this report).

History of Sedimentation and Paleogeography

The Lower Cretaceous strata of the area described are representative of part of the southward transgression of the Lower Cretaceous Arctic sea that is, in part, equivalent to the Early to Middle Albian Clearwater sea (approximately Moosebar equivalent) of Stelck (1958). The suggested occurrence of slightly older Aptian strata (Chamney, Part II) is of interest and indicates that early Lower Cretaceous rocks extend southeast of the Richardson Mountains. They also occur in the western part of the area, paralleling a similar development to the north on the east flank of the northern Richardson Mountains (Jeletzky, 1960, 1961). This supports the suggestion by Jeletzky that a north-south sedimentary trough, the Richardson Mountain Trough (Jeletzky, 1962), occupied the present site of the Richardson Mountains. Aptian sedimentation apparently was restricted to this trough whereas Albian sediments transgressed both eastward and southward over the more stable shelf of the Peel and Interior Plains.

Gabrielse (1967, p. 283) referred part of these rocks to the Peel - Caracajou Trough and suggested, on the basis of meager stratigraphic data (isopachs), that these strata may represent an exogeosyncline marginal to uplift to the southwest in Mackenzie Mountains. This study indicates that these isopachs should be revised considerably. More than 6,000 feet of Albian and younger strata were shown to be centered around the large westward bend of the Snake River (Fig. 19 of Douglas et al., 1963). The evidence at that time suggested that beds now assigned to the Trevor Formation occurred mainly above the Arctic Red Formation; microfossil evidence presented in this paper indicates that these two formations are lateral equivalents (Fig. 3 and 4). Nearly complete Albian sequences occur at sections 1 and 4 (1,838 feet and 1,490 feet respectively). On the basis of the known stratigraphy and regional development it appears that the maximum thickness of Lower Cretaceous sediments in the Peel Plain is between 2,500 and 3,000 feet. This is thinner than Aptian? and younger sequences to the south near Fort Liard (4,000+ feet, Stott, 1960b), Tetsa River (4,800+ feet, Stott, 1967) and Peace River (5,000+ feet). Thus, this negative structure probably was not an exogeosyncline as suggested by Gabrielse (1957) but simply a trough with the deeper parts filled mainly with marine muds and having on its western flank a complex of sands shed from uplands to the west. It appears that the Peel-Caracajou Trough is simply a southeastern extension of the Richardson Mountain

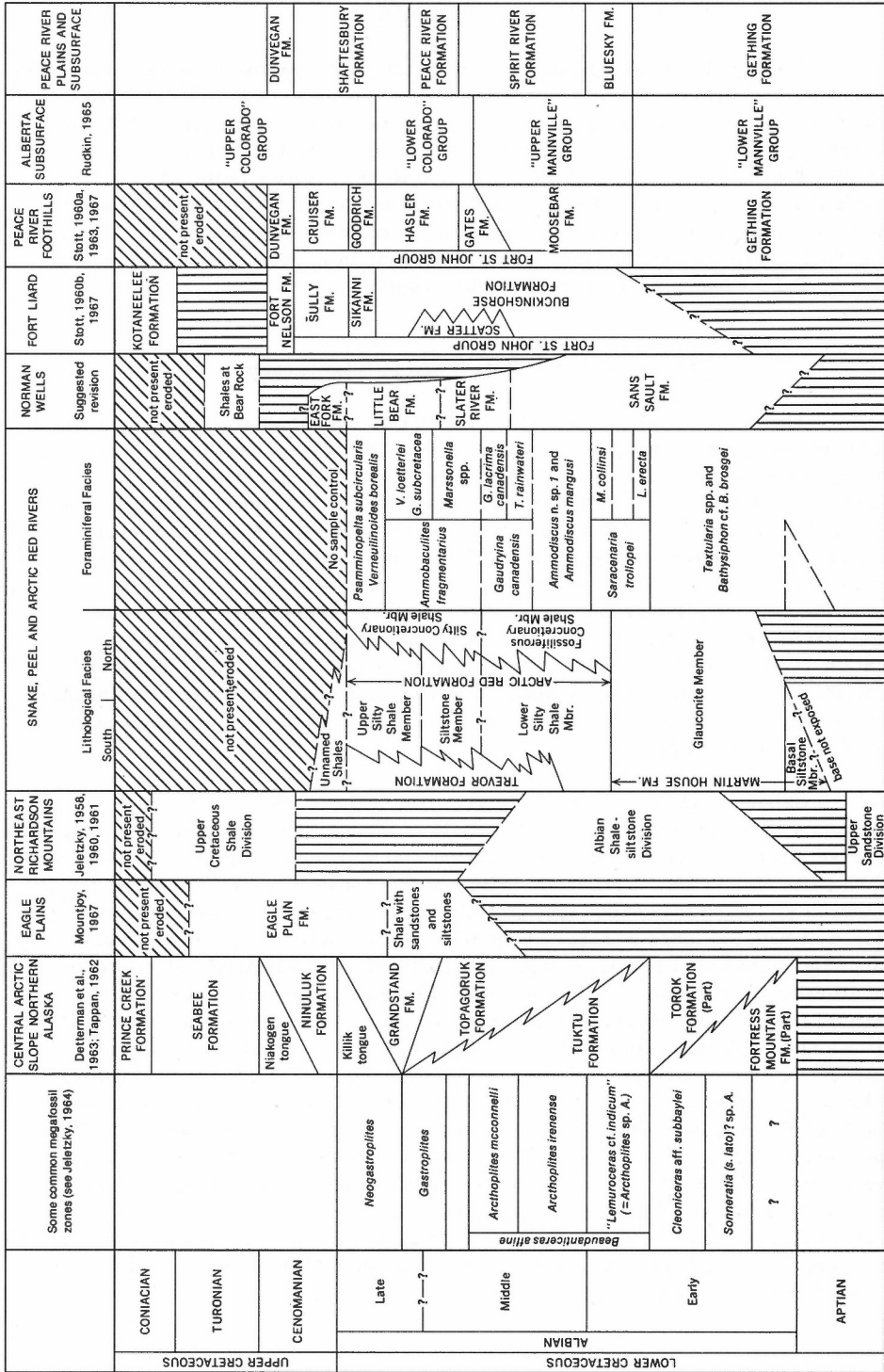


Figure 4. Correlation of Cretaceous formations of northwestern Canada and northern Alaska

Trough and a more appropriate name would be Richardson-Carcajou Trough. The gradation northeastward from fine- to medium-grained quartz sands of the Trevor Formation into more open marine siltstone and shale suggests the presence of a source area of sedimentary rocks to the west and southwest. Initial uplift of the Mackenzie Mountains or part of the region farther west may have begun at this time but there is no conclusive evidence for this.

Lower Cretaceous uplift, folding and thrusting, and Mid-Cretaceous intrusion of the western Ogilvie Mountains in the Tombstone area has been established by Tempelman-Kluit (1966). This deformation is known to extend as far east as Mayo and may have affected much of the Selwyn Mountains southwest of the Mackenzie Mountains. The structures in this region, however, are very complex and this makes analysis difficult. Gabrielse (1967, p. 293) suggested that this deformation indicates a major orogeny which may have deformed a large part of the mountain region northeast of the Tintina Trench. The Selwyn Mountains and western Mackenzie Mountains are suggested tentatively as the source of the sands of the Trevor Formation because of the fine-grained size of the Trevor sands and the fact that both the Mackenzie Mountains and the Selwyn Mountains consist largely of sedimentary rocks with minor amounts of metamorphic rocks.

Similar uplifts occurred about this time in the northern Rocky Mountains as evidenced by the Sikanni and Scatter sands (Liard-Tetsa region) and the Commotion and Goodrich Formations (Peace River region). These sands also were shed from areas to the west that were being uplifted during Albian time. The Trevor Formation is about the same age as these formations of the Fort St. John Group (Fig. 4). The time interval during which these sands were deposited corresponds, in southwestern Alberta, to a hiatus between the Upper Blairmore (Mill Creek Formation of Mellon, 1967) and the Alberta Group, following uplift and thrusting of at least the Main Ranges of the Rocky Mountains during the late Jurassic and Early Cretaceous (Price and Mountjoy, in press).

The presence of a Cenomanian unconformity in the Lower Mackenzie River region (Fig. 4) has been advocated. To the north on the eastern slope of the Richardson Mountains Jeletzky (1961, p. 534) inferred that a late Albian - early Cenomanian unconformity occurred between two shale divisions. To the southeast in the Norman Wells area no Cenomanian fossils have been found (Hume, 1954). Warren (1947, p. 119) suggested that the absence of Dunveganoceras in the Lower Mackenzie Valley was probably the result of non-deposition during the Cenomanian and that erosion may have been the cause of the absence of the Late Albian Neogastropilites fauna.

The oldest fauna of the Upper Cretaceous Shale division in the Richardson Mountains is late Cenomanian (Jeletzky, 1960, 1961, p. 541). It must be pointed out, however, that on the east flank of the Richardson Mountains it appears that the Albian shales and siltstones wedge out in a northward direction between Stony River and Rat River, so that north of this area Upper Cretaceous shales rest directly on Aptian sandstones (Jeletzky, 1960, 1961).

This study has shown the presence of Late Albian strata on the Peel River at section 1 and on the Snake River at section 4. Both sections appear to be overlain by younger strata and, although no definite Cenomanian fossils were collected, sediments of this age may be present but must await additional micro-paleontological studies by Chamney. Non-marine Cenomanian strata occur in the Eagle Plain to the west (Fig. 4, and Mountjoy, 1967). Until these strata are more thoroughly studied the absence of Cenomanian macrofossils need not indicate a Cenomanian gap or unconformity. Marine deposition in the Peel Plain may have been continuous during latest Lower Cretaceous and earliest Upper Cretaceous time. This interval warrants additional study.

