GEOLOGICAL SURVEY OF CANADA
BULLETIN 408

STRATIGRAPHY OF MESOZOIC STRATA, EAGLE PLAIN AREA, NORTHERN YUKON

J. Dixon

1992

Energy, Mines and Resources Canada   Energie, Mines et Ressources Canada

Canada

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Available in Canada through
authorized bookstore agents
and other bookstores

or by mail from

Canada Communication Group-Publishing
Ottawa, Ontario K1A 0S9

and

Geological Survey of Canada
601 Booth Street
Ottawa Canada K1A 0E8

and

Institute of Sedimentary and Petroleum Geology
Geological Survey of Canada
3303 - 33rd Street N.W.
Calgary, Alberta T2L 2A7

A deposit copy of this publication is also available
for reference in public libraries across Canada

Cat. No. M42-408E
ISBN 0-660-14223-6

Price subject to change without notice

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Manuscript submitted: 87.11.16
Approved for publication: 88.01.21

PREFACE

Few publications are available which document the Mesozoic stratigraphy of the Eagle Plain area, a shortcoming that this report attempts to rectify. The study incorporates new outcrop and subsurface data with previously available data into a comprehensive study of the Mesozoic succession. The data form the basis for sedimentological interpretations, the development of paleogeographic reconstructions, and speculations on the tectono-stratigraphic history of the area. Although to date Mesozoic strata have not yielded significant hydrocarbons on Eagle Plain, the data presented in this report will be important in any economic evaluation of the area.

Elkanah A. Babcock
Assistant Deputy Minister
Geological Survey of Canada

PRÉFACE

Il n'existe que quelques publications sur la stratigraphie mésozoïque de la région de la plaine d'éagle, une lacune que le présent rapport tente de recifier. Dans le cadre de l'étude, on a incorporé de nouvelles données sur les affleurements et les roches souterraines de façon à permettre une analyse globale de la succession mésozoïque. Les données forment la base d'interprétations sédimentologiques, de reconstitutions paléogéographiques et de formulations d'hypothès sur l'histoire tectonic-stratigraphique de la région. Même si, à ce jour, on n'a pas découvert d'importants réservoirs d'hydrocarbures dans les couches mésozoïques de la plaine d'Eagle, les données contenues dans le présent rapport seront utiles pour toute évaluation économique de la région.

Elkanah A. Babcock
Sous-ministre adjoint
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Abstract

Eagle Plain, in the northern Yukon, is underlain by about 2500 m of Jurassic and Cretaceous clastic sediments. Jurassic to Aptian strata are represented by the Bug Creek Group, and the Porcupine River, McGuire, Mount Goodenough, and Rat River formations, which are present only on the northern flank of Eagle Plain, abutting the Eagle Arch, and in Bell Basin. Albian and Upper Cretaceous strata extend across Eagle Plain. Five new formations are defined in Albian and Upper Cretaceous rocks. In ascending stratigraphic order these are: the Whitestone River Formation (Albian), Parkin Formation (Cenomanian), Fishing Branch Formation (Cenomanian–?Turonian), Burnthill Creek Formation (?Santonian) and Cody Creek Formation (?Santonian–?Campanian). The Upper Cretaceous formations are part of the Eagle Plain Group.

Jurassic to Aptian strata are mostly marine shelf deposits that formed during a time when extensional tectonism was dominant. Albian sediments were deposited during a period of both extensional and compressional tectonism, during which time a deep-water trough developed on the northern flank of Eagle Plain. South of the trough, but north of the Cordilleran Orogen, was a broad marine shelf. During the Late Cretaceous, compressional tectonics were dominant and deposition took place in a series of northward migrating foreland basins associated with the Cordilleran Orogen. North-to-south facies changes indicate a northward progression from nonmarine to marine shelf deposits in the youngest strata of the Eagle Plain Group.

Résumé

Le sous-sol de la plaine Eagle située dans le nord du Yukon, contient environ 2500 m de sédiments clastiques d'âge jurassique et crétacé. Les strates jurassiques à aptiennes sont représentées par le Groupe de Bug Creek et les formations de Porcupine River, McGuire, Mount Goodenough et Rat River, qui n'existent que sur le flanc nord de la plaine Eagle, en bordure de l'arche d'Eagle et dans le bassin Bell. Les strates d'âge albien et crétacé supérieur s'étendent sur l'ensemble de la plaine Eagle. Cinq nouvelles formations ont été définies dans les roches de l'Albien et du Crétacé supérieur. De bas en haut, ce sont : la Formation de Whitestone River (Albien), la Formation de Parkin (Cénomanien), la Formation de Fishing Branch (Cénomanien–?Turonien), la Formation de Burnthill Creek (?Santonien) et la Formation de Cody Creek (?Santonien–?Campanien). Les formations du Crétacé supérieur font partie du Groupe d'Eagle Plain.

Les strates du Jurassique à l'Aptien sont principalement des dépôts de plate-forme marine qui se sont formés à une époque où le tectonisme extensionnel était dominant. Les sédiments de l'Albien se sont déposés durant une période de tectonisme caractérisée à la fois par des phénomènes d'extension et de compression, au cours de laquelle s'est formée une profonde dépression marine sur le flanc nord de la plaine Eagle. Au sud de cette dépression mais au nord de l'Orogène de la Cordillère, se trouvait une vaste plate-forme marine. Durant le Crétacé supérieur, la tectonique due aux effets de compression a été dominante, et la sédimentation s'est produite dans une série de bassins d'avant-pays, associés à l'Orogène de la Cordillère et migrant vers le nord. Les variations nord-sud des faciès indiquent un passage progressif, en direction du nord, de dépôts non marins à des dépôts de plate-forme marine dans les strates les plus récentes du Groupe d'Eagle Plain.

Summary

Eagle Plain is an upland area, 400 to 800 m in elevation, bounded on the west, south and east by prominent escarpments. To the north, the uplands merge into the Keele Range; to the south, the escarpment faces the broad valley of the Ogilvie and Peel rivers. East of the plain are the Richardson Mountains, and to the west are the Ogilvie Mountains. Rolling hills covered with stunted conifers or Arctic grasses, which do not make for good exposure of strata, are typical features of Eagle Plain. Twenty-seven wells and a limited number of outcrops and cores provide the basis for understanding the Mesozoic geology.

Up to 2500 m of Jurassic to Upper Cretaceous strata are present in the Eagle Plain area, but only Albian and Upper Cretaceous strata extend under the entire plain. Jurassic strata of the Bug Creek Group are present only on the northeast flank of Eagle Plain at Salmon Cache Canyon, and extend only a few kilometres to the west of the canyon. Upper Jurassic Porcupine River strata are exposed along the northern flank, but extend only a few kilometres southward into the subsurface. Both Jurassic units consist of intercalated sandstone- and mudstone-dominant intervals. The Jurassic strata typically contain hummocky cross-stratified, planar laminated and bioturbated sandstones, which, along with the contained marine macro- and microfossils, indicate desposition in the nearshore and inner shelf realms.

Unconformably overlying Jurassic strata is a thin remnant of the Valanginian McGuire Formation. The McGuire Formation is a shale-dominant unit containing marine microfossils, and is preserved only in the vicinity of Salmon Cache Canyon. The next identified unit is the Barremian Mount Goodenough Formation, present principally in the northeastern area of Eagle Plain, but also found in an outlier on the banks of Peel River, southeast of Eagle Plain. Mount Goodenough strata rest unconformably on older beds and consist of a thin basal, transgressive sandstone abruptly overlain by a thick shale succession. The basal sandstone is mostly very fine to fine grained and is finely laminated to bioturbated.

Upper Barremian to Aptian Rat River strata have been tentatively identified in only one well, on the southern edge of Bell Basin (Bell River no. 1 N-50). The Rat River Formation consists of several coarsening-upward cycles several tens of metres thick in the basal part of the succession, and interbedded shale and sandstone units in the upper part. Sandstones are very fine to fine grained, but details of the contained sedimentary structures are lacking. Comparison with equivalent strata in the nearby Richardson Mountains, where hummocky cross-stratification, wave and current ripples, and burrowed to thoroughly bioturbated beds suggest that the Rat River strata are marine shelf deposits.

Resting with marked unconformity on older beds are the Albian Sharp Mountain and Whitestone River (new name) formations. Sharp Mountain strata consist of intercalated sandstone and conglomerate having a sediment gravity flow origin, and are present only in the northernmost part of Eagle Plain. Fragments of Lower Albian ammonites have been found in this unit. Whitestone River strata abruptly overlie the Sharp Mountain Formation in the Sharp Mountain area. South of Sharp Mountain, Whitestone River strata rest on various Paleozoic units. The Whitestone River Formation consists of up to 1500 m of shale intercalated with thin beds and laminae of very fine grained sandstone and siltstone. The sandstone/siltstone beds are a few millimetres to a few centimetres thick and contain planar and ripple crosslaminae. Whitestone River strata are interpreted as middle to outer shelf and slope deposits. Albian foraminifers and ammonite fragments have been recovered from this unit.

A major unconformity separates Albian from Upper Cretaceous strata of the Eagle Plain Group. Four new formations are identified in the Eagle Plain Group; in ascending stratigraphic order they are: the Parkin Formation (Cenomanian), the Fishing Branch

Formation (Cenomanian–?Turonian), the Burnthill Creek Formation (?Santonian), and the Cody Creek Formation (?Santonian–?Campanian). The Parkin Formation is up to 520 m thick and consists of a thin basal sandstone overlain by a thick shale succession. Cenomanian dinoflagellates have been recovered from the Parkin shales. Fishing Branch sandstones gradationally overlie Parkin shales and are up to 300 m thick. Hummocky cross-stratification and wave-ripple laminae, as well as burrows and some extensively bioturbated beds are typical sedimentary features of the Fishing Branch Formation. These features indicate deposition in a nearshore to inner shelf environment. The Parkin and Fishing Branch formations form a large-scale transgressive–regressive depositional cycle.

The Burnthill Creek Formation rests abruptly on Fishing Branch strata and consists of shale with interbeds of sandstone and siltstone. The formation is up to 432 m thick. Details of the contained sedimentary structures are scarce due to inadequate exposures and a lack of core material.

Gradationally overlying Burnthill Creek strata is the Cody Creek Formation, consisting of intercalated sandstone and shale. The sandstone beds are more prominent than the shales and in outcrop form very distinct, resistant-weathering bands. The sandstones are fine to coarse grained, and locally granular to pebbly. In the few outcrops examined in southern Eagle Plain, the sandstones contain medium- to large-scale trough crossbeds that are commonly part of thick fining-upward units. In northern Eagle Plain, the sandstones are mostly fine grained with local occurrences of coarser material. Hummocky cross-stratification is a common sedimentary structure in the northern sandstones, but also present are planar laminated beds and planar crossbeds.

Burnthill Creek and Cody Creek strata form another transgressive–regressive depositional cycle, with nonmarine strata predominating in southern Eagle Plain, and grading northwestward into marine shelf sediments.

A lack of indigenous fossils within the Fishing Branch, Burnthill Creek and Cody Creek formations prohibits any attempt at accurate dating. Comparison with better dated, and apparently coeval, strata from northern Yukon and adjacent Northwest Territories suggests that they probably were deposited during Cenomanian to Campanian time.

Under northeast Eagle Plain lies Eagle Arch, onto which progessively younger sediments onlap to the south. Jurassic to Valanginian strata are restricted to the north flank of the arch, but the Barremian Mount Goodenough Formation extends onto the arch. It appears that the arch was completely inundated during the Barremian, as is evidenced by the presence of an outlier of Barremian strata southeast of Eagle Plain. If pre-Albian strata were present under Eagle Plain, they were eroded in the late Aptian–Early Albian. In the Early Albian, a deep-water trough flanked northern Eagle Plain, which began to fill with westerly and northwesterly derived sediment gravity flow deposits. A broad, muddy shelf extended southward from the trough to the Cordilleran Orogen. During the Late Cretaceous, a moderately thick succession of clastics accumulated in a foreland basin in front of the rising Cordillera.

Sommaire

La plaine Eagle est une région de hauts plateaux, de 400 à 800 m d'altitude, limités à l'ouest, au sud et à l'est par des escarpements prononcés. Au nord, les hauts plateaux fusionnent avec le chaînon Keele; au sud, l'escarpement fait face à la vaste vallée des rivières Ogilvie et Peel. À l'est de la plaine se trouvent les monts Richardson, et à l'ouest les monts Ogilvie. Des collines onduleuses couvertes de conifères rabougris ou de plantes herbacées arctiques qui dissimulent partiellement les strates, sont des reliefs typiques de la plaine Eagle.

Vingt-sept puits de sondage et un nombre limité d'affleurements et de carottes de sondage nous ont fournis les éléments nécessaires pour comprendre la géologie du Mésozoïque.

Il existe dans la région de la plaine Eagle jusqu'à 2500 m de strates d'âge jurassique à crétacé supérieur, mais seules les strates d'âge albien et crétacé supérieur se prolongent sous toute la plaine. Les strates jurassiques du Groupe de Bug Creek n'existent que sur le flanc nord-est de la plaine Eagle à l'emplacement du canyon de Salmon Cache, et ne s'étendent que sur quelques kilomètres à l'ouest du canyon. Les strates de Porcupine River d'âge jurassique supérieur affleurent de long du flanc nord, et se prolongent sur seulement quelques kilomètres dans les terrains de subsurface vers le sud. Les deux unités jurassiques se composent d'intervalles à intercalations gréseuses, et à mudstones dominates. Les strates jurassiques contiennent typiquement des grès à stratifications entrecroisées en creux et bosses, à laminations planes et à bioturbations, qui en même temps que les macrofossiles et microfossiles marins contenus dans ces strates, indiquent une sédimentation dans des domaines littoraux et de plate-forme intérieure.

Il existe un mince vestige de la Formation valanginienne de McGuire, qui recouvre en discordance des strates jurassiques. La Formation de McGuire est une unité principalement composée d'argile litée contenant des microfossiles marins, et elle n'est conservée qu'à proximité du canyon de Salmon Cache. L'unité suivante identifiée est la Formation barrémienne de Mount Goodenough, principalement présente dans la région nord-est de la plaine Eagle, mais aussi présente dans une avant-butte sur les rives de la rivière Peel, au sud-est de la plaine Eagle. Les strates du Mount Goodenough reposent en discordance sur des lits plus anciens, et se composent d'un grès basal mince et transgressif recouvert directement par une épaisse succession d'argiles litées. Le grès basal a une granulométrie généralement très fine à fine, et une structure finement laminée à bioturbée.

Les strates de Rat River, d'âge barrémien supérieur à aptien, ont été identifiées de façon provisoire dans un seul puits de sondage sur le bord sud du bassin Bell (Bell River n° 1 N-50). La Formation de Rat River se compose de plusieurs cycles de granulométrie progressivement plus grossière vers le haut, qui atteignent plusieurs dizaines de mètres d'épaisseur dans la partie basale de la succession, et d'unités interstratifiées d'argiles litées et de grès à sa partie supérieure. Les grès sont de granulométrie très fine à fine, mais les détails des structures sédimentaires contenues sont oblitérés. La comparaison avec des strates équivalentes situées dans les monts Richardson proches, où existent des stratifications entrecroisées à bosses et creux, des rides symétriques et de courant et des lits bioturbés ou à cavitées creusées par des organismes fouisseurs, suggère que les strates de Rat River sont des sédiments de plate-forme marine.

Sur des couches plus anciennes, reposent en discordance marquée les formations albiennes de Sharp Mountain et de Whitestone River (nouvelle désignation). Les strates de Sharp Mountain se composent de conglomérats et intercalations gréseuses, dont l'origine est un écoulement sédimentaire de gravité, et ne sont présentes que dans la partie la plus septentrionale de la plaine Eagle. Dans cette unité, ont été trouvés des fragments d'ammonites de l'Albien inférieur. Les strates de Whitestone River recouvrent sans transition la Formation de Sharp Mountain dans la région du mont Sharp. Au sud du mont Sharp, les strates de Whitestone River reposent sur diverses unités paléozoïques. La Formation de Whitestone River se compose au maximum de 1500 m d'argiles litées interstratifiées avec de minces lits et lamines de grès et siltstones de granulométrie très fine. Les lits de grès et siltstones ont quelques millimètres à quelques centimètres d'épaisseur, et contiennent des lamines entrecroisées, les unes planes, les autres ondulées. Les strates de Whitestone River ont été interprétées comme étant des sédiments de plate-forme moyenne à externe et sédiments de talus continental. Dans cette unité, ont été trouvés des foraminifères et des fragments ammonitiques d'âge albien.

Une grande discordance sépare les strates albiennes des strates d'âge crétacé supérieur du Groupe d'Eagle Plain. Dans le Groupe d'Eagle Plain, ont été identifiées quatre nouvelles formations; de bas en haut, dans la colonne stratigraphique, ce sont : la Formation de Parkin (Cénomanien), la Formation de Fishing Branch (Cénomanien-?Turonien), la Formation de Burnthill Creek (?Santonien), et la Formation de Cody Creek (?Santonien-?Campanien). La Formation de Parkin a jusqu'à 520 m d'épaisseur et se compose d'un mince grès basal recouvert d'une épaisse succession d'argiles litées. Dans les argiles litées de Parkin ont été trouvés des dinoflagellés d'âge cénomanien. Les grès de Fishing Branch recouvrent graduellement les argiles litées de Parkin et atteignent jusqu'à 300 m d'épaisseur. Des stratifications entrecroisées en bosses et creux et des lamines avec rides symétriques, des cavités creusées par des organismes et certains lits bioturbés, représentent des structures sédimentaires typiques de la Formation de Fishing Branch. Ces structures indiquent une sédimentation dans un milieu littoral passant progressivement à un milieu de plate-forme interne. Les formations de Parkin et de Fishing Branch forment un cycle sédimentaire transgressif-régressif de grande échelle.

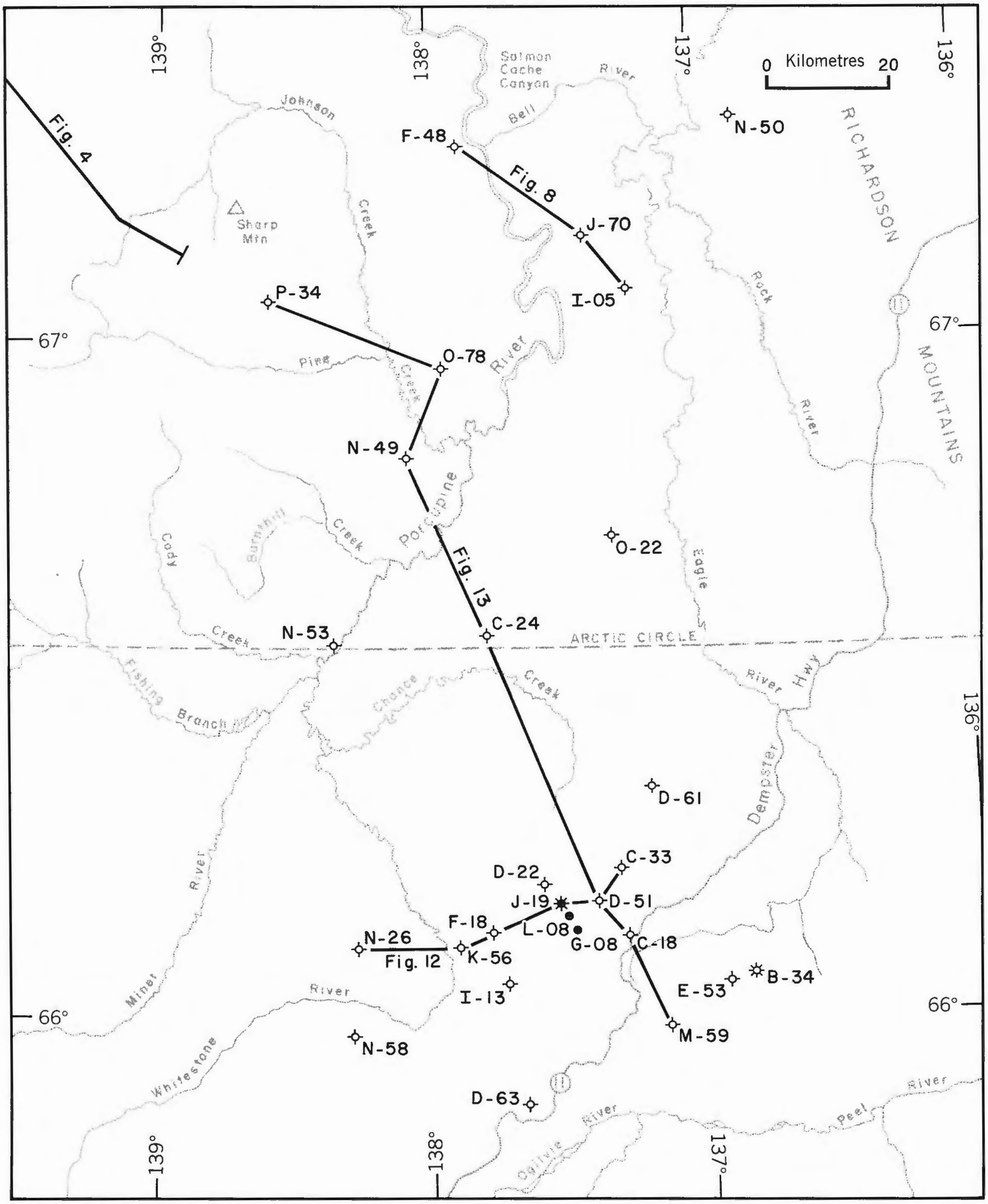
La Formation de Burnthill Creek repose sans transition sur les strates de Fishing Branch, et se compose d'argiles litées contenant des interstratifications de grès et siltstones. La formation peut atteindre 432 m d'épaisseur. Les détails des structures sédimentaires contenues sont rares, étant donné l'absence d'affleurements de bonne qualité, et de matériaux prélevés par carottage.

La Formation de Cody Creek qui se compose d'argiles litées et d'intercalations de grès recouvre progressivement les strates de Burnthill Creek. Les lits gréseux sont bien plus en évidence que les argiles litées, et lorsqu'ils affleurent, forment des bandes très nettes, résistantes à l'altération. Les grès sont de granulométrie fine à grossière, et localement granulaires à caillouteux. Dans quelques affleurements examinés dans le sud de la plaine Eagle, les grès contiennent des stratifications entrecroisées en auge, d'échelle moyenne à grande, qui font souvent partie d'épaisses unités s'affinant vers le haut. Dans le nord de la plaine Eagle, les grès ont principalement une granulométrie fine, et contiennent parfois des materiaux plus grossiers. Dans les grès situés au nord, une stratification entrecroisée en bosses et creux est une structure sédimentaire fréquente, mais il existe aussi des laminations planes et des lits entrecroisés plans.

Les strates de Burnthill Creek et de Cody Creek constituent un autre cycle sédimentaire transgressif-régressif, dans lequel les strates non marines prédominent dans le sud de la plaine Eagle, et passent progressivement vers le nord-ouest à des sédiments de plate-forme marine.

L'absence de fossiles indigènes dans les formations de Fishing Branch, de Burnthill Creek et de Cody Creek rend inutile toute tentative de datation précise. Une comparaison avec des strates mieux datées et apparemment contemporaines, du nord du Yukon et des Territoires du Nord-Ouest adjacents, suggère que ces formations se sont probablement déposées durant l'intervalle allant du Cénomanien au Campanien.

Dans le sous-sol du nord-est de la plaine Eagle, se trouve l'arche d'Eagle sur laquelle des sédiments progressivement plus jeunes se chevauchent au sud. Les strates d'âge jurassique à valanginien se limitent au flanc nord de l'arche, mais la Formation barrémienne de Mount Goodenough se prolonge jusque sur l'arche. Il semble que cette dernière ait été complètement ennoyée durant le Barrémien, comme l'indique la présence d'une avant-butte de strates barrémiennes au sud-est de la plaine Eagle. S'il a existé des strates pré-albiennes dans le sous-sol de la plaine Eagle, celles-ci ont été érodées durant l'Aptien supérieur-l'Albien inférieur. Durant l'Albien inférieur, en bordure du nord de la plaine Eagle, se trouvait une dépression en eau profonde, qui a commencé à se combler de dépôts formés par écoulements gravitaires de sédiments provenant de l'ouest et du nord-ouest. Une vaste plate-forme boueuse s'étendait au sud, de la dépression jusqu'à l'Orogène de la Cordillère. Durant le Crétacé supérieur, une succession modérément épaisse de roches clastiques s'est accumulée dans un bassin d'avant-pays, en face de la Cordillère en surrection.



Well Status: Abandoned, Gas, Oil, Oil/gas

Bell River #1 N-50
Birch B-34
Birch E-53
Blackie M-59
Chance G-08
Chance J-19
Chance L-08
Eagle Plains #1 N-49
East Chance C-18
East Pine Creek O-78
East Porcupine F-18
East Porcupine I-13
East Porcupine K-56
Ellen C-24
Molar P-34
North Chance D-22
North Hope N-53
North Parkin D-61
Schaeffer Creek O-22
South Chance D-63
Ridge F-48
West Parkin C-33
West Parkin D-51
Whitefish I-05
Whitefish J-70
Whitestone N-26
Whitestone N-58

INTRODUCTION

Geographic setting

Eagle Plain is an upland area with an elevation of between 400 and 800 m, and is bounded on the east, south and west by distinct escarpments. Mountains of the Keele Range form the northern boundary. The plain is approximately 170 km north to south and 80 km east to west. At the northeast corner, Eagle Plain merges into Bell Basin, a low-lying area at the confluence of Porcupine and Bell rivers. The Ogilvie and Peel rivers flow eastward, parallel to the southern escarpment, and Eagle River flows northward, parallel to the eastern escarpment. The Porcupine River flows northeastward across the area, dividing Eagle Plain into northwestern and southwestern parts. North of Porcupine River, the hills tend to be higher and more rugged than in the southwest, where they are undulating. To the west and south of Eagle Plain are the Ogilvie Mountains, and to the east, the Richardson Mountains (Fig. 1).

Stunted trees, typical of the boreal forest, cover much of the southern plain, except at the highest elevations. In the north, trees are present only in sheltered valleys, and much of the upland areas are covered by tundra grasses.

The Dempster Highway traverses the southern margin of Eagle Plain, linking Dawson City with the Mackenzie Delta communities. It is open most of the year, except for periods of extreme blizzard conditions during the winter. The link with Mackenzie Delta is broken during spring break-up and autumn freeze-up, when the rivers that have to be crossed cannot support an ice bridge or be negotiated by ferry. A winter road that was used to supply the village of Old Crow traverses Eagle Plain, but is now unused. Numerous seismic cut-lines crisscross Eagle Plain and are readily identified on some of the more recent aerial photographs.

There are no permanent settlements within Eagle Plain, although a motel at the southeastern edge of the plain, along the Dempster Highway, is open year-round. The motel has a small store where basic foods are available. Car repair facilities also may be found there. Gasoline, diesel and aviation fuel are sold at the motel. Road maintenance crews regularly work along the highway throughout the year. The closest communities are Old Crow to the north and Dawson City to the south.

***Figure 1.** (Left) The Eagle Plain area, showing locations of the twenty-seven wells (data from which are used in this study), and the cross-sections (Figs. 4, 8, 12, 13).*

Previous work

Very little has been published on the Mesozoic geology of Eagle Plain. Reconnaissance stratigraphic studies of Mesozoic strata were undertaken by Mountjoy (1967). Early summaries of the geology of Eagle Plain were compiled by Martin (1959, 1973) and Miall (1973). A local study of the northeast part of Eagle Plain was published by Young (1975). Jeletzky (1975a) defined and described the Albian Sharp Mountain Formation from northern Eagle Plain. Norris et al. (1963) mapped the distribution of Mesozoic strata at a scale of 1:1 000 000. More detailed mapping, at a scale of 1:250 000, was carried out by Norris (1981a, b, c, d, 1982a, b), and one of the maps, at a scale of 1:500 000, includes Eagle Plain (Norris, 1985a). Poulton (1982) discussed the Jurassic stratigraphy of northern Yukon and included some speculations about the extent of Jurassic strata under Eagle Plain. Paleozoic strata under Eagle Plain have been studied in more detail (e.g. Graham, 1973; Pugh, 1983).

There have been few biostratigraphic studies of Mesozoic strata of the Eagle Plain area. Several short reports on the microfossils from a few wells have been published (Norford et al., 1970, 1971, 1973; Brideaux et al., 1976), as well as a report of a bivalve from a core (Jeletzky, *in* Brideaux et al., 1976). Norris's maps (1981a, b, c, d, 1982a, b) identify fossil localities and the ages assigned to the rocks, and Jeletzky (1960, p. 19) briefly mentioned a fossil site in the Albian on Eagle Plain. On the north flank of Bell Basin, there are extensive exposures of the Upper Jurassic Porcupine River Formation, which Jeletzky (1977) described in detail, especially the biostratigraphy. Poulton (1987) described Middle Jurassic ammonites from Salmon Cache Canyon.

Exploration drilling for hydrocarbons began in 1957 with the spudding of Peel Plateau Eagle Plains no. 1 N-49, and has progressed sporadically up to the time of writing (1987). Twenty-seven wells have been drilled on Eagle Plain and in Bell Basin (Fig. 1, Appendix 1). A minor gas recovery from Upper Cretaceous strata was recorded at the Chance G-08 well, and three wells tested hydrocarbons from the Carboniferous Chance Sandstone Member of the Hart River Formation. Well logs, cuttings samples and cores are available for public viewing at the Geological Survey of Canada, Institute of Sedimentary and Petroleum Geology, Calgary, Alberta. Core from Mesozoic strata is available from twelve wells (Appendix 1).

Objectives

The absence of detailed descriptions of lithological units, formal nomenclature for much of the Mesozoic succession, and integration of surface and subsurface studies, are obvious gaps in the geological studies of Eagle Plain. This report is an attempt to address these shortfalls and to present new data along with a review and revisions of older data. The bulk of the report deals with Albian and Late Cretaceous stratigraphy; older strata have been dealt with by other authors and are only briefly described in this report in order to complete the stratigraphic coverage.

Acknowledgments

I would like to thank T.P. Poulton and D.A. Leckie for their useful comments on and criticisms of an earlier version of this manuscript. My appreciation to the cartographic unit at ISPG for their assistance in helping with the drafting of some of the figures, and to W. Sharman of the photographic department. L. Velcic and L. Haid proved to be able field assistants in 1985 and 1986, respectively. I would also like to thank D.J. McIntyre, who accompanied me in the field on several occasions and has given freely of his paleontological insights into Upper Cretaceous biostratigraphy. Camp facilities were kindly provided by J. Cinq-Mars in 1985 and D.W. Morrow in 1986. Polar Continental Shelf Project supplied helicopter support in 1985. The Western Arctic Scientific Resource Centre in Inuvik provided logistical support in 1985. Drafting was done by R. Neumann with additional help from B.E. Fischer and D. Valiquette.