In summary, marine Aptian (?) sediments are restricted to the western part of the Peel Plain. Albian sedimentation was initiated during a widespread, almost chronotaxial, marine boreal transgression. During Albian times, predominantly marine sediments were deposited in a shallow trough or basin which extended from the Arctic to the Peace River district. During Middle and Late Albian times, clastic debris derived from uplifts to the west probably formed deltaic complexes along the western part of the Richardson-Carcajou trough.

Variations in marine intensity are reflected by a general lack of clastics in the succession and the type and abundance of Foraminifera. Following the first Early Albian inundation (Glaucconite member of Martin House Formation) two periods of maximum inundation occurred in early Middle Albian and Late Albian corresponding to the predominance of black, non-silty shales in portions of the Lower Silty Shale and Upper Silty Shale members. All three marine transgressions correspond to times of marine inundation in northern Alberta and British Columbia (Bluesky Formation and equivalents; Moosebar, Clearwater - Grand Rapids and equivalents; Harmon and Joli Fou Formations and equivalents). The latest transgression (base of "Lower Colorado" of Rudkin, 1965) corresponds to the time when the Boreal and Gulfian seas joined. This transgression continued into Upper Cretaceous time. These variations, as illustrated by foraminifers, are plotted in Table 2 for section 1 on the Peel River by Chamney (see part II of this report).

Economic Geology

The Cretaceous rocks of the Peel and Arctic Red Rivers areas may be potential sources or reservoirs of petroleum. No commercial production has been obtained from the Cretaceous rocks in this region nor have petroleum seeps been reported in this area. For oil and gas seeps reported in the area to the east see Douglas et al., (1963, Fig. 3).

The fine-grained, in part glauconitic sandstones and conglomerates at the base of the Arctic Red Formation are overlain by shale and thus would make a suitable stratigraphic trap if sufficiently porous and permeable. Unfortunately the stratigraphic sequence dips gently southward and thus would permit the gradual migration of any petroleum to the surface. Some parts of the Glaucconite member probably thin and pinch out up-dip where they interfinger with shales to the northeast and might also be

covered by a thin veneer of Albian shales in the region between the Snake and Cranswick Rivers. Sufficient irregularities probably are present along the Cretaceous-Devonian unconformity to permit petroleum accumulations. Of particular significance in this regard is the truncation of Aptian or older sediments beneath the predominantly argillaceous Albian succession (Fig. 3) immediately east of the major normal fault that forms the east boundary of the Richardson Mountain structures.

Sandstones in Alberta that occupy an equivalent stratigraphic position near the base of the Lower Cretaceous succession, as well as the Athabasca Tar Sands (Rudkin, 1965; Carrigy, 1964) which are now considered to be of the same age, have produced heavy oils. Whether or not the Peel Plain Lower Cretaceous sediments were buried sufficiently deep for the formation of petroleum is not certain. If these sediments were covered by 1,000 feet or more of Upper Cretaceous sediments, the basal portion of the Albian would have been buried to depths of between 3,000 and 4,000 feet, near the presumed threshold of petroleum formation (depth of burial of the shallowest occurrences of petroleum is about 3,000 feet; Hedberg, 1964).

Few traces of bitumen were observed in these rocks, although the burned shales along the Arctic Red River are bituminous. All of the Arctic Red Formation is marine and can be considered as a suitable source for petroleum. To the southeast, near Norman Wells, Nauss (1944) reported about 20 feet of "petroliferous" crossbedded sandstone close to the base of the Sans Sault Formation in the upper Carcajou - Imperial River area. Also, in the basal (?) sandstone of the Sans Sault Formation, Foley (1944b) reported asphaltite in the Donnelly River area. Scattered outcrops of basal Cretaceous oil sands occur east of Fort Good Hope (Fig. 1) in the Rond Lake - Aubrey Lake - Lac Belot area (Oilweek, 1964). These deposits, drilled at Rond Lake, penetrated 65 feet of sand but no oil flowed into the borehole. The gravity of the oil was about 17° API. The nature and character of these oil sands is similar in many respects to the Athabasca 'Tar Sands'.

Siltstone and sandstone beds in the upper part of the Arctic Red Formation and in the Trevor Formation outcrop too close to the surface to have much petroleum potential.

PART II

FORAMINIFERAL SUBDIVISIONS

by
T.P. Chamney

Introduction

The purpose of this portion of the report on the Lower Cretaceous (Albian) of the Peel and Snake Rivers of the Yukon, is to outline the biostratigraphic subdivisions of a sequential reference section on the Peel and Snake Rivers. The rock exposures of this depositional interval in the area under investigation are numerous but very limited in vertical extent. Most of these have been examined and, where applicable, the micropaleontological results were used for the stratigraphic portion of the report. The sequential stratigraphic section was obtained by combining four of the most continuously exposed field outcrops investigated by Mountjoy and presented as the composite Section No. 1 of Tables 1 and 2.

Micropaleontological interpretations have been designed primarily for the purpose of stratigraphic application to assist the field mapping and to infer rock unit equivalencies with better known areas in the Western Canadian sedimentary basins. The major premise upon which the latter interpretations are made is based upon the sequence of marine transgressions and their respective microfossil content. These cyclical transgressions are well-represented by the lithologic succession in the Snake and Peel Rivers area owing to the proximity of this region to the boreal marine source during Albian time. The comparable sequence of marine transgressions and attendant microfossils are recognized over the western Interior Plains, particularly in the south and east where the related sedimentary units extend into the Alberta and Williston Basins.

Three gross marine transgressions are interpreted (Table 2) and referred to contemporaneous marine inundations southward into the Canadian Western Interior. Caution must be exercised in applying the southern rock-stratigraphic nomenclature directly to the area of this report. There is, however, a similarity between the two areas with regard to interpreted bathymetry of deposition of a marginal, shelf lithofacies and the resulting foraminiferal biofacies. All three major marine transgressions during the Albian stage appear to have had a boreal source. However, the foraminiferal assemblage recovered from the Skull Creek Formation (Joli Fou Formation equivalent) in the south, representing the last major marine incursion, is similar in part to the assemblages in the stratigraphic equivalents farther south in Texas that had a source from the Gulf of Mexico (Skolnick, H., 1958).

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Category of Foraminiferal Subdivisions

The upper boundaries of the subdivisions are based on the uppermost range of the species; thus, the base of each subdivision is more or less defined by the top or uppermost range of one or more of the underlying species in the assemblage of that subdivision. Some subdivisions represent the known local range of a species from its first appearance in the depositional interval to its uppermost or last appearance (in ascending order). The most common type of zone interpreted from this study conforms with the requirements for an assemblage zone as defined by Article 21 of the Code of Stratigraphic Nomenclature (American Stratigraphic Commission, 1961). Where boundaries are interpreted on the basis of the local range or teilzone of a species, then local range zones of Article 22 (American Stratigraphic Commission, 1961) are applicable. If subdivisions had been interpreted from the "Teilzone" column of Table 2 utilizing overlapping species ranges for the boundary criteria, then the requirements for concurrent-range zones of Article 23 (ibid) would be fulfilled. Subdivisions sufficiently limited in vertical range within a single geological stage are constructed and will be of use in resolving rock-stratigraphic equivalents (Arkell, 1956). The zones of this report are therefore designated as "Assemblage Zones" of biostratigraphic connotation and infer both time and ecological facies. An additional advantage of this class of zone is that it can be established from drill-cutting sample material on the basis of the uppermost range of the species; the base of species ranges cannot be validated from drill-cutting samples because of contamination contributed from all the exposed strata in the open hole.

Each assemblage zone is characterized by a distinct assemblage of microfossils. The density of control available from the Yukon (Norris, et al., 1963) allows the time ranges of index species to be established within the sequence of assemblage zones and, thus, sequences of concurrent-range zones can be related to the assemblage zones.

Chronostratigraphic units requiring concurrent-range zones will subsequently be made available from this study as more detailed taxonomic investigations are completed. Interpretation of such concurrent-range zones is indicated in the "Teilzone" column of Table 2, where gradational morphological series occur within some of the genera. For example, within the species of Gaudryina from Early to late Middle Albian age, there is morphological change from forms with a rounded test (G. nanushukensis Tappan) to forms with an extreme tricarinate test (G. subcretacea Cushman). Between the lowest and highest stratigraphic ranges of the two extreme forms intermediate forms are present (Gaudryina n. sp. 2). Similar morphological series are inferred within the few selected species ranges illustrated in this column.

Assemblage zones are designated by applying a binomial system of species names so that one calcareous and one agglutinated foraminiferal species are combined where possible to name the subdivision. The purpose of this is to include both the more open marine calcareous and the more restricted marine or benthonic forms. Thus, when applying these subdivisions to other areas exhibiting one or the other of the two extremes of environment, continuity of zone nomenclature will be maintained. The species selected to name the zone depends on its importance with

respect to its restricted vertical range, its regular occurrence within this time interval as indicated from published literature or previously studied section, or on its distinctiveness within the assemblage. The remainder of the species in the assemblage may be as important as those in the binomial designation but it is desirable to maintain a simple nomenclature.