REGIONAL GEOLOGICAL SETTING

Eagle Plain is part of Eagle Foldbelt (Fig. 2) (Norris, 1983), which consists, for the most part, of north trending, open anticlines and synclines with long axial traces (Fig. 3) (Norris, 1985a). At the northeast and southeast corners of the foldbelt, the trends change to northeast and east-southeast, respectively. Some minor thrusts have been mapped at the surface by Norris (1981a, c, 1982a). Reflection seismic profiles on and adjacent to Eagle Plain indicate that large thrusts underlie the foldbelt, and the folds are a surface expression of the thrusting (unpublished geological and geophysical reports submitted to Indian and Northern Affairs and to Canadian Oil and Gas Lands Administration).

The Taiga-Nahoni Foldbelt flanks the western and southern margins of Eagle Foldbelt. To the west, the folds are north trending, and east-directed thrusts are predominant. To the south, the folds trend east-west, and north-directed thrusts are dominant. Paleozoic and Proterozoic strata are widely exposed in the Taiga-Nahoni Foldbelt, with some Jurassic and Lower Cretaceous strata preserved west of Eagle Plain.

East of Eagle Foldbelt is the Richardson Anticlinorium, a lower Paleozoic-cored feature containing north trending folds and faults. Faulting is either normal or strike-slip; very few thrusts have been mapped.

On the northern flank of Eagle Foldbelt are elements of the northeast trending Aklavik Arch Complex (Fig. 2). Adjacent to Eagle Foldbelt, the complex consists of the Keele Block, Dave Lord Uplift, Canoe Depression and Rat Uplift (Norris, 1983). The complex is separated from Eagle Foldbelt by the Sharp Mountain Fault (Norris, 1981a). A reflection seismic line (Globe Universal Sciences Canada Ltd., 1973) across the Aklavik Arch Complex suggests that the fault is a thrust (Fig. 4). The Yukon and Dave Lord faults of the complex also appear to be thrust faults on reflection seismic profiles (Globe Universal Services Canada Ltd., 1973). Under northeast Eagle Plain, Eagle Arch (Moorhouse, 1966; Young, 1975) underlies Eagle Foldbelt.

STRATIGRAPHY

Introduction

The distribution of Mesozoic strata is illustrated in Figure 3, and correlations are shown in Figure 5. The Figure 3 map is based on the work of Norris (1981a, b, c, d, 1982a, b) and fieldwork done by J. Dixon and D.J. McIntyre in 1984, 1985 and 1986. The field studies led to some modifications of Norris's mapped units and the elimination of the Rat River Formation and Mount Goodenough Formation from some areas adjacent to Eagle Plain.

Jurassic to Upper Cretaceous strata are present adjacent to, and underlying Eagle Plain; however, the bulk of the preserved succession consists of Albian and Upper Cretaceous rocks (Fig. 3). Up to 2500 m of Jurassic to Upper Cretaceous strata are preserved under Eagle Plain (Fig. 6); the thickest known succession occurring in the Molar P-34 well. Exposures of Jurassic strata are scattered along the Keele Range and extend northeastward into Salmon Cache Canyon. In the subsurface, Jurassic strata extend south of the Keele Range for only a few kilometres. Valanginian strata are present locally on the northeast flank of

Eagle Plain. The Barremian Mount Goodenough Formation was mapped along the western and southwestern flanks of Eagle Plain (Norris, 1981c, 1982a) but subsequent mapping and fossil identification indicate that much, if not all, of the strata mapped as Mount Goodenough Formation is a younger, Albian unit (the newly named Whitestone River Formation). Similarly, Norris (op. cit.) appears to have misidentified Rat River strata on the flanks of Eagle Plain. What were formerly considered to be Rat

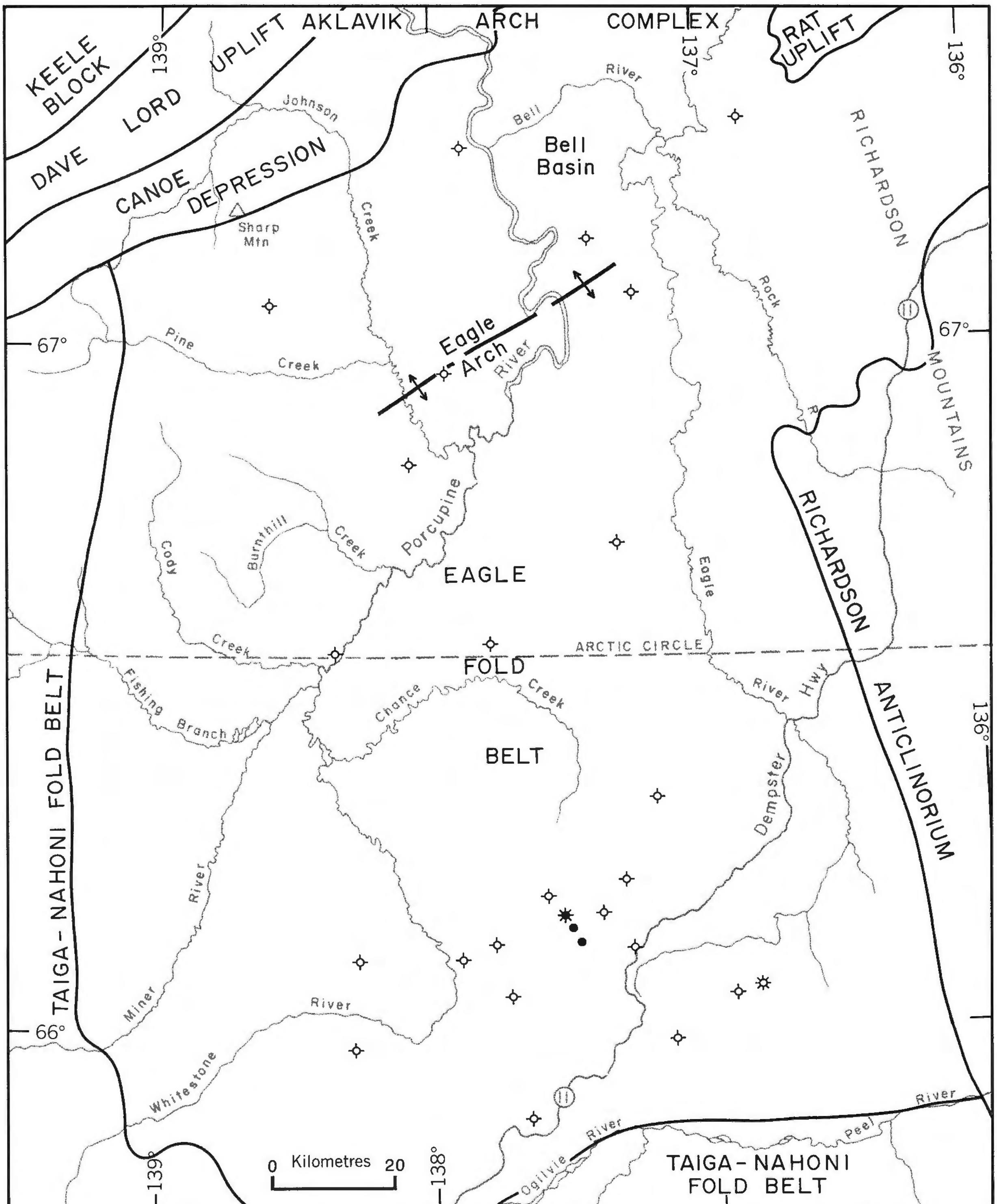
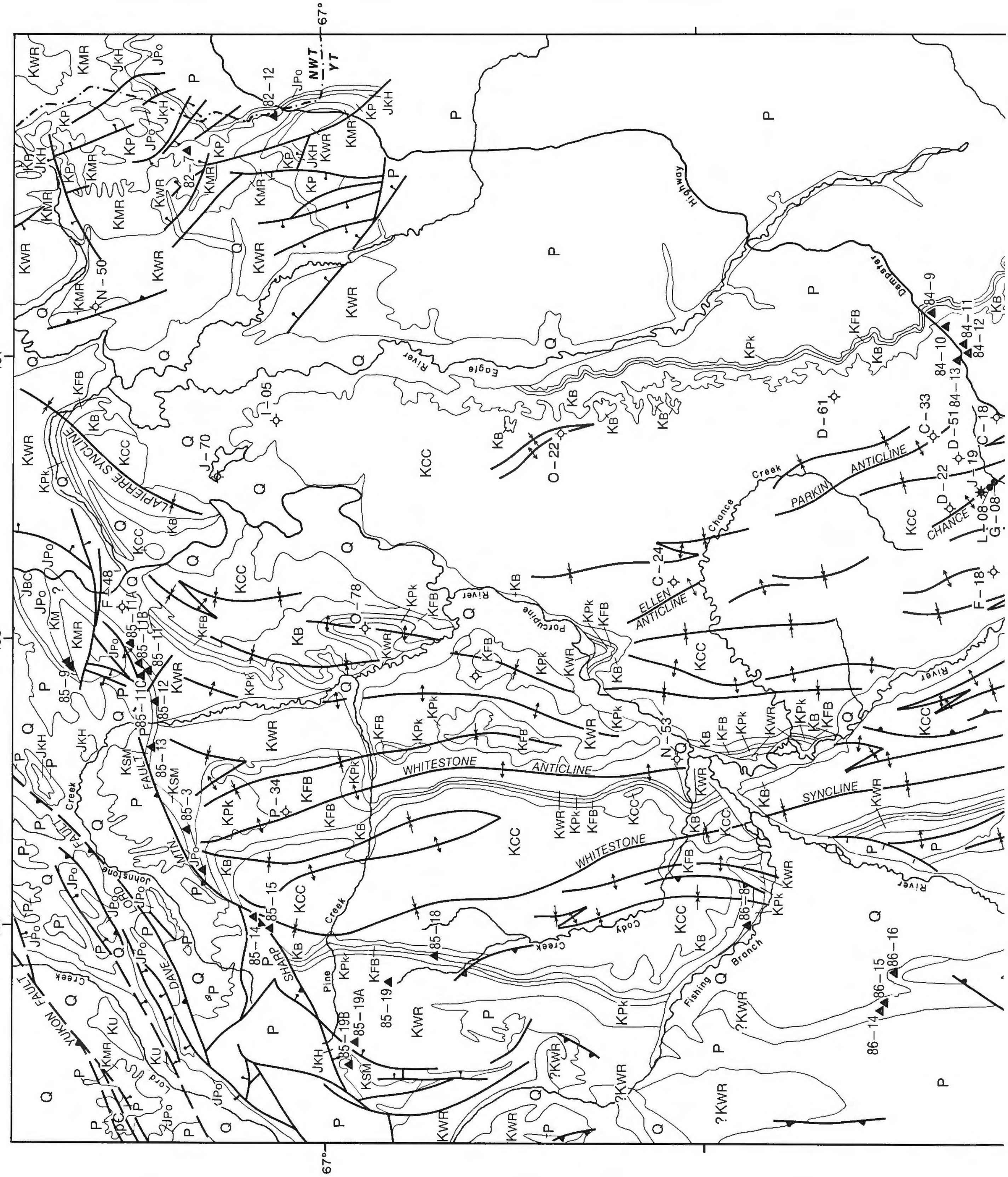


Figure 2. Tectonic elements. (Modified from Norris, 1983.)



67°
NWT
YT
137°
138°
139°
LAPIERRE SYNCLINE
WHITESTONE ANTICLINE
WHITESTONE SYNCLINE
PARKIN ANTICLINE
ELLEN ANTICLINE
CHANCE
SHARP MTN. FAULT
DAVE LORD FAULT
YUKON FAULT
Dempster Highway
Eagle River
Porcupine River
Chance Creek
Pine Creek
Cody Creek
Fishing Branch
Johnstone Creek

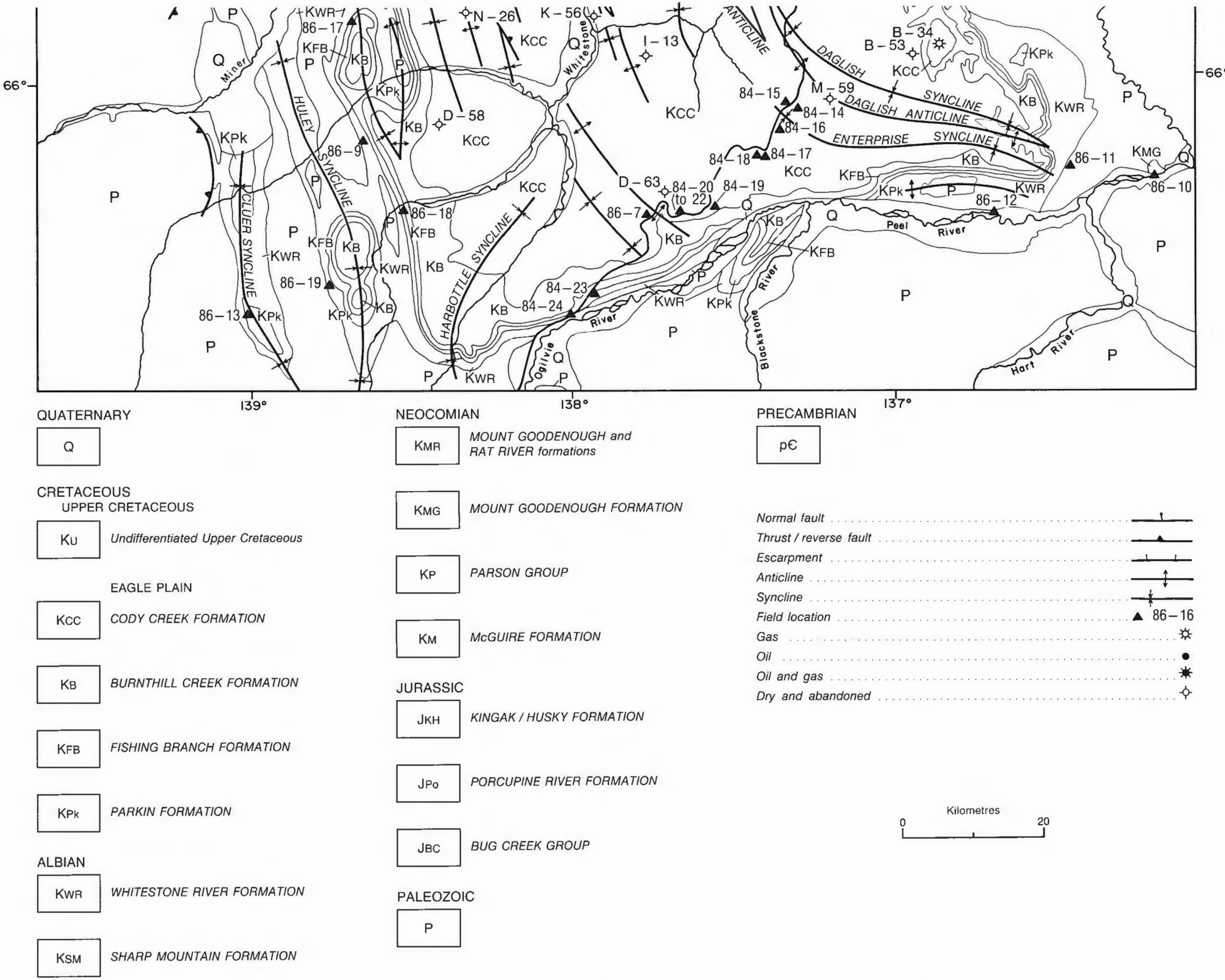


Figure 3. Geological map, Eagle Plain area. (Modified from Norris, 1985a.) Well locations and field sections indicated.

River strata, mapped on the western and southwestern flank, are now considered to be a younger, Albian unit (Whitestone River Formation). Most of what was mapped as Rat River Formation between Johnson Creek and Porcupine River on the north flank of Eagle Plain, are now known to be Upper Jurassic Porcupine River strata (Dixon, 1986a).

Albian strata outcrop along all the flanks of Eagle Plain, but the bulk of Eagle Plain is immediately underlain by Upper Cretaceous strata. Exposures on the plain and the escarpments are poor and contacts between the various stratigraphic units are rarely exposed; consequently, the well data provide a more reliable guide to the stratigraphic succession and the nature of the contacts.

Jurassic stratigraphy

The Lower and Middle Jurassic Bug Creek Group is present in Salmon Cache Canyon and environs (Poulton, 1982, 1987), where previously the Kingak had been mapped (Norris, 1981b). Middle and Upper Jurassic strata of the Porcupine River and Husky formations have been mapped by Jeletzky (1975b, 1977) and Norris (1981a, b) along the Keele Range and northwestward into the Salmon Cache Canyon area. The thickest known subsurface occurrence of presumed Jurassic strata (446 m) is in the Ridge F-48 well (Fig. 7).

Bug Creek Group

Distribution and description

The Lower and Middle Jurassic Bug Creek Group was originally identified and defined from the northern Richardson Mountains (Jeletzky, 1967; Poulton et al., 1982) and has been mapped into the Bell River Basin (Norris, 1981b). Strata mapped and described as Kingak Formation in the Salmon Cache Canyon area (Jeletzky, 1975a; Norris 1981a, b) are now identified as part of the Bug Creek Group (Poulton, 1978, 1982, 1987).

Bug Creek strata are generally recessive weathering and consist of shale- and sandstone-dominant intervals. At Salmon Cache Canyon they rest unconformably on Permian rocks and are faulted against the younger Porcupine River strata. In the Waters River area, a thin shale tongue of the Husky Formation sits abruptly on Bug Creek strata (Poulton, 1987, p. 7).

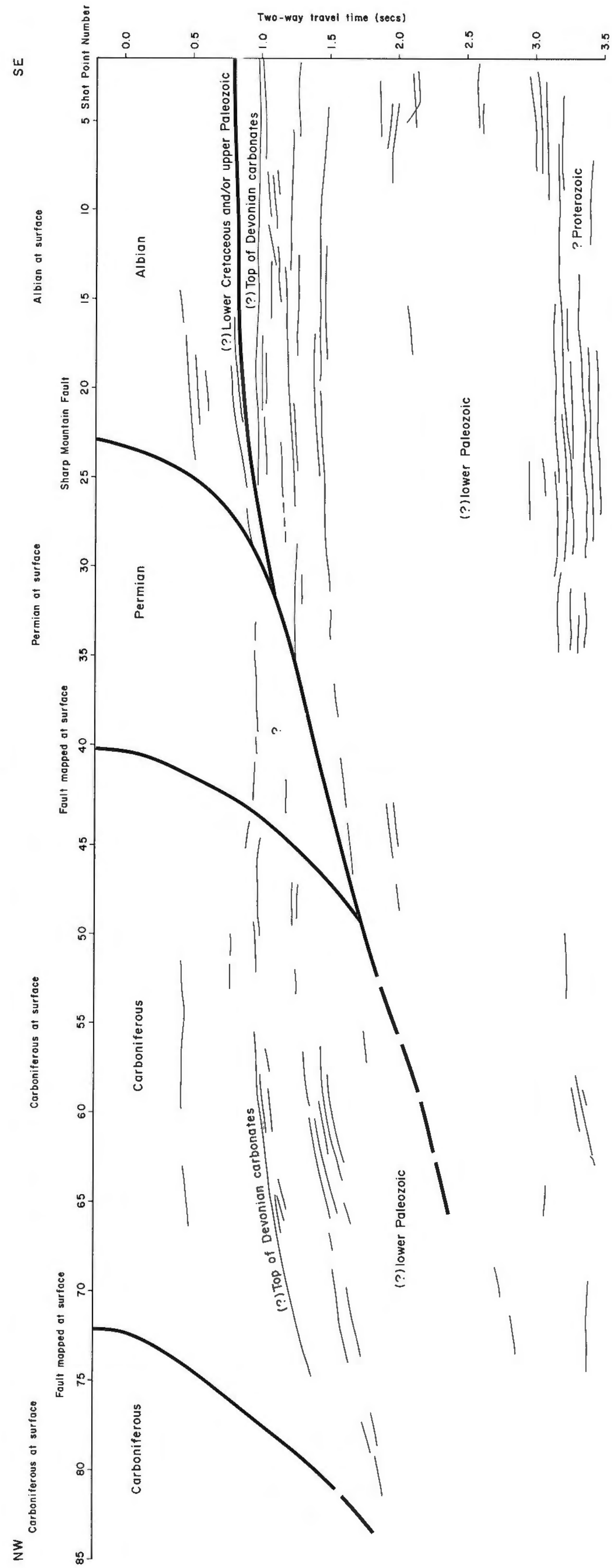


***Figure 4.** Interpretive tracing from a reflection seismic line across the Aklavik Arch Complex at the north end of Eagle Plain. (From Globe Universal Services Canada Ltd., 1973, line number 16; location indicated on Figure 1.)*

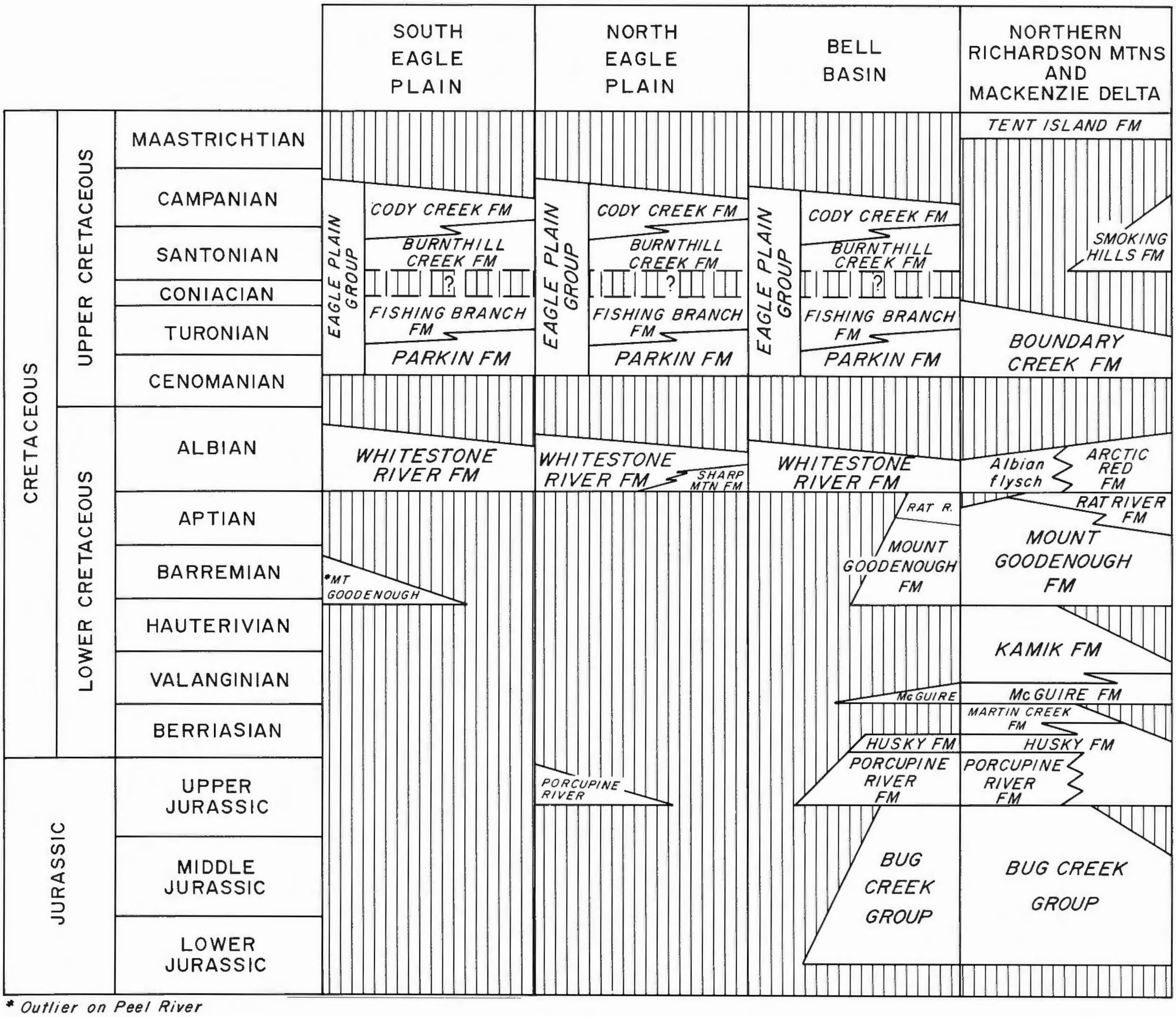


Figure 5. *Table of formations.*

Poulton (1978, 1987) identified all the component formations of the Bug Creek Group within the Waters River and Salmon Cache Canyon areas. They are, in ascending stratigraphic order, the shale and sandstone Murray Ridge Formation, the sandstone-dominant Manuel Creek Formation, the shale-dominant Richardson Mountains Formation, and the sandstone-dominant Aklavik Formation. Poulton (1982) showed that Bug Creek strata thin southwestward from Waters River toward Salmon Cache Canyon and are absent on northern Eagle Plain. Their absence on Eagle Plain is corroborated from the nearby Ridge F-48 well, approximately 14 km south-southeast of Salmon Cache Canyon, where Bug Creek strata cannot be identified. Also, geological mapping (Dixon, 1986a) a few kilometres to the west of the Ridge F-48 well, on each side of Johnson Creek, indicates that younger Porcupine River strata rest directly on Paleozoic rocks. Bug Creek strata also are absent throughout the remainder of Eagle Plain.

Depositional setting

Limited description of the lithological succession and contained sedimentary structures are available but the abundance of ammonites and other macrofossils indicates that much of the Bug Creek Group is marine in origin. Poulton (1978, 1982) noted that the Salmon Cache area is located between the shale-dominant, marine, Lower and Middle Jurassic succession to the east in northern Ogilvie Mountains, and the sandstone-dominant, chiefly marine facies in the Richardson Mountains to the northeast.

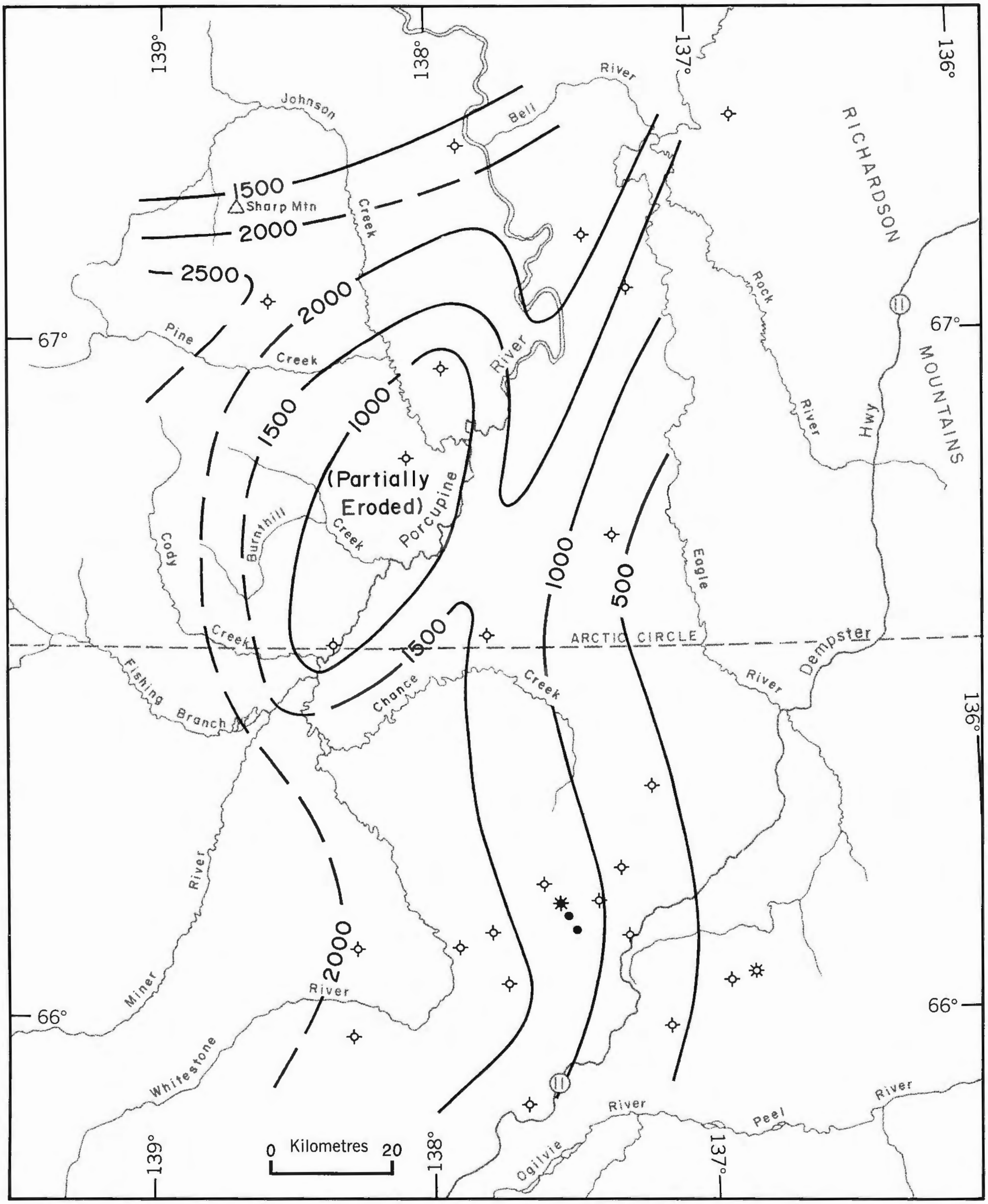


Figure 6. Isopach map of Mesozoic strata. Contour interval 500 m.