Considerable emphasis has been placed on the agglutinated or arenaceous group of the Foraminifera microfossils for interpretation of the biostratigraphic subdivisions. These are generally a more primitive form of benthonic dwellers and the difficulties encountered in their application have been previously reported by Tappan (1960, p. 281). They are much more tolerant to physical and chemical changes of the marine environment than are the calcareous forms and can survive much longer in the restricted, shallow inland seas. As a result, locally evolved or endemic species are derived that differ in degree from the parent stock, remaining in the more permanent ocean source.

In order to accomplish regional correlation by means of the biostratigraphic application of these benthonic foraminifers, relatively close-spaced control sections are required. It is evident from a comparison of the Albian foraminiferal assemblages recovered from Operation Porcupine to those of the Arctic slope of Alaska (Tappan, 1962), that varietal differences within a species increases proportionately with the increase in distance away from this more permanent Alaskan marine source. Rock sample material from the north was made available for micropaleontological study by Operation Porcupine and by contributions from petroleum companies. The recovery of numerous foraminiferal specimens from this material has greatly assisted in validating benthonic species identifications in spite of these ecologically influenced varietal differences and the attendant changes of the original test by diagenetic mineralization and compressional effects.

Environmental Interpretations

Variations in marine transgression throughout the Albian depositional interval have been shown on a graph on the extreme right of Table 2. The graph values are relative and only represent variation between the two extremes of marine environment interpreted from the total microfauna recovered from the rock sample material. These two extremes are designated as "open marine" and "restricted marine" and, for the purpose of this report, are defined as follows:

- a) Open marine indicators include foraminiferal species requiring open marine conditions or, at least, daily supply of open marine water. These forms are represented by most of the calcareous Foraminifera and the degree of open marine conditions is relative to both the quantity and the actual species of calcareous foraminifer, i. e., the superfamily Nodosariacea is somewhat tolerant to restricted conditions and the superfamilies Globigerinacea and Cassidulinacea are quite sensitive to restricted circulation of open marine conditions.

- b) Restricted marine conditions are indicated by the absence or very rare occurrence of calcareous Foraminifera. The degree of restriction is indicated by the relative abundance of agglutinated, benthonic forms and the actual species present, i. e., the superfamily Ammodiscidacea appears to be more tolerant to chemical and physical changes than the Lituolacea. Of the former group, the simple tubular and unilocular forms represent the most tolerant species.

Caution should be exercised in applying the graph values to discrete rock units of Section 1. The interpreted value for each sample is plotted at the mid-point of the interval and each point is then joined to smooth out the graph line. Some samples represent rather large vertical intervals so that the graphed environmental changes are not entirely coincident with the exact depositional horizon from which the critical species were recovered. The graph indicates seven ecological subdivisions and the interpreted sequence of events is as follows:

- Aptian ? regression.
- 1. - basal Albian coarse clastic accumulation.
- 2. - Early Albian marine transgression.
- 3. - early Middle Albian marine regression ? or marine indicators masked by coarse clastic invasion.
- 4. - middle portion of the Middle Albian marine transgression.
- 5. - uppermost middle portion of the Middle Albian marine regression with strong influx of coarse clastic detritus.
- 6. - late Middle Albian represents most extensive Albian marine transgression.
- 7. - Late Albian restricted marine conditions.
- uppermost Late Albian restricted marine conditions and transitional beds approaching non-marine conditions of the overlying Cenomanian.

Foraminiferal Subdivisions

In the microfossil lists for each subdivision only the first recovery in descending stratigraphic order (the limit of the uppermost range of a species) is reported. If additional control is required it can be obtained from the plotted range and quantitative recovery illustrated in Table 1. The microfossil lists are divided into three groups in order of their increasing relative importance of usefulness for more discriminating biostratigraphic subdivisions as follows:

- a) Long-ranging species
- b) Species common to the underlying zone
- c) Species restricted to the described interval

1. Psamminopelta subcircularis - Verneulinoides borealis
assemblage zone (1,838 to 1,638 feet of section 1)

P. subcircularis is restricted to the interval but V. borealis and varieties have been recovered from rocks of older Albian age. Several additional equivalent stratigraphic sections that were examined for part I of this report provided numerous specimens of the genus Miliammina associated with P. subcircularis. In northeastern British Columbia, the same association of species is present in beds underlying the Fish Scales marker beds. In this latter area, species that are similar to M. manitobensis Wickenden, 1932 (Wickenden, 1945) are also present which permits regional correlation with rocks of Late Albian age. This depositional interval in the western interior Plains is defined at the base by the top of the Viking Formation and at the top by the Fish Scales marker beds. It carries no formally published rock unit name but, in Manitoba, the M. manitobensis zone is represented by the upper two-thirds of the Ashville Formation (Wickenden, 1945, p. 22) or the Mowry Formation of the United States Geological Survey standard stratigraphic nomenclature (Price, L.L., 1963). Thus, the term "Mowry Sea" is used, as shown on the frequency graph of Table 2, to represent the Late Albian marine transgression from the boreal source, which inundated a very extensive area southward into the western interior of Canada and the United States. The foraminiferal assemblage recovered from strata throughout the total extent of this marine invasion is somewhat unique in that very few calcareous foraminifers have been recorded. Abundant agglutinated, benthonic forms and abundant fish remains are usually recovered. It is suggested that these facts may be explained by the presence of favourably aerated surface conditions for the fish and very restricted circulation on the bottom. Such a bottom environment would not support predators and, hence, the remains of the near-surface organisms were allowed to accumulate with little destruction.

Long-ranging Albian species:

Ammodiscus rotalarius
Gaudryina cf. G. nanushukensis
Haplophragmoides cf. H. neocomianus
Reophax troyeri
Trochammina cf. T. rainwateri

Species common to underlying late Middle Albian age:

Haplophragmoides cf. H. topagorukensis
H. multiplum
Hippocropina cf. H. barksdalei
Reophax minuta

Species restricted to the interval:

Psamminopelta subcircularis
Verneulinoides borealis

2. Ammobaculites fragmentarius
assemblage zone (1,638 to 1,198 feet of section 1)

This zone is subdivided into two additional assemblage zones consisting of an upper V. loetterlei and a lower Marssonella spp. zone. Ammobaculites fragmentarius is one of the regional index species for the total Albian stage in the Western Interior Canadian sedimentary basin. In section 1 of this report the species does not range higher than the late Middle Albian and, therefore, has been used as the name species to designate the assemblage zone under discussion. The uppermost range of several other agglutinated species, such as the distinctive tricarinate Gaudryina species and the larger more robust species of Haplophragmoides aff. H. gigas, are terminated also at the upper boundary of this zone. This major faunal change is thought to be analogous to similar faunal changes exhibited in the Plains area at the top of the Joli Fou Formation or, possibly, within the sandstones of the overlying Viking Formation. For this reason the name "Joli Fou Sea" is used for the late Middle Albian interval of marine transgression (transition) in the frequency graph of Table 2.

Valvulineria loetterlei - Gaudryina subcretacea
assemblage sub-zone (1,638 to 1,348 feet of section 1)

The species V. loetterlei was chosen as one of the zone names because of its very abundant occurrence in this interval. Its uppermost range is about 100 feet below the top of the interpreted assemblage zone boundary and its presence in older Albian rocks has been recorded in Alaska (Tappan, 1962) and in the older Clearwater and Moosebar Formations of northeastern British Columbia and Alberta (Stelck et al., 1956) as Gyroidina cf. G. nitida (Reuss). Gaudryina subcretacea was chosen as the second zone name because it represents one of the distinctive tricarinate species of the genus which reaches both its acme of development and the limit of its uppermost range at the top of the designated boundary of the assemblage zone. The variety and abundance of calcareous foraminifers in this interval (Table 1) suggest the maximum open marine conditions during Albian time.

Long-ranging species (Early and Middle Albian):

- Bathysiphon brosgei
- Gaudryina cf. G. canadensis
- G. n. sp. 2 (short triangular)
- Haplophragmoides cf. H. multiplum
- Reophax cf. R. incompta
- Saccamina sp.
- Verneulinoides cf. V. borealis
- Dentalina cf. D. dettermani
- Lenticulina n. sp. 2
- L. n. sp. 4
- Marginulinopsis cf. M. umiatensis

Species common to superzone A. fragmentarius:

Ammobaculites fragmentarius
Gaudryina n. sp. 1 (tricarinate)
Haplophragmoides spissum
Hyperammina cf. H. gryzbowski
Textularia topagorukensis
Citharina sp.
Gavelinella cf. G. stictata
G. cf. G. awunensis
Globorotalites cf. G. umbilicatus
Lenticulina ingenua
L. topagorukensis
Marginulina cephalotes
M. gatesi
Marginulinopsis jonesi
Nodosaria nana
Saracenaria cf. S. spinosa
? Tribrachia sp.
Valvulineria cf. V. loetterlei

Species restricted to interval:

Gaudryina subcretacea
Psamminopelta n. sp. 1
P. bowsheri
? Siphotextularia cf. S. rayi
S. cf. S. andersoni
Spiroplectammina sp.
Trochammina n. sp. 1
Citharina cf. C. acuminata
Dentalina n. sp. 1
D. n. sp. 2
? Eurycheilostoma robinsonae
Frondicularia sp. fide Tappan 1962
? Gavelinella cf. G. ammonoides
Globorotalites alaskensis
Globulina prisca
Lenticulina bayrocki
L. cf. L. bayrocki
L. n. sp. 1
L. n. sp. 2
Lingulina cf. L. rediviva
Marginulina planiscula
Marginulinopsis umiatensis
Nodosaria doliiformis
N. cf. N. doliiformis
Planularia sp.
Rectoglandulina cf. R. kirschneri
Saracenaria grandstandensis

S. cf. S. valanginiana
Tribrachia n. sp. 2
Vaginulina cf. V. kochi
V. n. sp. 1
Valvulineria loetterlei

Marssonella spp.
assemblage subzone (1,348 to 1,198 feet of section 1)

Marssonella Cushman, 1933, has been placed in the synonymy of Dorothia (Loeblich et al., 1964, p. C275), but the uppermost range of this group of distinctive, conical species has been recorded from previous studies as a marker in the late Middle Albian and as such the original generic assignment of Marssonella has been retained. Only a few foraminifers were recovered from this zone of which Marssonella spp. were the most significant. They are common in all sections examined within the same general stratigraphic interval. Because of the paucity of agglutinated forms of foraminifers the environment interpreted is one of restricted marine conditions owing to the great influx of coarse clastic detritus.

Species common to the underlying older Albian:

Marssonella spp.
Gaudryina canadensis
G. nanushukensis

Species restricted to the interval:

Astacolus sp.
Spiroplectammina cf. S. koveri
Textularia cf. T. gravenori

3. Gaudryina canadensis
assemblage zone (1,198 to 871 feet of section 1)

The zone name species ranges stratigraphically above and below the interval boundaries as indicated in the teilzone portion of Table 2. The species was chosen because of its abundance in this section and its very common occurrence regionally within the Middle Albian of the Canadian western Interior. The species best represents the time interval between the two major Albian marine incursions, the Early Albian "Clearwater" and the late Middle Albian "Joli Fou" seas. The zone is subdivided into two additional assemblage zones and the less restricted marine conditions indicated by the Globulina lacrima subsp. canadensis is referred to the "Notikewin Sea". In the Albian stage of the Canadian Plains province, there is a similar change toward marine conditions recorded by the sediments of the post-Clearwater and pre-Joli Fou Formations. The term "Notikewin" is used in a broad sense because the marine transgressions are somewhat diachronous from northwest to southeast and the rock stratigraphic terminology representing this increased salinity in the successive geological provinces changes with each province.

Globulina lacrima subsp. canadensis - Saccammina n. sp. 1
assemblage sub-zone (1, 198 to 941 feet of section 1)

This is the upper subdivision of the Gaudryina canadensis assemblage zone and is represented lithologically by a homogeneous shale underlying the most persistent sandstone marker in the vicinity of the junction of the Snake and Peel Rivers. The calcareous foraminifer G. lacrima subsp. canadensis persists higher in the stratigraphic sequence of the Yukon than in comparable Albian sections to the south and east. In these latter areas, it has been reported only from older Albian of the Clearwater or Moosebar Formations (Mellon and Wall, 1956). Saccammina n. sp. 1 was chosen to represent the agglutinated, benthonic assemblage of this zone. The reason for the choice is that the same species is recovered from the stratigraphic equivalents to the south over a vast area of the Canadian Western Interior where it is very difficult to recover any marine organisms. Beds of stratigraphic equivalence thus referred to would include strata of the Upper Blairmore Formation of the Plains or Manville Group. The recovered microfauna represents a rather restricted marine environment with only three calcareous species of Foraminifera present.

Species common to older Albian:

Ammobaculites cf. A. fragmentarius

Bathysiphon n. sp. 1

Eponides sp.

Haplophragmoides topagorukensis

Nodosaria cf. N. concinna

Species restricted to the interval:

Globulina lacrima Reuss subsp. canadensis

? Histopomphus cf. H. redriverensis

Reophax cf. R. minuta

Saccammina n. sp. 1

Trochammina rainwateri - Reophax n. sp. 1
assemblage sub-zone (941 to 871 feet of section 1)

T. rainwateri and varieties of the species have been recovered throughout the Albian of the study-area. It was chosen as a zone name for this interval because of its abundance in comparison with other foraminifers recovered. The upper boundary of this zone is, however, coincident with the uppermost range of Reophax n. sp. 1. These simple, uniserial, agglutinated forms are quite long-ranging (R. troyeri) ranges throughout the Albian (Table 2) but, if detailed study of these simple genera is undertaken, such range limits become useful in intervals of poor recovery such as this zone represents. This latter condition signifies quite restricted marine conditions with very little or no connection with open marine waters.

Species common to older Albian:

Ammobaculites cf. A. reophacoides

Gyroidina sp.

Haplophragmoides sp. C. Stelck and Wall

Reophax n. sp. 1

Species restricted to the interval:

? Gaudryinella sp.

Trochammina rainwateri

4. Ammodiscus n. sp. 1 - Ammodiscus mangusi
assemblage zone (871 to 632 feet of section 1)

The depositional interval represented by this zone contains the uppermost range of several significant Early Albian species. The general abundance of Ammodiscus spp. is considered more significant because these forms are usually associated with the uppermost range of Glomospirella spp. in equivalent zones of other northern sections. This latter genus originates in the Permian, reaches its acme of development in the Neocomian (Barremian) and appears to become extinct in the early Middle Albian. In some species of this genus the initial variable plane of the coiling tube is easily overlooked and the obvious remaining planispiral tube arrangement is mistaken for Ammodiscus. This group of primitive, tubular coiled forms, which have in the test wall a high silica cement ratio to agglutinated grains, are quite tolerant to additions of fresh water. The assemblage zone suggests that the environment was one of very restricted marine conditions with very little coarse clastic sediment and quiet-water conditions. In all specimens recovered the ratio of silica cement to agglutinated clastic grains is very high, indicating a paucity of clastic grains, but abundant silica.

Species common to older Albian:

Haplophragmoides n. sp. 1

H. n. sp. 1A

H. n. sp. 2

Reophax n. sp. 2

Species restricted to the interval:

Ammodiscus n. sp. 1

A. mangusi

A. rotalarius

Bathysiphon n. sp. 2

5. Saracenaria trollopei zone
(622 to 331 feet of section 1)

This distinctive species and its companion assemblage sub-zone species are confined to the designated interval. They are associated throughout this Early Albian stage with the ammonites Lemuroceras and Beudanticeras. In Alaska this association is present in the Wolf Creek Test Well No. 3, from 3,092 to 3,122 feet in the upper portion of the Topagoruk Formation, approximately 350 feet below the base of the Grandstand Formation (Berquist, 1959, p. 482). In northeastern British Columbia, a similar association is present in the Clearwater and Moosebar Formations (Stelck and Wall, 1956, pp. 11-14).

The lithological character of the total S. trollopei zone of the study-area is much coarser than its stratigraphic equivalents to the south in areas of the Moosebar and Clearwater Formations but compares more favourably, however, with the lithofacies and bathymetry of the Cummings Member of the Plains Mannville Group in Alberta and Saskatchewan. The environmental interpretation based on the S. trollopei microfossil assemblage indicates a transgressive marine cycle. The base consists of coarse, clastic sediments with a few open-marine, calcareous Foraminifera and these reach the acme of development in the uppermost shale member. In this latter shale, the open-marine inference is further strengthened by the presence of the radiolarians Dictyomitra sp. and Lithocampe sp. which were recovered as pyritic casts.

The relative extensiveness of marine transgressions based on the quantity and quality of open-marine calcareous foraminifers is of significance. Deposits of the "Clearwater Sea" have resulted in a thicker stratigraphic sequence than those of the "Joli Fou Sea", but the latter marine sediments contain a much greater number and variety of calcareous species in the Yukon area. To the south and east in the Plains province the characteristic lithofacies of the Joli Fou Formation (H. gigas zone) persists farther south and east over the Plains than does the Clearwater Formation. The Joli Fou Formation, at its southern extremity, provides rare calcareous species whereas the Clearwater Formation equivalent, where present, usually provides a few calcareous, lagenid species. Because of this, it is suggested that the "Joli Fou Sea" was a much more extensive marine transgression but of shorter duration, which did not permit the establishment of the more environmentally sensitive calcareous species during its invasion into the western interior of Canada.

Species common to the underlying Albian/Aptian transitions:

- Bathysiphon cf. B. brosgel
- Gaudryina cf. G. barrowensis
- Glomospirella sp.
- Saracenaria aff. S. valanginiana

Species restricted to the interval:

Bathysiphon n. sp. 3
Gaudryina cf. G. subcretacea (tricarinate)
Astacolus cf. A. incrassatus
Citharina recta
Gavelinella cf. G. intermedia
Globulina cf. G. prisca
Lenticulina erecta
L. cf. L. topagorukensis
Marginulina cf. M. planiuscula
Marginulinopsis collinsi
M. cf. M. collinsi
Nodosaria aff. N. proboscidea
? Planularia cf. P. umbonata
Quadriformina sp.
Saracenaria trollopei
Valvulineria sp.

Lenticulina erecta and Bathysiphon cf. B. brosgei
assemblage sub-zone (430 to 330 feet of section 1)

The lower subdivision of the S. trollopei zone is designated as the L. erecta and B. cf. B. brosgei assemblage sub-zone. This depositional interval has provided microfaunal elements in common with both the underlying Textularia spp. assemblage zone and the overlying Marginulinopsis collinsi assemblage sub-zone. The lower L. erecta subdivision of the major zone S. trollopei appears to represent an additional depositional interval of older Early Albian. This conclusion is made from a comparison with the equivalent S. trollopei zone (Beaudanticeras zone) in the Clearwater or Moosebar Formations to the south in the Canadian Western Interior region. In this latter area only the upper subdivision of M. collinsi has been reported.