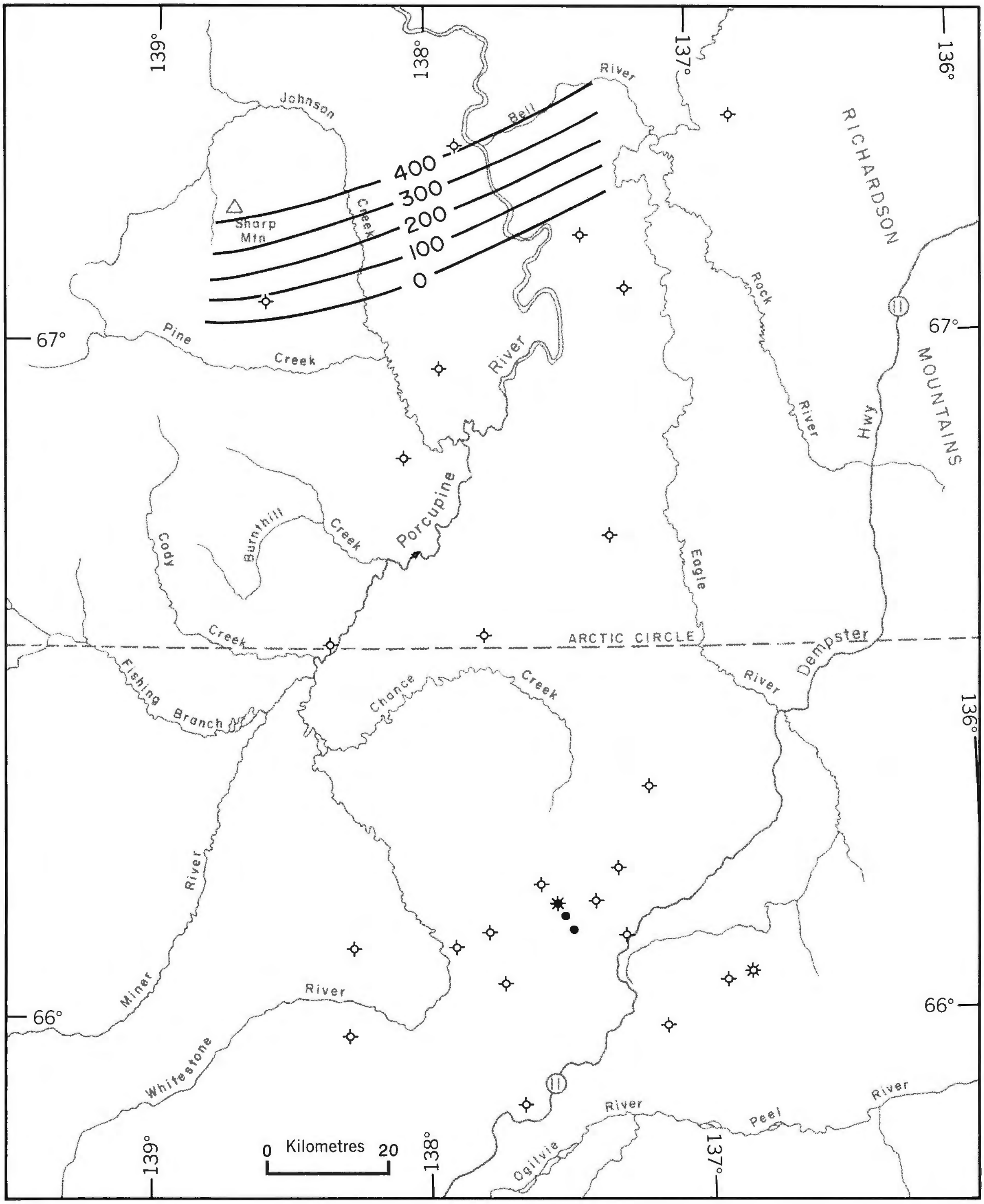


Figure 7. *Isopach map of Jurassic strata. Contour interval 100 m.*

Age

Poulton (1978, 1982, 1987) collected and identified ammonites from the Bug Creek Group in the Waters River and Salmon Cache Canyon areas. Sinemurian to Oxfordian ammonites have been identified in Bug Creek strata.

Porcupine River and Husky formations

Distribution

Jeletzky (1975b) defined and described in detail the Porcupine River Formation from Salmon Cache Canyon. The Husky Formation is a shale-dominant unit originally identified from the eastern slopes of the northern Richardson Mountains (Jeletzky, 1967). Porcupine River strata are approximately equivalent to the lower and arenaceous members of the Husky Formation, but in parts of the western Richardson Mountains and adjacent to Bell Basin and northern Eagle Plain, tongues of the Husky interdigitate with Porcupine River strata, and in many areas overlie the Porcupine River sandstones.

The Porcupine River Formation consists predominantly of sandstone with some intercalations of mudstone. A thin shale tongue of the Husky Formation commonly separates Porcupine River sandstones from underlying Bug Creek strata, but where Porcupine River facies rest directly on Paleozoic strata, such as in the vicinity of Johnson Creek, there appears to be no intervening shale. However, in the Ridge F-48 well, between log depths of 1600.2 to 1636.8 m (5250–5370 ft.; Fig. 8, in pocket), there is a shale-siltstone interval between strata identified as Porcupine River Formation above and Upper Devonian Imperial Formation below (Young, 1975) which could be equivalent to the Husky tongue seen elsewhere in the Keele Range.

Near Sharp Mountain, Porcupine River strata are overlain unconformably by the Albian Sharp Mountain Formation, and in the Molar P-34 well, overlying strata are the newly named, Albian Whitestone River Formation. In Salmon Cache Canyon, Porcupine River strata are overlain by the Husky Formation, but southwest of Salmon Cache Canyon, the Valanginian McGuire Formation progressively truncates the Porcupine River Formation (Fig. 9). It is apparent from the airphoto (Fig. 9) that a discordance exists between identified Porcupine River strata and a shale unit identified as McGuire Formation.

South of the exposures in the Keele Range, Porcupine River strata have been identified in the Molar P-34 and Ridge F-48 wells, and Young (1975, Fig. 2) identified some in the Whitestone J-70 well. The correlations are based mostly on lithological character and stratigraphic position; only the Molar P-34 well provided paleontological data to support the correlations (Chamney, *in* Norford et al., 1971). South of these wells, Jurassic strata are absent below the sub-Mount Goodenough and sub-Whitestone River unconformities. Chamney (op. cit.) identified Lower to Upper Jurassic strata between log depths of 2331.7 to 2485 m (7650–8153 ft.) in the Molar P-34 well. Young (1975) argued that the lithological and well log characteristics were inconsistent with the paleontological data, and that the unconformity between Jurassic and Devonian strata was more likely to be at the 2435.4 m (7990 ft.) level, higher than the fossil evidence indicated. The discrepancy was attributed to contamination of the deeper levels by caving material. Young's (op. cit.) conclusions are consistent with the regional stratigraphic setting of Mesozoic beds. If the strata at the Molar P-34 well are Porcupine River Formation, Chamney's identification of Lower Jurassic strata would be inconsistent with the better dated type area, where Porcupine River strata are Middle to Late Jurassic in age.

Thickness

The thickest subsurface section of presumed Middle and Upper Jurassic strata is in the Ridge F-48 well, between log depths of 1191.2 to 1636.8 m (3908–5370 ft.). Three divisions are apparent (Fig. 8): a shale interval between 1600.2 and 1636.8 m (5250 and 5370 ft.), which is probably a tongue of the Husky Formation; a sandstone-dominant interval between 1409.7 and 1600.2 m (4625 and 5250 ft.), identified as Porcupine River Formation; and an interval of shale and siltstone between 1191.2 and 1600.2 m (3908 and 5250 ft.), which may be equivalent to the Husky Formation, or could equally be a shale-rich interval in the Porcupine River Formation. These are the same unnamed intervals identified by Young (1975, Fig. 2). In the Molar P-34 well, there is only a thin section of Porcupine River Formation, between log depths of 2328.7 to 2435.4 m (7640–7990 ft.). The thinness of the P-34 section is due to pre-Albian erosion. At the Whitefish J-70 well, Young (op. cit.) correlated the strata below 1978.2 m (6490 ft.) with the possible Husky section in the Ridge F-48 well. The identification of the strata in J-70 as Husky Formation is tenuous and the strata could equally well be basal sandy beds of the Mount Goodenough Formation, such as those present in the nearby Whitefish I-05 well (Fig. 8).

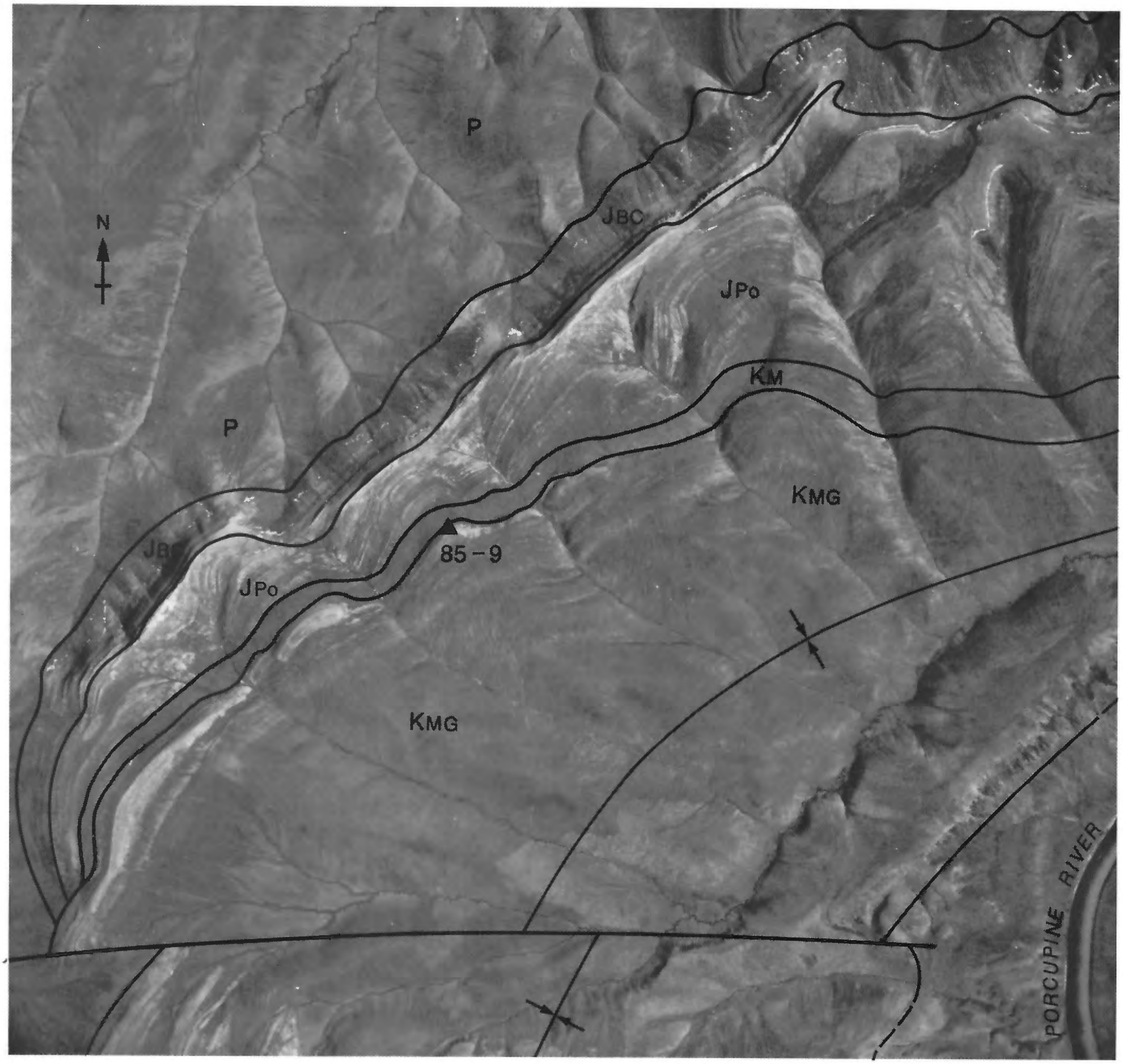


Figure 9. Aerial photograph (National Air Photo Library number A14071-26) of the area immediately west of Salmon Cache Canyon, illustrating unconformable relationships within Mesozoic strata. P, Permian; JBC, Bug Creek Group; JPo, Porcupine River Formation; KM, possible McGuire Formation; KMG, possible Mount Goodenough Formation. 85-9 is a field locality number.

Lithology

The Porcupine River Formation consists mostly of very fine to fine grained sandstone that weathers white to light grey. Massive appearing beds are prevalent, but where sedimentary structures are visible they include low-angle cross-stratification, hummocky cross-stratification, ripple crosslamination, vertical and U-shaped burrows, and burrow mottling. Bivalves are present in some beds. Core from the Porcupine River Formation was cut in the Ridge F-48 well (cores 1 and 2) and the Molar P-34 well (cores 11 and 12). The sandstones in these cores are similar in character: fine grained, light grey, well cemented, containing burrows and appearing to be devoid of other sedimentary structures. Poorly preserved bivalves are present in the core from the Ridge F-48 well. Core 11 from the Molar P-34 well consists of burrowed to extensively bioturbated, silty to sandy mudstone with only faint remnants of original laminae in some beds. Jeletzky (1975b) reported local abundance of carbonaceous detritus in some sandstone beds.

The Husky Formation is a shale-dominant succession with thin interbeds of siltstone and very fine grained sandstone. Ironstone concretions are locally common. The thin siltstone/sandstone beds generally are millimetres to a few centimetres thick and contain fine, planar or crosslaminae. Marine bivalves are locally common.

Depositional setting

The preserved sedimentary structures and fossils indicate a predominance of marine strata in both the Porcupine River and Husky formations. Jeletzky (1975b) suggested that some of the Porcupine River strata were nonmarine in origin, basing his conclusions on the presence of carbonaceous material and interpreted rootlets. The evidence is ambiguous — such beds could represent nearshore or lagoonal deposits, especially when intimately interbedded with sandstones and mudstones containing marine fossils, and bioturbated beds. The overall character of Porcupine River strata in the study area is that of nearshore to inner shelf sediments.

Age

Within the northeast Eagle Plain area, the Porcupine River Formation contains species of the bivalve *Buchia* that indicate an age range from Oxfordian (Middle Jurassic) to Tithonian (Late Jurassic; Jeletzky, 1977). The immediately overlying Husky Formation has been dated as Late Jurassic, although a diachronous contact has been interpreted by Jeletzky (1977).

Lower Cretaceous stratigraphy

McGuire Formation

Description

McGuire Formation (Dixon and Jeletzky, 1991) is the formal name that replaces the informal, Valanginian Bluish grey shale division (Jeletzky, 1961) of the northern Richardson Mountains. McGuire strata have not been previously identified in the area but are present in a few, poorly exposed outcrops immediately to the west of Salmon Cache Canyon (Fig. 9). These outcrops appear to be the only occurrences in the study area. McGuire strata consist of dark grey to bluish black shale. The samples collected at locality 85-9 (Figs. 3, 9) were from frost polygons that have brought the underlying rocks to the surface. Foraminifers from locality 85-9 (Figs. 3, 9) are typical of assemblages from the Valanginian McGuire Formation of the northern Richardson Mountains area (Fowler, unpublished Geological Survey of Canada report number 1-SPF-1985). Norris (1981b) mapped the same interval as Mount Goodenough Formation, based on a questionable Hauterivian–Aptian date for a fossil locality that appears to be from the overlying sandstone (GSC loc. 70598).

McGuire strata unconformably overlie Porcupine River strata and the truncation and discordance are readily seen on aerial photographs (Fig. 9). At section 85-9, the McGuire is overlain by a sandstone unit that Norris (1981b) mapped as Rat River Formation. The correlation of this sandstone is not well constrained due to a lack of biostratigraphic control. It is possible that the sandstone is the basal unit of the Mount Goodenough Formation and the recessive interval above the sandstone (mapped as possibly Albian by Norris, 1981b) is typical Mount Goodenough shale. The scenario is consistent with the known regional stratigraphic setting, the merging of unconformities along the Eagle Arch, and the presence of the sub-Mount Goodenough unconformity in the Whitefish I-05 well. In support of the Mount Goodenough correlation is the fact that, southwest of locality 85-9, McGuire shales appear to be truncated and the overlying strata rest on Porcupine sandstone. This was observed while flying along the outcrop trend and is apparent on the aerial photograph (Fig. 9). Furthermore, if the fossil locality on Norris's map (1981b; GSC loc. no. 70598) is within the sandstone, the indicated age range would be consistent with the identification as Mount Goodenough Formation.

Depositional setting

The sparsity of exposure prevents the collecting of much data about the lithological succession and the contained sedimentary structures; consequently, details of the depositional setting are lacking. The presence of marine foraminifers from the one sample site suggests a muddy, marine shelf setting.

Age

The microfossils collected from locality 85-9 are similar to assemblages from McGuire strata in the northern Richardson Mountains. Although the foraminifers are not age-diagnostic, the associated *Buchia* species in the Richardson Mountains occurrences indicate an early Valanginian age for the McGuire Formation (Jeletzky, 1961).