Marginulinopsis collinsi assemblage sub-zone
(622 to 590 feet of section 1)

The upper subdivision of the S. trollopei zone is separated from the lower subdivision of L. erecta by 60 feet of more indurated sandstone. The M. collinsi species designating this assemblage of several distinctive calcareous species, has been recovered from numerous stratigraphic equivalents over a very large geographic area from Arctic America to the Canadian Western Interior sedimentary basins. It is not as common in the Early Albian of the Yukon as some of the equally distinctive calcareous species plotted in the chart of Table 1 for this depositional interval, but the name was selected to represent the assemblage because the species is more common in regions to the south.

6. Textularia spp. - Bathysiphon cf. B. brosgei
assemblage zone (330 to 0 feet of section 1)

The depositional interval of the basal 330 feet in reference Section 1, in the vicinity of the junction of the Snake and Peel Rivers is composed predominantly of coarse silt and sand. The assumed high energy environment was not a favourable one for Foraminifera and, thus, only a few arenaceous or agglutinated, benthonic species are present. Therefore, the total interval has been tentatively assigned to one assemblage zone with a more distinctive 30-foot assemblage sub-zone of Pyrulina cf. P. cylindroides at the base. With the exception of this latter sub-zone, the few benthonic foraminifers reported did not contribute to the age dating. Assignment of the depositional interval to a transitional age is based on its stratigraphic position between the known Early Albian S. trollopei zone and the ? Aptian, P. cf. P. cylindroides assemblage sub-zone. The latter age assignment is based on similar foraminiferal species obtained from sample material dated by macrofossils from the Barrier Creek area north and west of the Peel River section outlined in this report. The sample material was contributed by J. A. Jeletzky in the form of fragmentary remains of the Aptian species Tropaeum cf. T. australe (Moore), GSC No. 35695 (Jeletzky, 1965). Foraminifera, including Pyrulina cf. P. cylindroides, were obtained after laboratory preparation of the internal sediment filling of the macrofossil specimens.

Summary

The microfossil distribution chart of Table I was first compiled in order to establish the vertical succession of the Foraminifera. Then the micropaleontological subdivisions were interpreted as illustrated in Table II, in terms of zones, assemblage zones, and assemblage sub-zones. The biostratigraphic relationship to the mappable rock units in the field was then added when the stratigraphic data was corrected and summarized by Mountjoy (Part I). As a summary to this portion of the report the following discussion is now oriented in terms of the rock unit subdivisions of the Albian stage in the Yukon.

Martin House Formation

Basal Siltstone member: The solitary calcareous Foraminifera recovered from the lower 325 feet of Section 1 was from the basal 73 feet in sample 1a (Table 1). The ecological significance for this latter interval is one of more open-marine conditions than that suggested by the microfaunal recovery from the remainder of the Basal Siltstone member which provided a few simple, agglutinated, benthonic foraminifers indicating very restricted marine environment. No marine microfossils were recovered from the top of sample 2. The age assignment to ? Aptian has been previously discussed and the interval has been designated as the Pyrulina cf. P. cylindroides assemblage sub-zone.

Glauconite member: A lower Textularia spp. - Bathysiphon cf. B. brosgiei assemblage zone and an upper Saracenaria trollopei zone have been interpreted as two distinct assemblages. Species of the latter zone range upward for 25 feet into the basal shales of the overlying member. The ecological significance of these two assemblages is a change from agglutinated, benthonic species of restricted marine environment upward into the calcareous foraminifers of more open-marine species. Age assignment of the S. trollopei zone (including the Marginulinopsis collinsi sub-zone), to the Early Albian is quite well documented as discussed above; the lower assemblage zone has not been satisfactorily dated. Several agglutinated foraminiferal species, representing only the more tolerant primitive forms are common to both depositional intervals. With reference to the teilzones of Table II, Gaudryina cf. G. barrowensis, Gaudryina cf. G. subcretacea and Reophax n. sp. 3 have almost simultaneous termination of their species ranges near the boundary of the upper and lower zones. This rather discrete microfaunal facies change does, however, indicate a possible hiatus which effected the change, thus terminating the range of these species. Therefore, the boundary between the two zones within the Glauconitic member may possibly represent a stage boundary. The age assignment of the lower zone has been shown as Albian - ? Aptian Transition.

Arctic Red Formation

Lower Silty Shale and Fossiliferous Concretionary Shale members:

Foraminifera recovered from this depositional interval were divisible into two significant assemblage zones. In addition, the basal 25 feet of shale was included in the underlying marine transgressive zone. The lower subdivision is represented by the Ammodiscus n. sp. 1 and Ammodiscus mangusi assemblage zone and the upper by the Gaudryina canadensis assemblage zone. The latter is divisible into two distinct assemblage sub-zones; a lower Trochammina rainwateri - Reophax n. sp. 1 and an upper Globulina lacrima canadensis. The ecological interpretation of the microfauna indicates a change from a lower restricted marine condition of the Ammodiscus spp. interval to an upper open-marine environment of the Globulina lacrima canadensis. Age assignment of the Lower Silty Shale member has been placed between the underlying, well documented S. trollopei zone of the Early Albian and the overlying V. loetterlei assemblage sub-zone of late Middle Albian. The facies boundary with the overlying Trevor Formation sandstone is contained within the upper portion of this rock-stratigraphic unit and this facies boundary rises stratigraphically from south to north. At approximately the lowest stratigraphic horizon of this interfingering sequence of coarse clastics, a microfaunal facies change is indicated by the simultaneous termination of three species ranges shown in the teilzone column of Table 2. This microfaunal facies change occurs approximately 100 feet above the base of the member and affects the uppermost species ranges of Haplophragmoides n. sp. 1A, a very small form of H. aff. H. spissum, Haplophragmoides n. sp. 2, referable to H. aff. H. neocomianus and Reophax n. sp. 2. Conditions responsible for this change may have been caused by tectonic movements which rejuvenated the sediment source areas which, in turn, provided the coarser clastic sediments of the Trevor Formation. Sediments of the Trevor Formation are thought to have been deposited near the end of the Early Albian marine transgression.

Thus, some of the basal portion of the Lower Silty Shale member may represent Early Albian deposition with the remainder of this member being deposited in early Middle Albian time. Again, it should be emphasized that the finer time subdivisions of early and late for the Middle Albian are arbitrarily designated to coincide with the interpreted cyclical environments of deposition within the Middle Albian and, therefore, may not coincide exactly with these boundaries.

Siltstone member and equivalent northern facies: The Siltstone member is present in the southern part of the report-area but, in the northern part, this member is represented by silty concretionary shales very similar to the underlying Lower Silty Shale member. The high energy environment of deposition carrying the coarser clastic silts into the basin affected the microfauna of this area. Somewhat poor microfossil recovery was obtained from the lower two-thirds of this depositional interval and the only distinctive Foraminifera present was Marssonella spp., which was used to name the assemblage sub-zone of the total assemblage zone of Ammobaculites fragmentarius. The recovery of Valvulineria loetterlei and associated calcareous foraminifers from the upper one-third of the Siltstone member and its northern equivalent indicate more normal marine conditions. This point of change within the Siltstone member represents the boundary between the early and late Middle Albian. On the basis of ecological interpretation the upper two-thirds of the Siltstone member plus the lower one-third of the overlying Upper Silty Shale member represent a complete depositional cycle from restricted marine (Marssonella spp.) to open-marine (Valvulineria loetterlei) of the late Middle Albian.

Upper Silty Shale member and equivalent northern facies: A very obvious microfaunal change occurs approximately 225 feet above the base of the Upper Silty Shale member in Section 1. The prolific, open-marine, calcareous Foraminifera of the Valvulineria loetterlei assemblage sub-zone in the lower 225 feet are completely terminated as are several long-ranging, Middle Albian agglutinated species shown in the teilzone range of Table 2. The remainder of the upper depositional interval provided only agglutinated, benthonic species designated as the Psamminopelta subcircularis-Verneulinoides borealis zone. The somewhat consistent pattern of environmental cycles observed within the underlying Early and Middle Albian intervals thus appears to be broken within this Upper Silty Shale member. The previous sequences have included a regressive and "stillstand" interval of very restricted marine conditions after a transgressive, open-marine assemblage such as the V. loetterlei of the lower one-third of this member. But in this case, restricted but very good marine conditions persisted, supporting abundant agglutinated but no calcareous Foraminifera. The above mentioned changes coincide with the interpreted position of the Late Albian - Middle Albian boundary at this contact 225 feet above the base of the member. V. borealis and P. subcircularis have previously been reported from the Late Albian of Alaska (Tappan, 1962) and Berquist (1958, p. 199) also has found that V. borealis does not occur in beds younger than Late Albian.

Interpretation of Cyclical Environments

Environments for each biostratigraphic subdivision have been interpreted from the ecological significance of the foraminiferal assemblages. The most complete phases of an observed cycle are associated with the G. lacrima canadensis marine transgression and on the basis of this reference the phases in ascending order are:

- Phase 1. Very restricted marine to non-marine conditions represented by a few simple, agglutinated foraminifers representing species which are very tolerant to additions of fresh water; some samples are barren of marine microfossils. The paleogeomorphology could be one of oscillating conditions between subaerial (land) and subaqueous (shallow sea) conditions in a paralic zone.
- Phase 2. Restricted marine with agglutinated foraminifers becoming more abundant upward in the depositional interval indicating an improvement of marine conditions as an initial phase of a transgressing sea.
- Phase 3. Open marine conditions which support calcareous foraminifers and other open-marine organisms. The extensiveness of a marine incursion is indicated by the abundance and variety of these species but it can also be modified when the microfossils are diluted and masked by the contemporaneous influx of coarse clastic sediments with the transgressive sea.
- Phase 4. Restricted marine conditions start with abundant agglutinated foraminifers and these gradually diminish upward in number and the facies changes to simple, agglutinated species at the top of depositional interval. This final phase of the cycle represents regression of the seas leaving somewhat land-locked bodies of saline waters with continued addition of freshwater run-off from the land areas.

Placing this set of criteria into the rock-stratigraphic framework the following cyclical interpretation for the Albian stage is proposed:

Table 3. Cyclical Environments

ROCK UNIT (member)	CYCLE	PHASE	Description in Section 1 (Tables 1 & 2)
Upper Silty Shale	D. "Stillstand" (Late Albian)		<u>V. borealis</u> zone, upper 50 feet of unit 17 and the unit 18
	C. (late Middle Albian)	4	not distinguishable from overlying phase or is missing from the sequence.
3		<u>V. Loetterlei</u> zone of unit 17;	
2 1		upper 50 feet of unit 16; lower 2/3 of unit 16 - <u>Marssonella</u> spp. zone	
Siltstone	B. (early Middle Albian)	4	basal unit 16;
Silty Shale		3	remainder of unit 13, <u>Globulina lacrima canadensis</u> zone
	2	unit 12 and 1/2 of unit 13,	
	1	remainder of unit 11	
Glaucinite	A. (Early Albian)	4	lower 100 feet of unit 11;
		3	unit 8)
		3	unit 8) <u>S. trollopei</u> zone;
Basal Siltstone	(? Aptian)	2	unit 5 and lower 1/3 of unit 8
		4	lower 230 feet of units 3 to 5;
		3	<u>P. cf. P. cylindroides</u> of sample 1;
		1 & 2	base of section not completely exposed

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APPENDIX

Measured Sections

Section 1. Peel River below mouth of Snake River (66° 04½' to 66° 09'; 134° 04' to 145° 02')

This is a composite section measured along the bank on both sides of Peel River between 10 and 15 miles downstream from the mouth of Snake River (field stations 115, 116, 117, 118, Figure 2). It is the type section of the Arctic Red Formation. More than 1,600 feet of strata are exposed on the northeast flank of a homocline on which the beds dip about 11 degrees northeast near the axis. Northward the strata dip progressively less steeply and finally become essentially flat.

The strata consist mainly of shales containing numerous thin clay (bentonite?) layers and are recessive. Siltstones and sandstones with minor amounts of glauconite are present at the base.

Foraminifera from this section indicate that these strata range in age from Aptian (?) to Late Albian.

The section was measured in three separate parts, each part overlapping the next to some extent. The overlapping parts are included in this description together with information concerning correlation between them.

The top of the section begins at 66° 09' N latitude and 145° 02' W longitude about 10 miles upstream from the mouth of George Creek (Figure 2, 118). The base of the section is at 66° 04½' N latitude and 134° 04' W longitude, 10 miles downstream from the mouth of Snake River (Figure 2, 115).

Downstream, beds between the top of the section and George Creek are essentially flat lying and strata stratigraphically higher than those in section 1 (Figure 2, 118) appear to be absent. Those beds comprise a series of dark-weathering shales but lack the intercalated resistant beds of section 1.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
<u>Arctic Red Formation</u> (1,838+ feet)			
Upper Silty Shale Member (400+ feet)			
18	Inaccessible outcrops downstream, shales as below, estimated thickness	125	1,838
<u>Station 118</u> - east side of Peel River			
17	Shale, silty, medium to dark grey-brown; weathers very light brownish grey in small chunks; bedding indistinct; several 2- to 5-foot thick siltstone interbeds, very argillaceous,		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	forming resistant ribs along riverbank; orange- to brown-weathering concretions occur at intervals of 5 to 10 feet; 50 feet above base a wet clay bed forms a good marker bed. Clay layers also occur at 110, 125 and 148 feet above base. Pelcypods found in concretions about 95 feet above base, GSC loc. 52733, indeterminate. Above 200 feet unit is very poorly exposed. Another 100 feet of hillside above 275 feet with a few scattered exposures of shale	275	1,713
<u>Siltstone Member (240 feet)</u>			
16	Siltstone, medium to dark grey, argillaceous, weathers light grey, bedding obscure, layers of concretions spaced every 5 to 15 feet. Unit forms a prominent resistant cliff which can be traced for 5 miles on both sides of the river. A clay layer weathering white occurs 20 feet above base causing a dark wet line; 115 feet above base another clay bed or lense; 135 feet and 210 feet above base fairly prominent clay beds form good markers. In the upper 25 feet the resistant cliff gradually becomes recessive. The last resistant band of cliff occurs 5 feet below top of unit	240	1,438
<u>Lower Silty Shale Member (616 feet)</u>			
15	Covered	23	
(Note - base of unit 16 above is correlated with base of unit 14 at station 117. This siltstone forms a marker unit which is easy to recognize).			
<u>Station 117 (west side of Peel River)</u>			
14	Siltstone, light to medium grey, argillaceous, fairly soft, abundant concretions, weathers light grey, resistant. Forms a much thicker unit on east side of river, see unit 16 above	50	

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
13	Shale, dark grey, slightly silty, hard, weathers light to medium bluish grey; occasional siltstone concretions and lenses that weather reddish brown. Resistant layers of siltstone and siltstone concretions occur at 65, 85, 119, 134, 137, 156 and 166 feet above base. 284 feet above base is a 2-inch thick clay bed weathering yellow to white. Lower 50 to 70 feet resistant, upper 150 feet very recessive. 282 feet above base a pelecypod found in a concretion. GSC loc. 52714, indeterminate	307	1,198
	(Note - basal 50 to 70 feet of unit 13 forms a moderately resistant unit which can be correlated with unit 12 of station 116. Total thickness of unit 12 was not measured but is estimated to be about 80 feet).		
	<u>Station 116</u> (east side of Peel River)		
12	Shale, dark brownish grey, silty, a few concretionary layers and concretions, weathers light grey to light brown; more resistant than underlying unit; estimated thickness 45 feet. Complete thickness not shown because basal part correlates with continuation of section across river	20	891
11	Shale, medium brown, slightly silty, particularly at the base; weathers recessive, slightly darker than underlying unit, rare concretions. Some beds slightly more resistant, from 45 to 50 feet, from 90 to 95 feet, from 140 to 150 feet, and from 210 to 223 feet, above base. Between 210 and 223 feet above base becomes silty, and concretions are more abundant	239	871
10	Covered	10	632
9	Shale, dark brownish grey, very silty, weathers light grey, a few concretions, unit largely talus covered	40	622

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
<u>Martin House Formation (582+ feet)</u>			
Glauconite Member (509 feet)			
8	Sandstone, very glauconitic, fine-grained. Numerous single siltstone concretions and siltstone concretionary layers throughout the unit, all weathering light to medium reddish brown; resistant. The basal 10 or 12 feet of the unit is resistant; recessive interval between 12 and 37 feet, resistant siltstone band 10 feet thick at 37 feet above base; unit resistant between 60 feet and 130 feet above base and is recessive above this	192	582
7	Siltstone, medium to dark grey with a few siltstone concretions weathering light reddish brown. 17 feet present, correlates with top of unit 5 below	17	
(Note - units 7 and 8 of station 116 correlate with units 5 and 6 of station 115 respectively - both form distinct traceable units in this area)			
<u>Station 115</u> (east side of Peel River, 3/4 mile upstream from 116)			
6	Sandstone, light grey, fine-grained, argillaceous, soft, glauconitic; traces of fine laminations, bedding obscure; some reddish brown-weathering concretions generally at the base or top of the sandier parts and spaced 1 to 10 feet apart. Unit weathers light grey to yellowish brown; resistant and relatively inaccessible at this point; argillaceous portions form a few benches on the hillside 1 to 3 feet thick	100	
5	Siltstone, and silty shale, dark brownish grey, recessive 18 feet above base, but contains a 1-foot thick bed of pale orange-weathering concretions; another 1-foot thick bed occurs at 25 feet; 25 feet above the base is a 6- to 7-foot thick moderately resistant siltstone		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	unit, very glauconitic, medium grey to greenish grey, with a concretionary layer at the top which weathers light to medium grey to grey-brown. 43 and 50 feet above base are resistant beds of concretions and very glauconitic siltstone	59	390
4	Sandstone and siltstone, forming 6 to 8 prominent bands, 3 to 5 feet thick, with concretionary layers at base of the sandstone units. Sandstone is fine-grained, light grey with traces of fine laminations and glauconite. Siltstone is medium to dark brown, sandy. Prominent wet clay layer at top. Unit weathers light yellowish brown with pale orange coloured concretions, bedding obscure. The rock is not well indurated but forms a resistant cliff and marker unit. The unit consists of between 60 and 70 per cent sandstone. One pelcypod collected from the upper 7 feet, GSC loc. 52744, indeterminate	38	331
3	Siltstone and shale, as in underlying unit; first siltstone extends up to 12 feet, then shale to 27 feet, followed by a 5-foot thick resistant light weathering siltstone bed. Above 33 feet the unit is dominantly shale, recessive; occasional siltstone concretions that are light to medium reddish brown-weathering and up to 2 feet in diameter. Thin, white-weathering, yellow to light grey clay layers present at 12, 83, and 177 feet above base which form wet marker beds. Between 155 and 160 feet and 170 and 177 feet above base are resistant siltstone beds. 190 feet above base a 3-foot thick sandstone bed of the same lithology as unit 2, weathers light grey to light brown, resistant. One gastropod noted from a concretion collected from talus about 170 feet above base	207	293

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
2	Sandstone, non-calcareous, fine-grained, light brownish grey, a trace of laminations, some glauconite especially in the concretionary layer at the base; weathers light brown, with 1- to 2-inch thick interbeds of siltstone as in underlying unit. 8 feet above base is a 2-foot thick covered interval, probably siltstone. Grades upward into overlying siltstone unit	13	86
	Basal Siltstone Member (73+ feet)		
1	Siltstone, medium brownish grey, non-calcareous, weathers light brown, moderately resistant; bedding obscure. Siltstone alternates with recessive shale, very silty, dark brownish grey which forms units 5 to 20 feet thick. Scattered siltstone concretions, weathering medium reddish brown present in shales. Resistant siltstone beds occur between 5 and 10 feet, 40 and 45 feet, and 60 to 65 feet above base. Talus cover to river level; estimated thickness	73	73

The base of the section is at river level at this point which is about 10 miles downstream from the mouth of the Snake River and just south of the crest of the prominent anticline or monocline prominently exposed on the east bank of the Peel River.