Mount Goodenough Formation

Distribution

Mount Goodenough Formation (Dixon and Jeletzky, 1991) is the formal name that replaces the informal Upper shale-siltstone division (Jeletzky, 1958, 1960, 1961) of the northern Richardson Mountains. Norris (1985a) mapped the occurrence of Mount Goodenough strata throughout most of the northern Yukon. Mount Goodenough strata occur in the Whitefish I-05 well, where Barremian–Aptian bivalves were reported from core 3 (Jeletzky, *in* Brideaux et al., 1976, p. 11) and in an isolated exposure on Peel River, southeast of Eagle Plain (locality 86-10, Fig. 3). Other sections of Mount Goodenough Formation occur immediately west of Salmon Cache Canyon, in the core of an unnamed syncline, and in the Whitefish J-70 well. Norris (1981b, c, 1982a) mapped Mount Goodenough strata along the western and southwestern margin of Eagle Plain, but field observations and some paleontological data indicate that the bulk of the strata are part of the Albian Whitestone River Formation. The thickest known, or interpreted, section of Mount Goodenough Formation is 341 m (1119 ft.) thick in the Whitefish J-70 well (Fig. 10).

Lithology

In the Whitefish I-05 well, the Mount Goodenough succession occurs between log depths of 1216.2 to 1450.8 m (3990–4760 ft.). A basal sandstone, between 1430.1 and 1450.8 m (4692 and 4760 ft.), unconformably overlies Upper Devonian clastic rocks, and in turn is abruptly overlain by a shale succession. The sandstone was cored (core 4) and is mostly fine grained, with at least two beds containing some medium- to granule-sized grains. Structureless and crossbedded intervals are present. Some of the crossbeds occur in cosets, each set separated by a planar discontinuity surface. Carbonaceous particles are common in the sandstone. The Paleozoic–Mesozoic contact should have been preserved in core 5, according to the given core depths, but the core contains only Devonian strata. Consequently, the recorded core depths must be too shallow by at least 0.6 m (2 ft.).

The shale succession overlying the basal sandstone has been cored at three intervals in the Whitefish I-05 well (core 1-3). Core 1 (1214.9–1233.2 m/3986–4046 ft.), the stratigraphically highest, consists of thin interbeds of shale, siltstone and very fine grained sandstone. Siltstone and sandstone beds are up to 33 cm thick, but most are less than 10 cm thick. They contain ripple crosslaminae, many of which have been wave modified. Wavy bedding is common in the intervals where the sandstone beds are less than 5 cm thick. Sandy beds have abrupt bases and abrupt to gradational tops. Many sandstone beds show loading at their bases and some are completely deformed. Burrows are common in the shale-dominant intervals. Cores 2 and 3 are similar to core 1, but the number and frequency of siltstone and sandstone beds are considerably lower.

Young (1975, Fig. 2) incorporated the uppermost, sandy beds of the I-05 succession into the Rat River Formation (Young identified the sandstone beds as Upper sandstone division, *sensu* Jeletzky, 1958) based on their sandy nature and relative stratigraphic position when compared and correlated with a surface section to the east. Although it is possible that the sandy beds are Rat River Formation, I have chosen to include the uppermost beds within the Mount Goodenough Formation. Without biostratigraphic control and because of the relatively poor development of sandstone in the interval, it is equally feasible to retain the strata within the Mount Goodenough Formation. In areas of the Richardson Mountains to the east, the Mount Goodenough Formation contains significant intercalations of thin bedded sandstone and siltstone in its upper member (Jeletzky, 1958).

The only other significant occurrence of Mount Goodenough strata in northeast Eagle Plain occurs in the core of the syncline in the vicinity of Salmon Cache Canyon. Here the succession is poorly exposed, consisting of a basal, very fine to medium grained sandstone overlain by a recessive weathering interval, presumed to be underlain by shale. Norris (1981b) originally mapped the basal sandstone as Rat River Formation and the overlying interval as the Albian map unit KWR. However, he indicated that the basal sandstone contains fossils that suggest a Hauterivian to Aptian age (GSC loc. 70598), which is consistent with the identification of the sandstone as basal Mount Goodenough and the overlying shale also as part of the Mount Goodenough Formation.

At locality 86-10 (Fig. 11) Mount Goodenough strata are preserved in an isolated outcrop in a small syncline on the north bank of Peel River. Here, the Mount Goodenough Formation consists of a 10 m thick basal sandstone resting unconformably on Permian strata, and overlain by shale. Access to the sandstone is difficult (Fig. 11), although the upper part of the sandstone can be viewed. This upper part

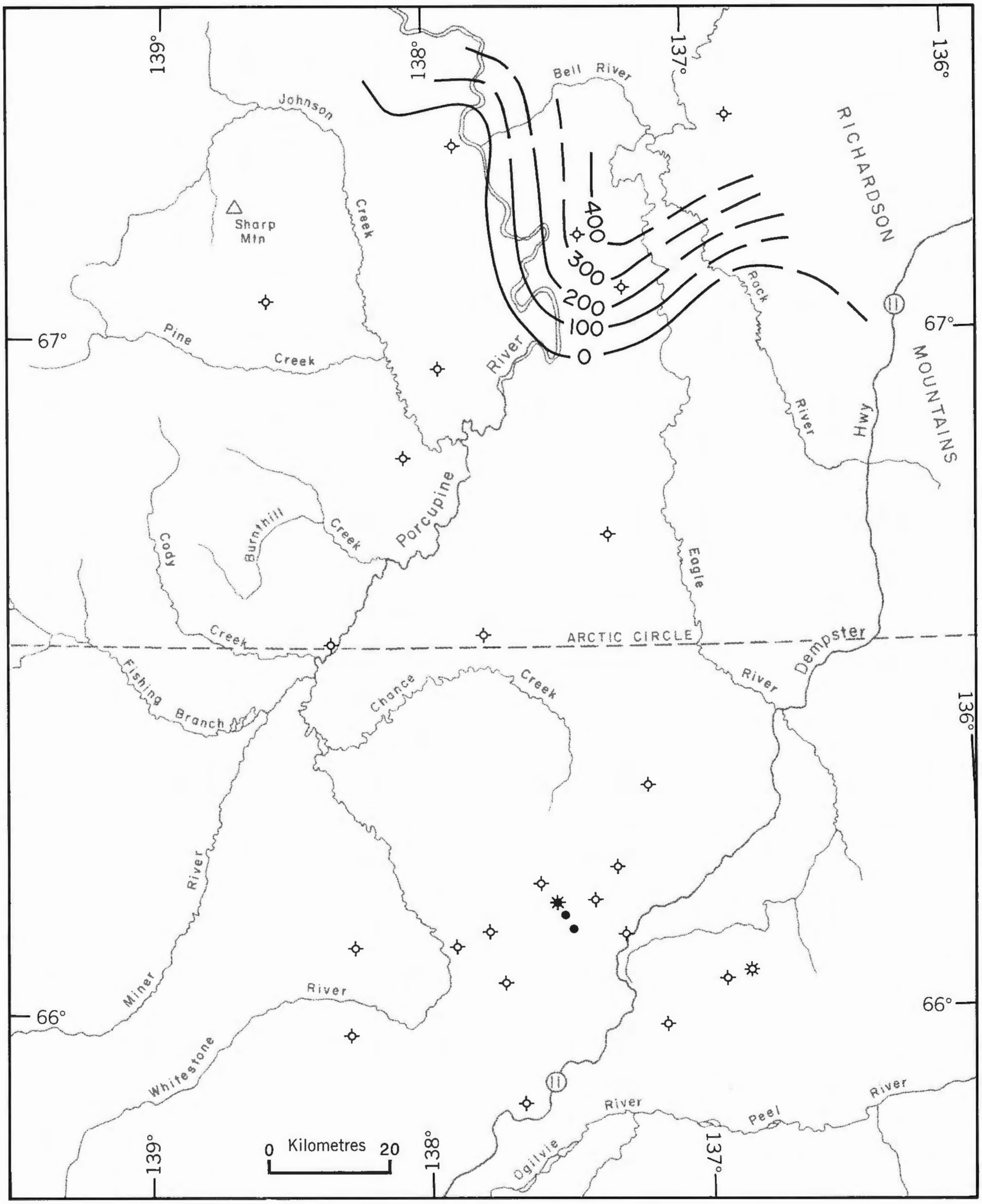


Figure 10. Isopach map of Mount Goodenough strata. Contour interval 100 m.

consists of silty, argillaceous, very fine grained sandstones that are burrowed to thoroughly bioturbated. Carbonaceous debris is abundant. The sandstones are medium grey in colour with rust coloured streaks. Abruptly overlying the basal sandstone are about 1.5 m of pebbly shale. The pebbles are generally 5 mm or less in diameter and consist of highly polished, black chert. Large ironstone concretions, up to 60 cm long, and belemnites are present within the pebbly shale. Gradationally succeeding the pebbly shale is about 29 m of shale in which there are few or no pebbles, and in which ironstone concretions are fewer and smaller than in the pebbly shale and there is a tendency for the upper beds to become more fissile. The shale succession contains a few centimetre-thick beds of siltstone and very fine grained sandstone that are generally bioturbated. The upper shales in this outcrop tend to have a rusty hue. The lower shales contain foraminifers typical of the Barremian Mount Goodenough Formation, whereas the upper shales contain Albian foraminifers (S.P. Fowler, unpublished Geological Survey of Canada paleontological report number 1-SPF-1985). The relatively thin amount of Barremian shale and the absence of Rat River strata suggest that there is a shale-on-shale disconformity within the outcrop, which cannot accurately be located on the basis of lithological change.

Young (1975, Fig. 2) identified Mount Goodenough strata in the Whitefish J-70 and Ridge F-48 wells. The Whitefish J-70 succession, between log depths of 1745.9 to 2087.3 m (5728–6848 ft.) is interpreted as Mount Goodenough Formation, based on a comparison with the succession in Whitefish I-05. If correctly correlated, the overlying unit is the Rat River Formation, gradationally overlying Mount Goodenough shale. There is very little log character similarity to justify correlation of Mount Goodenough Formation into the Ridge F-48 well. Furthermore, in outcrops close to the Ridge F-48 well, Albian strata rest directly on the Porcupine River Formation, indicating truncation of Mount Goodenough strata, suggesting that the latter unit is unlikely to be present in the Ridge F-48 well.

Core 1, in the Whitefish J-70 well, was cut in what are probably the basal sandstones of the Mount Goodenough Formation. The core contains four depositional units, ranging from 10 to 90 cm thick.

Figure 11. Outlier of Mount Goodenough Formation (KMG), southeast of Eagle Plain, resting unconformably on Permian strata (P). Locality 86-10 on Peel River. (ISPG photo. 2619–17.)

Each unit consists of 5 to 50 cm of low-angle, crosslaminated, very fine to fine grained sandstone, gradationally overlain by a 5 to 40 cm thick unit of bioturbated sandstone. Each depositional unit has an abrupt base.

Depositional setting

The Mount Goodenough Formation appears to be entirely marine in its known area of occurrence, as is evident from fauna and the ubiquitous presence of burrows and burrow mottling. The basal sandstone also has sedimentary structures typical of marine environments and is interpreted as representing deposition during a transgression, after a period of major uplift and erosion. After the transgression, the supply of coarse clastic material was reduced and mud was the dominant sediment. The origin of the pebbly shale immediately overlying the transgressive sandstone is elusive. A sediment gravity-flow origin is possible, although the presence of numerous concretions within the pebbly shale suggests a generally low rate of sedimentation for the interval. A base-of-slope setting during a period of slow sedimentation could account for the unusual lithology. A similar, and age-equivalent unit, the Pebble shale, is known in Alaska (Bird and Molenaar, 1987), and its origin also has been difficult to deduce.

Age

The Mount Goodenough Formation in the northern Richardson Mountains has been dated as late Hauterivian to Barremian, and possibly as young as early Aptian, based on the contained bivalves (Jeletzky, 1958, 1960, 1961). Similar Barremian-Aptian bivalves have been identified in core from the Whitefish I-05 well. Foraminifers from the Mount Goodenough succession in the northern Richardson Mountains form a distinct assemblage that can be used to identify equivalent assemblages from other areas in the northern Yukon (Fowler, 1985). Such an assemblage was found in some of the shales at locality 86-10, on the Peel River (S.P. Fowler, unpublished Geological Survey of Canada paleontological report number 1-SPF-1985). Well preserved dinoflagellates from locality 86-10 also indicate a Barremian age (D.J. McIntyre, unpublished Geological Survey of Canada paleontological report number 4-DJM-1987). Norris (1982b) indicated a Hauterivian age on his map for strata at locality 86-10. The determined ages and lithology at locality 86-10 are consistent with a Mount Goodenough identification.

Rat River Formation

Distribution

The Rat River Formation (Dixon and Jeletzky, 1991) is the formal name that replaces the informal Upper sandstone division originally described from the northern Richardson Mountains (Jeletzky, 1958). Strata believed to be Rat River Formation were mapped on the north, west and southwest flank of Eagle Plain (Norris, 1981a, b, c, 1982a). However, Dixon (1986a) remapped most of the strata identified as Rat River Formation along the northern flank, either as Porcupine River Formation or Sharp Mountain Formation, based on lithological characteristics and biostratigraphic data. Fieldwork in 1986 and some biostratigraphic data from along the west flank of Eagle Plain (S.P. Fowler, unpublished Geological Survey of Canada paleontological report number 1-SPF-1986; D.J. McIntyre, unpublished Geological Survey of Canada paleontological report number 4-DJM-1987) indicate that much of the strata previously mapped as either Mount Goodenough or Rat River Formation (Norris, 1981a, b, c, 1982a) are either Albian or Upper Cretaceous. The only area where Rat River strata may be present is in the Whitefish J-70 well, between log depths of 1576.4 and 1745.9 m (5172 and 5728 ft.). Mount Goodenough strata appear to be correlatable between the Whitefish I-05 and J-70 wells, and in the latter, interbedded sandstones and shales arranged in coarsening-upward cycles gradationally overlie Mount Goodenough beds. The interbedded sandstones and shales in J-70 are in the correct stratigraphic position, and are the right lithology to be Rat River Formation.

Lithology

At the Whitefish J-70 locality, the presumed Rat River succession consists of four major coarsening-upward cycles in the lower two thirds, overlain by at least nine or ten thinner coarsening-upward cycles (Fig. 8). The upper boundary is chosen at 1576.4 m (5172 ft.) where, on the sonic log, there is a significant shift to a slower transit time. The sonic shift coincides with a minor lithological change, from the silty and sandy beds of the Rat River succession to a shale-dominant succession. The sandstones are very fine to fine grained, commonly argillaceous to silty and light grey. Interbedded shales are grey, and silty to sandy. The nearest exposures of Rat River Formation are to the northeast, in the vicinity of Waters River and on the west flank of Richardson Mountains. In the outcrop areas, the Rat River succession is very similar to that identified in the Whitefish J-70 well, consisting of a series of coarsening-upward cycles.

Depositional setting

No observations of sedimentary structures or macrofauna are possible in the J-70 well; consequently, the environment of deposition cannot be directly interpreted. However, in outcrop areas to the north and east, marine bivalves have been recovered and low-angle cross-stratification, hummocky cross-stratification, burrows and burrow mottling, are present. Coarsening-upward cycles also are typical of the outcrop areas. The sedimentary features of the Rat River Formation are interpreted as representing prograding and/or aggrading shelf or shoreline deposits.

Age

There are no paleontological data from the immediate study area to indicate the age of strata tentatively identified as Rat River Formation. On a regional basis, Rat River strata are dated as being possibly as old as late Barremian and as young as Aptian, based on a sparse bivalve fauna (Jeletzky, 1958, 1960). Foraminifers from Rat River strata in the northern Richardson Mountains are very similar to those in the underlying Mount Goodenough Formation and normally cannot be used to indicate Rat River equivalence (S.P. Fowler, pers. comm., 1986).

Sharp Mountain Formation

Distribution

The Lower Albian conglomerate and sandstone succession of the Sharp Mountain Formation was described and named by Jeletzky (1975a) in the Keele Range to the north of the study area. Norris (1981a) mapped its occurrence on the northern flank of Eagle Plain and in outliers near Porcupine River, north of the eastern Keele Range. Dixon (1986a) added to the descriptions, made corrections to some of Norris's mapping and identified new outcrop belts of Sharp Mountain strata. The Sharp Mountain Formation is known only within the Keele Range and northern Ogilvie Mountains. There are no known subsurface equivalents. The Molar P-34 well is only 17 km south-southeast of the type section, yet the Albian succession lacks any of the conglomeratic or thick sandstone intervals that typify Sharp Mountain Formation. Accurate measurements of thickness are lacking due to poor exposure, but in the type area there are between 600 and 1000 m of strata.

Lithology

At the type area, the succession consists of alternating conglomerate- and sandstone-rich intervals. The conglomerates are mostly clast-supported and consist of small pebbles (generally less than 2 cm in diameter), which are predominantly chert. Sandstones are generally fine to medium grained, and commonly pebbly. Bedding in the conglomerates and sandstones is difficult to detect, although well developed parting planes suggest that beds are thin, ranging from 5 to 50 cm. Sedimentary structures are sparse, and where present tend to be better preserved in sandstone beds. Low angle crosslamination, planar lamination and ripple crosslamination are the most commonly preserved structures.

Depositional setting

Jeletzky (1975a) originally identified the origin of the Sharp Mountain beds as shallow marine to nonmarine, whereas Dixon (1986a) citied evidence for their origin as sediment-gravity flow deposits within the Albian Keele Trough. The latter interpretation is consistent with the interpretations for similar, coeval deposits in the Blow Trough to the north (Young, 1972, 1973a, b) and Kandik Basin to the southwest (Dixon, unpublished 1986 field observations).

Age

Macro- and microfossils are sparse in Sharp Mountain strata, although Jeletzky (1975a) collected and identified a few Early Albian ammonites from the type section of the Sharp Mountain Formation. Elsewhere, in the northern Ogilvie Mountains, Early to Middle Albian foraminifers were collected from intercalated shales (Dixon, 1986a).

***Whitestone River Formation** (new name)*

Introduction

Albian strata other than the Sharp Mountain Formation are known to occur extensively on the flanks of, and underlying, Eagle Plain (Norris, 1981a, b, c, d, 1982a, b, 1985a). Much of the strata adjacent to Eagle Plain and mapped by Norris (op. cit.) as unit KBI, Mount Goodenough Formation (Map unit KMG) and Rat River Formation (Map unit KRR) are known to be Albian, based on biostratigraphic data and remapping. Some areas mapped as Albian (map unit Kwr), especially along the western and southern escarpments, include Upper Cretaceous strata as well as Albian.

Definition

It is herein proposed that all Albian strata adjacent to and underlying Eagle Plain, which predominantly consist of shale, with thin interbeds of sandstone and siltstone, be called the Whitestone River Formation. It is named after Whitestone River, which flows through the southwest part of Eagle Plain and is a southern tributary of Porcupine River (Fig. 1). Continuous exposures of Albian strata are uncommon; consequently, a subsurface section is designated as the type section, at Socony Mobil et al. Whitestone YT N-26 (66°05′59″N, 138°20′00″W; 696.5 m/2285 ft. kelly bushing elevation; 691.3 m/2268 ft. ground elevation; spudded 7th March 1964; completed 6th August 1964; total depth 2464.3 m/8085 ft.). The Whitestone River Formation is present between log depths of 1423.4 to 1929.4 m (4670-6330 ft.) (Fig. 12). The upper and lower contacts are well defined on logs and by lithological changes, and the interval is readily correlatable to nearby wells (Fig. 12).

Due to lack of core in the type well, the Molar P-34 well is designated as a reference. Ten cores were cut in the Whitestone River Formation and biostratigraphic data are available (Chamney, *in* Norford et al., 1971, p. 10–13). It appears that the Molar P-34 well may have been a better choice for the type section; however, the upper and lower contacts of the formation are not well defined, hence the need to use a different well. The Whitestone River Formation is present between log depths of 960.1 and 2328.7 m (3150 and 7640 ft.) in the Molar P-34 well. One of the few reasonable exposures of Whitestone River strata occurs along the north side of Peel River, at locality 86-12 (Fig. 3). The exposure consists of a 60 to 80 m high cliff that extends laterally for about 0.75 km. The strata dip gently to the north, into the cliff; consequently, there is not a great deal of vertical exposure.

Much of what Norris (1981a, c) identified as map unit Kwr on the west flank of Eagle Plain is a shale formation within the overlying Eagle Plain Group. However, Albian strata are present underlying these Upper Cretaceous shales (foraminiferal identifications from localities 86-9 and 86-19; S.P. Fowler, unpublished Geological Survey of Canada paleontological report number 1-SPF-1986). A thin sandstone unit is commonly present at the base of the Upper Cretaceous shale, and this may have been the unit Norris (op. cit.) identified as Rat River Formation.

Thickness

The thickest known occurrence of the Whitestone River Formation occurs in the Molar P-34 well, where there are 1545 m of section (Fig. 14). Strata are thickest under the northwest part of Eagle Plain, thinning to the east and southeast. There is a rapid thickening of section just northwest of Porcupine River (Fig. 14). Albian strata have been locally removed at the Whitefish I-05 well by mid-Cretaceous erosion. The thickness trends are a function of original depositional trends and mid-Cretaceous erosion.

Lithology

In the Whitestone N-26 well, Albian strata appear to be a uniform succession of grey shale with fine laminae of silt and very fine sand. Scattered throughout the interval are ironstone concretions. Core 2, from Whitestone N-26, was cut in Albian strata and consists of the typical lithology. Toward the base of the Whitestone River Formation, the shale tends to be slightly more radioactive than the overlying strata, as is evident from the gamma-ray log response. The general lithology seen at N-26 is typical for all the wells in the Eagle Plain area. At the Molar P-34 well, there is a tendency for some intervals to contain more millimetre-thick beds of silt/very fine sand. Many of the sandy beds have load structures on their bases (Fig. 15). Burrows and burrow mottled beds are present in some of the Molar P-34 cores. Lithotypes in the few exposures are very similar to those of the type section. At the west end of the exposure at locality 86-12, a large slump fold was noted in the succession.

Whitestone River strata rest unconformably on underlying strata and are unconformably overlain by the Eagle Plain Group. At the Whitestone N-26 well, the formation is underlain by Carboniferous sandstones and overlain by the sandstone member of the Upper Cretaceous Parkin Formation (Fig. 12). At the Birch B-34 well, the basal contact was cut by core 1. At this contact, a dark-grey to black, pyritic shale rests abruptly on a Permian chert-pebble conglomerate. The top 10 to 20 cm of the conglomerate is siderite-rich (Fig. 16). At the Pine Creek O-78 well, the Albian–Paleozoic contact also was cored (core 6) and, there, the basal 1.1 m of Whitestone River strata

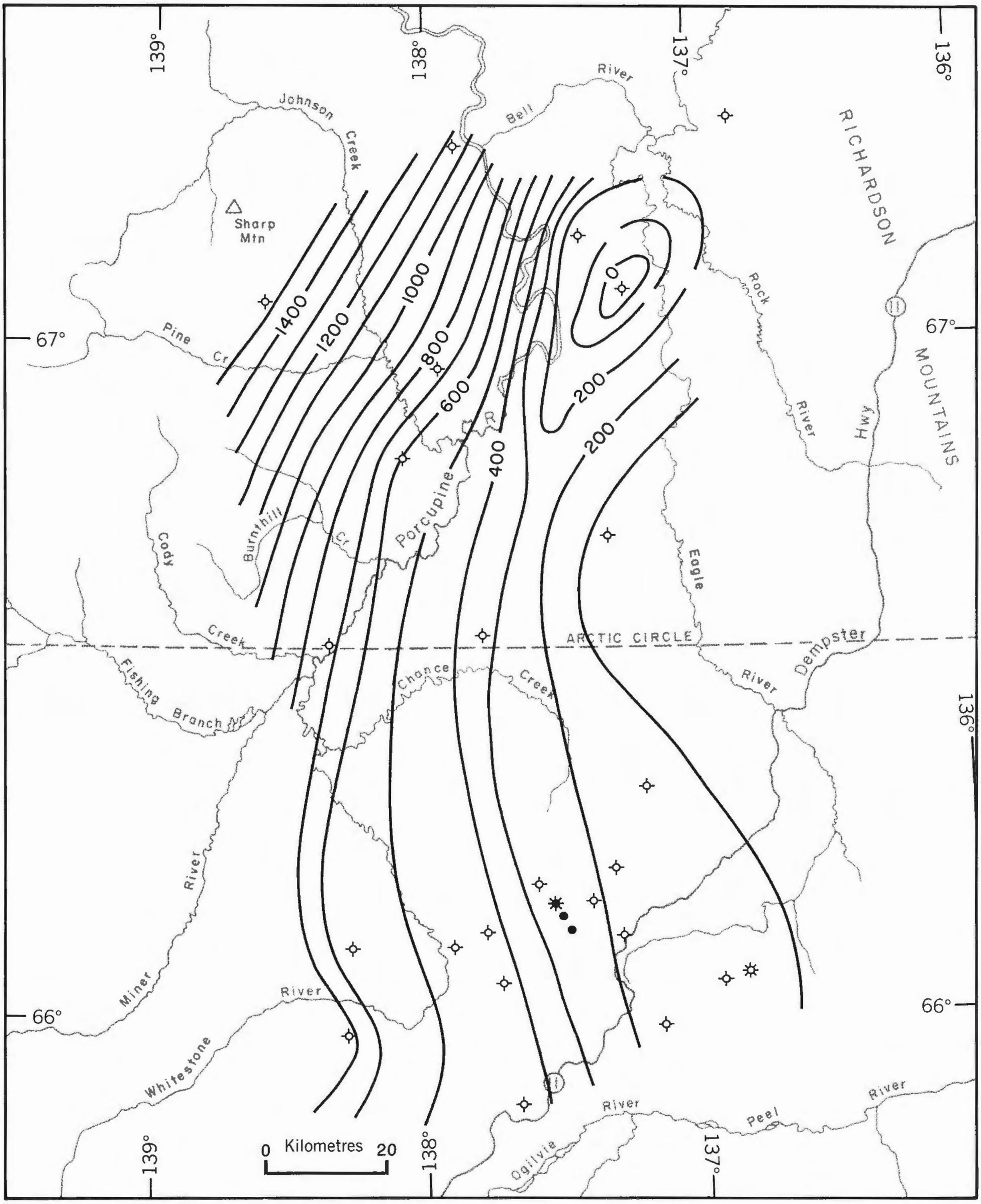


Figure 14. Isopach map of Whitestone River Formation. Contour interval 100 m.

consist of bioturbated, argillaceous, very fine to fine grained sandstone. Burrowed to thoroughly bioturbated shale gradationally overlies the sandstone. At Sharp Mountain, on the northern flank of Eagle Plain (locality 85-3, Fig. 3), Whitestone River strata abruptly overlie the Albian Sharp Mountain Formation (Dixon, 1986a). Under most of Eagle Plain, Whitestone River strata rest on Paleozoic rocks, although in the northeast they rest on Neocomian and Jurassic strata (Fig. 17).

In many of the wells of southern Eagle Plain, the Whitestone River Formation contains several, distinct, correlatable log-markers (Figs. 12, 13, in pocket). The log-markers separate intervals that differ in the amounts of intercalated silt/sand, giving rise to the differing log responses. A distinct basal interval, characterized by a generally low sonic-transit time, is present in most of the penetrated Albian sections. However, many of the log-markers are not everywhere present, especially in the northern and Whitestone wells. Where present, the markers clearly show a general thinning of the formation to the east and southeast, due both to depositional thinning and post-Albian erosion.

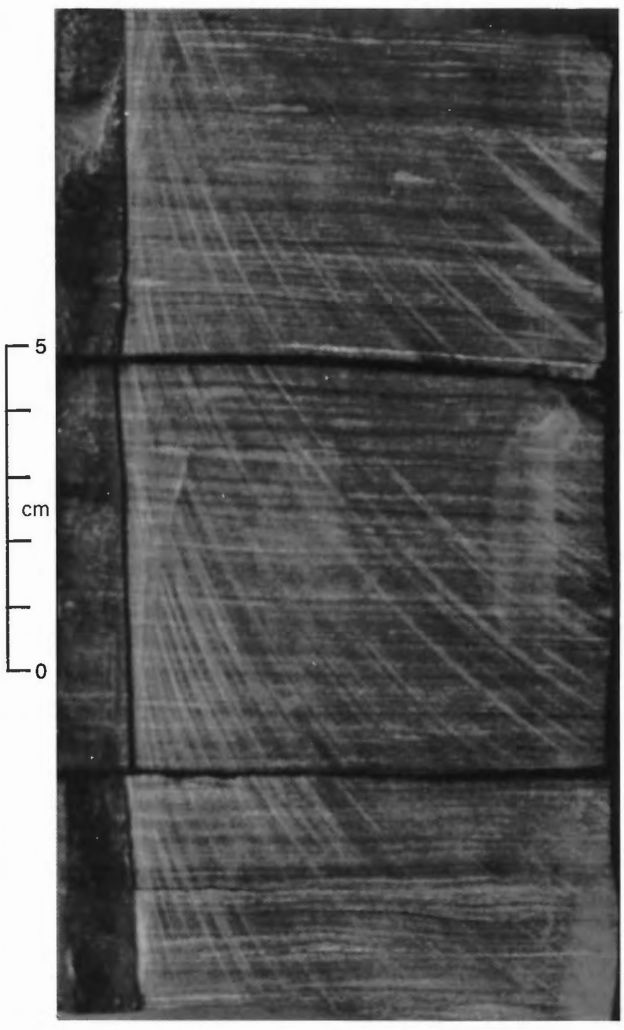


Figure 15. *Interlaminated mudstone and siltstone in the Whitestone River Formation, from Molar P-34 well (core no. 8).*