Units 3 to 8 inclusive of section 1 form a resistant interval about 500 feet thick. This interval can be traced upstream through a series of discontinuous outcrops to the exposures on the east side of the Peel River at the mouth of Snake River. The base of this resistant interval occurs at the top of section 2, units 5 and 6. Tentative identification of foraminifera from this interval of section 2 indicates the presence of the Textularia spp. and Bathysiphon cf. B. brosgel Assemblage zone.

Section 2. (10616) Mouth of Snake River (66° 01', 134° 13')

This section was measured on the northeast side of the Peel River about 2 miles downstream from the mouth of Snake River. These strata are assigned to the Glauconite member of the Martin House Formation on the basis of microfaunal content.

The uppermost two units (5 and 6) form the base of a prominent siltstone and sandstone interval that can be followed downstream to the more resistant upper half of the Glauconite member of section 1, and upstream along the Snake River for about 15 miles in the vicinity of station 84 (Figure 2).

The thickness of Cretaceous strata above the underlying Devonian (?) rocks is not known. These rocks were previously mapped as Devonian by Stelck (see Hume, 1954, map 1034A).

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
<u>Martin House Formation</u>			
Glauconite member			
6	Siltstone, and shale, very silty, medium brown, non-calcareous; siltstone concretions, light grey, weathering reddish brown. The siltstone and shale weather light grey to light brownish grey; slightly recessive compared with resistant underlying siltstone unit. Forms top of river exposure. Unit 6 was measured 600 yards southeast of lower part of section 2	30	491
5	Siltstone and shale, silty, medium brown, non-calcareous; the unit weathers light brown to medium grey and forms a moderately resistant unit at the top of the cliff which can be mapped along the river to the south and north. There are reddish brown-weathering concretions in the basal 20 feet and again at 50 feet. The basal 3 feet are resistant. There are 2 layers of reddish brown-weathering concretions, one at 15 feet and the other at 33 feet	110	461

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
4	<p>Shale, silty, medium brown with abundant siltstone concretions, solitary and in layers. These weather reddish brown. The shale weathers light to medium brown in chunks, moderately resistant. The base of this rock unit is selected at a white-weathering clay band. The second (from the bottom) white-weathering band formed by an impervious clay layer is at 16 feet. There are layers of concretions of siltstone at 5 feet and 23 feet. After 23 feet the concretions stop. It is less silty above 25 feet, and less resistant. The third white-weathering layer caused by impervious clay is at 45 feet. Solitary siltstone concretions start again at 64 feet. There is a bed of siltstone at 84 feet and another at 94 feet. The fourth white-weathering clay bed is at 110 feet. Siltstone concretions found at 115 feet, 118 feet, 133 feet, and at 143 feet. At 124 feet there is a 5-foot thick interval of more silty shale, moderately resistant. The last 20 feet of the unit became gradually more silty and more resistant</p>	164	351
3	<p>Shale, silty to very silty, medium brown, non-calcareous. The unit weathers light to medium grey in irregular small pieces; poor fissility; concretions of siltstone at 6 feet, 17 feet, 33 feet, and 46 feet. At 15 feet the lowermost white-weathering clay bed is found. White deposit of carbonate and sulphate (?) due to the water layer coming to the surface at this point. Above 25 feet the unit is recessive, and breaks into smaller irregular chips up to $\frac{1}{4}$ inch</p>	47	187
2	<p>Shale, silty, medium grey brown, chunky in the basal 5 feet. There are beds of siltstone concretions at 1 foot, 13 feet, and 37 feet, all 6 inches to 1 foot thick. At 14 feet there is a clay layer, grey, 1 to 2 inches thick with carbonaceous or lignite beds in the middle. This clay weathers orange-brown. After the basal 5 feet, the dark bluish grey shale is similar to the unit below but is less fissile</p>	38	140

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
1	<p>Shale, non-calcareous, medium to dark grey, abundant small spherical objects approximately $\frac{1}{2}$ inch in diameter. The unit weathers light grey to reddish brown; bedding indistinct with partings $\frac{1}{4}$ inch to 2 inches thick. It is not quite fissile. Small spherical bumps are visible on the weathered surface and occur as high as 50 feet above base. The colour is predominantly dark bluish grey above 5 feet and shale becomes more fissile. There are some 2- to 5-foot thick rusty weathering intervals which are slightly more resistant. Some plant fragments. Siltstones are light brownish grey, finely laminated, with some pyrite, weather reddish brown, resistant, forming a prominent marker. Beds of siltstone concretions occur at 65, 71, 87, 89 and 102 feet above base. Thin, light yellow, clay beds 1 to 2 feet above base. Thin, light yellow, clay beds 1 to 2 inches thick occur at 60, 80 and 102 feet above base</p>	102	102

Section 3. Snake River about 8 miles above mouth

This section of the Martin House Formation was measured on the north side of Snake River about 8 miles upstream from the mouth (65° 58', 133° 58', station 85, Figure 2) where sandstones form a prominent cliff. The strata are essentially flat or dip very slightly to the east.

This section is correlated with the base of section 4 a few miles upstream. The presence of glauconite indicates that these strata are equivalent to the Glauconite member and this is confirmed by preliminary studies of the foraminifera of section 1 on Peel River. The thickness suggests that a nearly complete sequence of this member is present.

The section begins at the highest point that was accessible and ends at river level.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
<u>Martin House Formation</u>			
Glauconite Member (450+ feet)			
3	Sandstone, fine- to medium-grained, argillaceous, soft, light brownish grey, weathers light grey in units 5 to 20 feet thick forming a prominent cliff at top of section. Lower half of cliff contains beds of argillaceous siltstone and fine-grained sandstone 5 to 10 feet thick. Some sandstone in talus is glauconitic	100+	450
2	Siltstone and silty shale, dark grey-brown with numerous concretions up to 1 foot in diameter. Resistant sandstone units occur at 205, 230 and 255 feet above base and are 3, 5 and 4 feet thick. Sandstone is fine- to medium-grained, light to medium grey and weathers light grey; very resistant. Traces of pelecypods. Talus fossil collection GSC loc. 52609. <u>Inoceramus</u> cf. <u>anglicus</u> Wood, indet. ammonite	275	350
1	Sandstone, fine-grained, light grey-brown, non-calcareous, soft, with reddish brown-weathering concretions; weathers light grey, extends down to river level	75	75

Section 4. Snake River between 14 and 19 miles above mouth. (65° 54' to 57', 133° 38' to 46').

This is a composite section measured along the river bank on the north side of Snake River between 14 and 19 miles above its mouth. More than 1,400 feet of dominantly shaly strata are exposed along this section of the river. The strata dip gently to the east or are flat-lying. On the basis of the regional geology and preliminary micropaleontology the strata of this section are assigned to the Arctic Red Formation and to the upper part of the Martin House Formation. Because no prominent siltstone unit is present these strata cannot be assigned to members. This succession is equivalent to much of the Arctic Red Formation of Section 1. The silty development between 390 and 520 feet above the base of unit 5 might represent the Siltstone member of section 1. Foraminifera tentatively dated as Late Albian have been recovered from samples collected from near the top of the section.

The section was measured in three separate parts and the thickness of some intervals between sections was estimated. The top of this section occurs at station 81 (Figure 2) and the base at station 84.

No younger beds appear to be present. Outcrops for about 5 miles upstream are essentially horizontal and expose the same stratigraphic interval as that in the upper part of the section described below. The base of the section appears to correlate with the upper and middle parts of section 3 (station 85) downstream.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
<u>Field Station 81</u>			
<u>Arctic Red Formation (lower)</u>			
5	Shale, silty, non-calcareous, medium to dark bluish grey, weathering medium bluish grey, in part reddish brown; moderately resistant. Numerous siltstone concretions and lenses 1 to 4 inches thick, weathering dark reddish brown and spaced 1 to 5 feet apart occur throughout much of the unit. Concretions absent in interval 105 to 135 feet above base. Prominent, wet clay layers about 1 inch thick occur 159, 329, 352, 430, 452, and 562 feet above base, weathering yellow-grey. The thickest is 3 inches thick and occurs at 452 feet. Shales are very silty between 390 and 520 feet above base. Prominent light coloured layers occur in upper 120 feet and concretions very abundant in upper 80 feet. A few pelecypods (<u>Inoceramus?</u>) occur between 290 and 350 feet above base	680	1,490

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
4	Covered interval down to river level, exposures along strike and downstream suggest shales as above	165	810
	<u>Field Station 82</u> The silty shales of the above outcrop were traced downstream for about 1 mile. The following shales occur below 15 to 20 feet of resistant, silty shale traced from the base of station 81.		
3	Shale, silty, medium brownish grey to blue grey, weathers medium bluish grey, recessive; numerous clay bands between 60 and 70 feet above base weather reddish brown; large concretions occur in basal 50 feet and concretionary siltstone interbeds in upper part	240	645
2	Covered between stations 82 and 83. Estimate between 100 and 150 feet of section covered to the top of the siltstone-sandstone unit which outcrops at station 83	100+	405
	<u>Field Station 84</u> Top of this part of the section assumed to reach top of siltstone-sandstone unit		
<u>Martin House Formation</u>			
Glauconite Member (?)			
1	Siltstone, non-calcareous, soft, medium brownish grey; occasional siltstone concretions up to 1 foot diameter; weathers light grey, moderately resistant, bedding indistinct. Basal 25 feet and interval from 68 to 77 feet above base is more resistant forming small cliffs. Resistant 6-foot thick beds of siltstone occur at 131 and 138 feet above base. Resistant argillaceous, coarse siltstone or fine-grained sandstone occurs at 160 to 162, 230 to 238, 262 to 270 and 282 to 287 feet above base. At 225 feet above base a tube-like concretion, 15 feet long, consisting of numerous reddish brown-weathering concretions piled on each other cuts across the bedding	305	305

The siltstone and sandstone of unit 1 are correlated with the middle and upper part of section 3, and are tentatively assigned to the Glauconite member.

Camsell (1906) reported Cretaceous Inoceramus from sandstones above the mouth of Snake River. His map indicates that these fossils were collected just downstream from the base of the above section.

Section 5. (106E13) Trevor Range, east side

This section is a composite section measured along one of the unnamed creeks that drain the east side of the Trevor Range about 6 miles southeast of Dog Lake or 11 miles south-southeast of the mouth of the Snake River (65° 50' and 134° 03'). The strata dip gently westward.

The section was measured in three separate parts. Distinct marker units provide a reliable means of correlation between the closely spaced sections. It begins at the lowest outcrops exposed in the creek (station 28, Fig. 2) and ends at the rim of a ridge of the plateau-like Trevor Range (station 27).

More than 600 feet of additional sandstones outcrop above the top of this section on ridges to the west. Exposures on the west side of Trevor Range indicate that the total thickness of this sandstone unit is more than 1,200 feet thick. The lower 204 feet of this section (units 1 to 7) contain microfossils which occur at the base of the Arctic Red Formation and top of the Martin House Formation (Galuconite member) in section 1 and are tentatively assigned by Chamney to the Marginulinopsis collinsi subzone. The overlying 357-foot interval that is gradational to the overlying Trevor Formation contains microfossils representative of the upper part of the Saracenia trollopei zone.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
<u>Field Station 27</u>			
<u>Trevor Formation (base)</u>			
19	Sandstone, fine-grained, light greyish brown, slightly calcareous; small snails throughout with occasional concretions in some beds; a few plant fragments and stems. Rare chert pebbles present in upper 50 feet. Unit resistant; weathers yellowish brown, in beds 1 inch to 1 foot thick, averaging 3 inches to 4 inches. Clay balls and pebbles found at 70 feet. The unit weathers yellow-brown and green, but predominantly pale green. A few pelecypods occur 110 feet above base GSC loc. 52598: <u>Posidonia</u> cf. <u>nahwisi</u> McLearn s. lato, (poorly preserved) <u>Inoceramus</u> ex. gr. <u>anglicus</u>	+120	902

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
<u>Arctic Red Formation</u>			
Lower Silty Shale member (357 feet) gradation to overlying Trevor Formation			
18	Covered - 50 to 75 per cent; scattered outcrops of sandstone, fine-grained, light grey to light brown, dense, quartzose; the unit weathers light brown. At 157 feet the unit becomes predominantly sandstone, fine-grained, light grey to light brown, with plant stems and fragments present. The unit weathers light yellowish brown, in beds 1 inch to 1 foot thick	202	882
17	Sandstone, light brown, very fine-grained, dense, a few concretions; unit weathers light brown in essentially one resistant bed. This is part of the sandstone-siltstone sequence below, but it more thickly bedded	9	680
The section here was projected to the outcrop across the creek. The thickness of section omitted or repeated could be as much as 20 feet. Prominent jointing, 30° and 120°			
16	Partly covered interval with 1-foot to 3-foot thick beds of sandstone showing. The siltstone and shale intervals are largely covered and appear to be 1 foot to 5 feet thick. The unit weathers light yellow-grey to brown. The sandstone is very fine-grained, light brown, quartzose, with a trace of plant fragments. The bedding is indistinct	104	671
15	Sandstone, medium grey, fine-grained, in part argillaceous with interbeds of siltstone and silty shale, dark grey; talus from the sandstone contains a few leaf and plant fragments; unit weathers light yellowish grey; indistinct beds from 1 inch to 1 foot thick	12	567

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
14	Sandstone, dark grey, fine-grained, non-calcareous, weathers dark blue-grey to grey-brown in creek bed in beds 1 inch to 1 foot thick; base of this unit is exposed farther downstream; estimated thickness of unit is about 30 feet and correlates with parts of units 8, 9 and 10 below	30 _±	555
	(Note - base of unit 14 above is equivalent to the base of unit 8 at field station 29. This sandstone bed forms a distinct marker unit along both sides of the creek)		
	On north side of creek from station 28 and about 300 yards upstream. This section overlaps the lower 91 feet of section at station 27.		
	<u>Field Station 29</u> (measured on north side of creek about 1 mile east of upper part at station 27)		
13	Estimate 200-250 feet of exposure; appears to be predominantly sandstone similar to the beds below, fine-grained, light to medium grey-brown, with traces of plant fragments. The unit weathers light greenish grey to brown, and occurs in unit 5 feet and 10 feet thick, with interbeds of dark grey recessive siltstone and argillaceous sandstone	225 _±	525
12	Siltstone, brownish grey, traces of plant fragments, recessive, light to medium grey in colour, with thin indistinct beds. At 7 feet above the base there is a 3-foot thick sandstone bed	17	300
11	Sandstone, fine-grained, light grey, quartzose, with flecks of dark argillaceous material; plant fragments present; unit weathers light yellow-brown in obscure beds about 1-3 feet thick. This is the thickest sandstone unit above the base	14	283

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
10	Siltstone and silty shale, dark grey, with interbeds of sandstone, fine-grained light grey. Parts have abundant plant fragments. The unit weathers light grey-green to grey-brown. At 16 feet there is a 2-foot thick sandstone bed, with the first prominent amount of plant fragments. Sandstone occurs at the base, at 16 feet, and at the top. Upward in the section the amount of shale and siltstone decreases and the amount of sandstone increases	42	269
9	Shale, very silty, and siltstone, argillaceous, dark grey; sandstone interbeds up to 1 foot thick. There is a 1-foot thick bed of sandstone 4 feet above base of this unit, with two other 6 inch beds evenly spaced above. It is similar to the unit below	14	227
8	Sandstone, fine-grained, medium grey-green; weathers light greenish grey and brown in 1-foot thick beds. This unit forms the first prominent sandstone unit at the lower end of this section. Correlates with unit 14 at field station 27	4	213
<u>Martin House Formation</u>			
Glauconite member (?)			
7	Sandstone, fine-grained, medium grey, in part argillaceous, a few plant fragments present. The unit weathers light greenish grey in 1- to 2-foot thick beds. It is interbedded with shale and siltstone, dark grey, in 1- to 5-foot thick units. Six siltstone beds form resistant ribs	25	209
6	Shale, medium to dark grey, very silty, non-calcareous, weathers light grey; zone of concretions of siltstone and ironstone at 13 feet and 20 feet. The zone at 20 feet is a unit of 3 beds more than 2 feet thick. They weather grey-brown. At 32 feet and 40 feet there are 6-inch to 1-foot beds of siltstone concretions. There is a distinctive wet band		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	above the bed at 32 feet caused by water seepage. Above 50 feet the shale is very silty. The uppermost 15 feet is siltstone	98	184
5	Siltstone and sandstone, very fine-grained. The basal 2 inches are white, the upper part is greenish grey. Unit weathers medium grey-brown and forms a resistant unit on the hillside	1	86
4	Shale, silty, slightly calcareous, dark brownish grey, weathers medium grey, blocky	15	85
3	Covered to creek-bed: exposed at station 28 on south side of creek about 1/8 mile southeast of station 29		
<u>Field Station 28</u>			
2	Shale, silty, very dark brownish grey, non-calcareous; a few pelecypods and an echinoderm collected in basal 5 feet. Unit weathers dark grey, and forms blocky talus. Pelecypods occur throughout. Siltstone concretions occur at 40 and 52 feet above base. Shale contains more silt near the top	65	70
	GSC loc. 52596 from basal 5 feet: <u>Inoceramus</u> cf. <u>anglicus</u> Woods, <u>Lemuroceras</u> sp. ?		
	GSC loc. 52595 from upper 15 feet: <u>Inoceramus</u> cf. <u>anglicus</u> Woods, <u>Lemuroceras</u> sp. indet.		
	Both lots are doubtfully referred to the upper part of the <u>Beudanticeras</u> zone by J.A. Jeletzky		
1	Covered to creek bed	5	5
	GSC loc. 52697 collected from about halfway between stations 27 and 29. Appears to be the same shale unit as unit 2 or possible base of unit 6: <u>Cleoniceras</u> sp. or <u>Lemuroceras</u> ? sp. indet.		