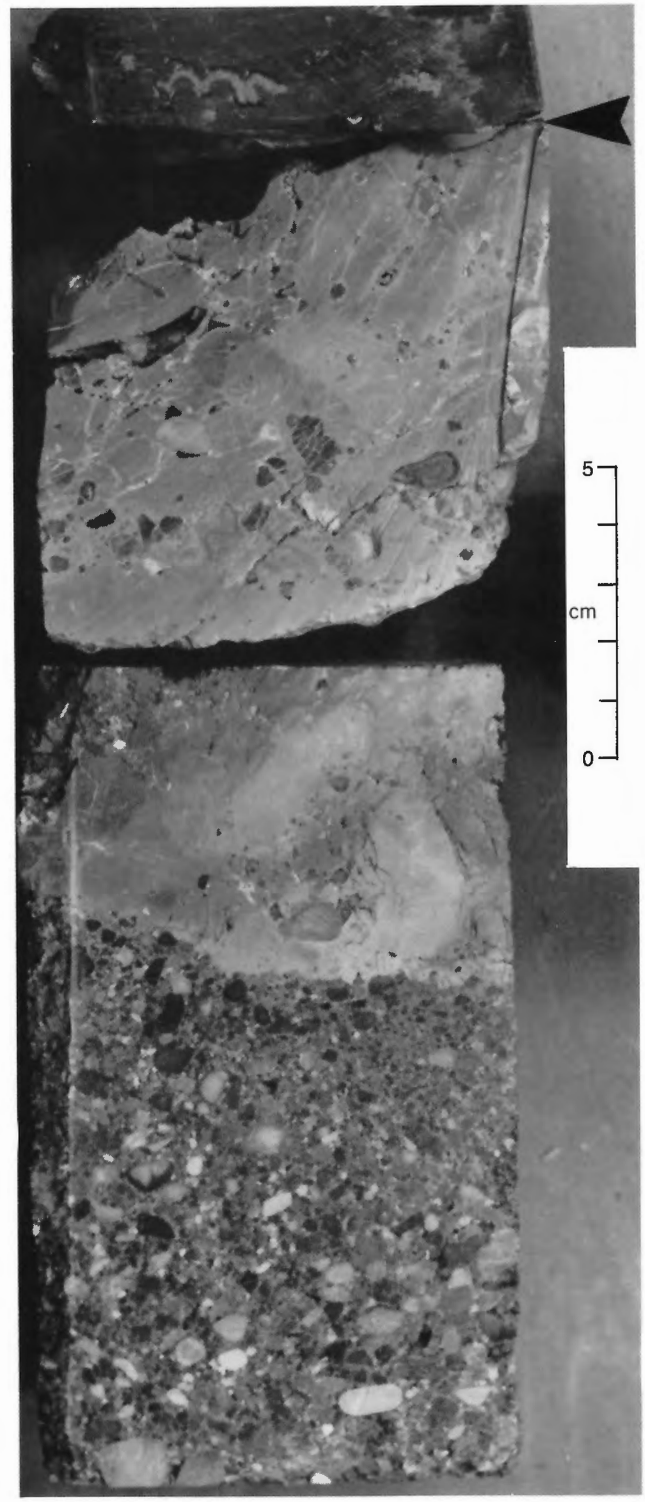
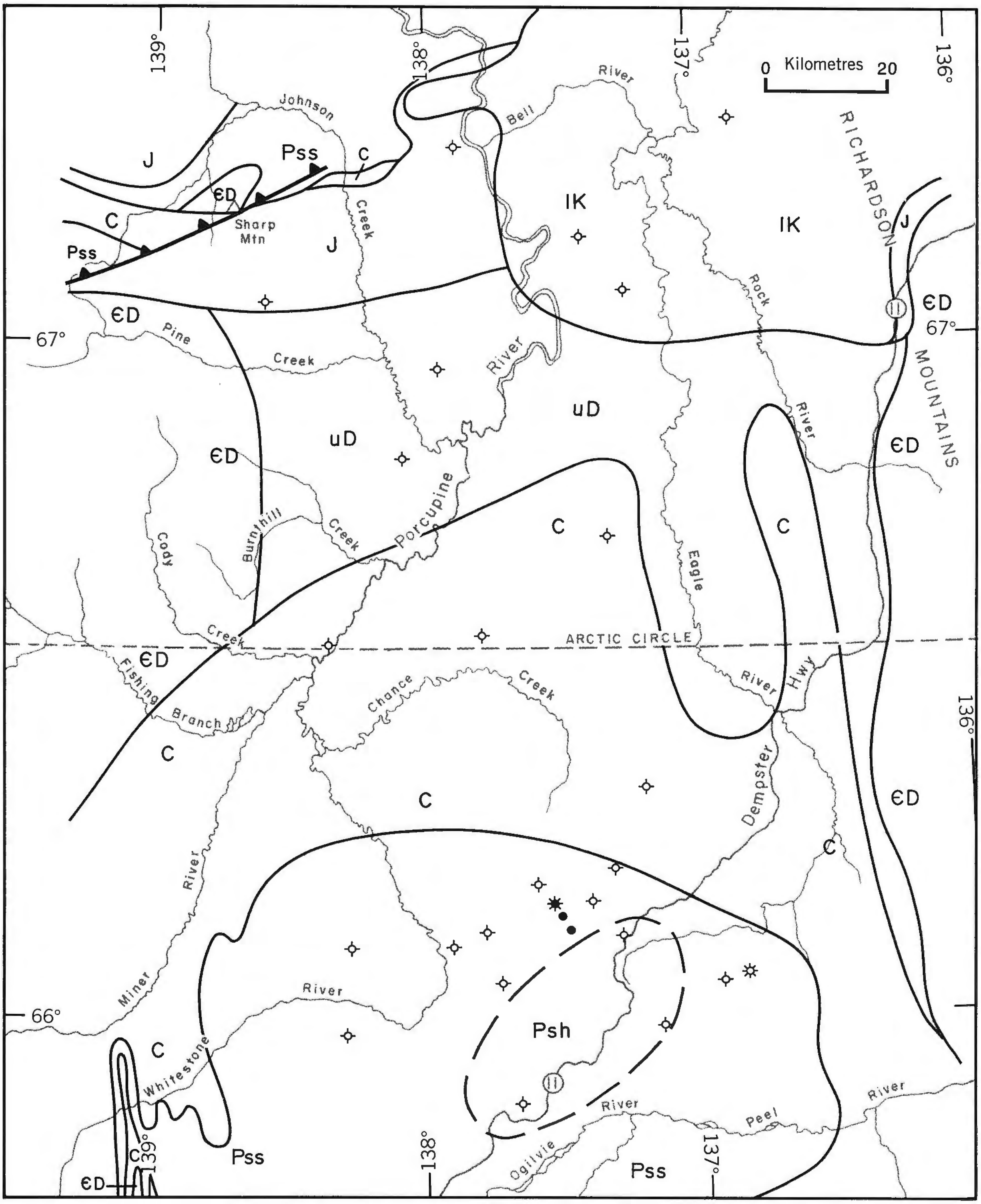


Figure 16. *Contact (arrow) between Permian and Whitestone River Formation, core no. 1, Birch B-34 well. Dark shale of the Whitestone River Formation overlying light coloured, sideritized conglomerate (Permian), in turn overlying unaltered conglomerate. (ISPG photo. 2801-14.)*



ЄD: Cambrian to Lower Devonian uD : Upper Devonian

C: Carboniferous Pss: Permian sandstone Psh: Permian shale

J: Jurassic IK : Lower Cretaceous (Berriasian to Aptian)

Figure 17. Pre-Albian geology, Eagle Plain and adjacent areas. (See Figure 1 for definition of well symbols.)

On the western side of the Quaternary-filled plain between Miner and Fishing Branch rivers (Fig. 3), Norris (1981c) mapped the Mount Goodenough and Rat River formations. Exposure in this area is very poor — most of the ground is covered with vegetation — but generally, the succession consists of a shale interval overlying Paleozoic carbonates, followed by a sandstone, which is in turn overlain by a shale. Both shale intervals are recessive weathering and form subdued topography, whereas the sandstone is more resistant and forms a distinct ridge, commonly tree covered. Samples from the lower shale yielded no microfossils (locality 86-14), but the upper shale contained Albian foraminifers (locality 86-15; Fowler, unpublished Geological Survey of Canada paleontological report number 1-SPF-1986). The intervening sandstone appears to be in transitional contact with the overlying shale, but its lower contact was not seen. It is possible that the lower shale is a Paleozoic unit; however, a Mesozoic age is still conceivable.

Depositional setting

The shale dominance and presence of marine fossils indicate a low-energy marine environment, interpreted as outer shelf to, possibly, slope. Thin beds of planar to ripple crosslaminated, coarse grained siltstone and very fine grained sandstone could have been deposited by low density, sediment-gravity flows or as deposits of turbid flow, processes typical of outer shelf and slope environments.

Age

Macrofossils are not common in Whitestone River strata, but foraminifers are generally quite abundant. The microfossils are identified as Albian forms, generally Early to Middle Albian (Chamney, *in* Norford et al., 1972, p. 16–17; Wall, *in* Brideaux et al., 1976, p. 10; Fowler, 1986, unpublished Geological Survey of Canada paleontological report number 1-SPF-1986). Jeletzky (1960, p. 19) identified Albian macrofossils from an outcrop on Porcupine River. Palynomorphs in Whitestone River strata are generally thermally altered, such that recognition is difficult to impossible. Where they are identifiable, the strata commonly contain an abundance of reworked Carboniferous, Jurassic and Early Cretaceous forms; indigenous spores and dinoflagellates tend to be a minor component (D.J. McIntyre, unpublished Geological Survey of Canada paleontological report number 4-DJM-1987).

Upper Cretaceous stratigraphy

Eagle Plain Group (revised status)

Mountjoy (1967, p. 5-7) named the Upper Cretaceous sandstones that underlie most of Eagle Plain, the Eagle Plain Formation. The type section is located on the east side of Fishing Branch River, approximately 18 km due east of its confluence with Miner River (locality 86-8 on Fig. 3; Fig. 18). Norris (1981a, b, c, d, 1982a, b) expanded the Eagle Plain Formation to include underlying units that were grouped by Mountjoy (1967) as an unnamed, possibly Albian, shale-siltstone unit. Norris (1981a, b, c, d, 1982a, b) identified four informal map units within the expanded Eagle Plain Formation, identified as Kwr, Kfb, Kb and Kcc. Only map unit Kcc is the equivalent of Mountjoy's (1967) original Eagle Plain Formation. Map unit Kwr was recognized as an Albian shale succession, and is now identified as the Whitestone River Formation; the other units were considered to be Upper Cretaceous. Some petroleum exploration drilling reports also included strata below Mountjoy's (1967) Eagle Plain Formation within that formation, informally identifying a lower sandstone unit as the "Blackie sandstone". A few of the drilling reports also informally identify a "Blackie shale" between the overlying "Blackie sandstone" and an underlying Albian shale. It is apparent that the original definition of the Eagle Plain Formation has become expanded through time and usage; consequently, there is a need to redefine and clarify the nomenclature.

It is proposed that the name Eagle Plain be retained, but to raise the status of the unit to a group containing four mappable formations. In ascending stratigraphic order, the new formations are: Parkin, Fishing Branch, Burnthill Creek and Cody Creek, the last three corresponding to map units Kfb, Kb and Kcc of Norris (1981a, b, c, d, 1982a, b). The Parkin Formation is part of Norris's map unit Kwr, although most of the latter is now included in the Whitestone River Formation. The Parkin Formation also corresponds to the informally named "Blackie shale" mentioned in some drilling reports. The Fishing Branch Formation is equivalent to the "Blackie sandstone" used by some drillers. Although the proposed changes to the Eagle Plain Formation are drastic, the common usage of the various units now identified should take precedence over formality. The four formations of Eagle Plain Group are recognizable at Mountjoy's (1967) type section, albeit poorly exposed except for the Parkin Formation (Figs. 18, 19).

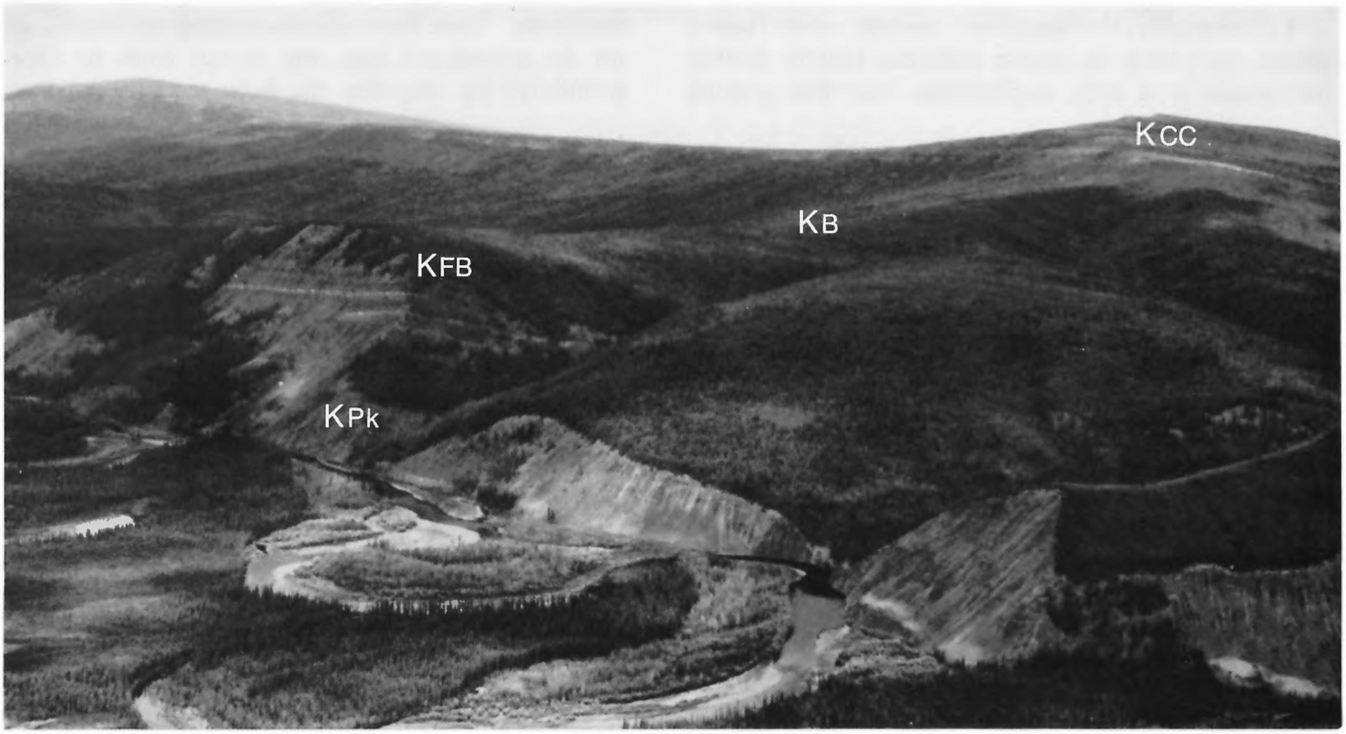


Figure 18. Type section, looking to the north, of Mountjoy's (1967) Eagle Plain Formation (now a group). Revised stratigraphy: KPk, Parkin Formation; KFB, Fishing Branch Formation; KB, Burnthill Creek Formation; KCC Cody Creek Formation. (ISPG photo. 2619–20.)

Parkin Formation (new name)

Definition. The name Parkin Formation is proposed for a shale-dominant succession at the base of the Eagle Plain Group, with its type section in Chevron SOBC Western Minerals West Parkin YT C-33 well between log depths of 548.6 to 697.4 m (1800–2288 ft.). West Parkin C-33 is located at 66°12′04″N, 137°21′56″W; has a kelly bushing elevation of 520 m (1706 ft.); a ground elevation of 514.5 m (1688 ft.); was spudded on the 29th of November 1971, and completed on the 15th of January 1972, to a total depth of 1256.7 m (4123 ft.). The formation rests abruptly and unconformably on the Albian Whitestone River Formation (Figs. 8, 12, 13). The upper contact is placed at the base of the first prominent sandstone interval, above which sandstones comprise 30 per cent or more of the succession and in which the sandstone units are thick and prominent. The Parkin Formation is named after the Parkin C-33 well, in which the type section occurs.

At the original type section of the Eagle Plain Formation (locality 86-8, Fig. 3), part of the Parkin Formation exposed in the cliffs cut by the river (Figs. 18-20) was originally identified as Albian (Mountjoy, 1967) and subsequently mapped as the Albian map unit Kwr (Norris, 1981c). The basal contact is not exposed at locality 86-8, but the gradational nature of the upper contact is well displayed.

The known thickness of the Parkin Formation ranges up to 521 m (1709 ft.) at the Molar P-34 well (Fig. 21). The general thickening of strata to the northwest is entirely depositional in character.

Two informal members are recognized throughout most of the formation's area of occurrence; in ascending stratigraphic order, they are a Sandstone member and a Shale member.

Sandstone member. The Sandstone member occurs between log depths of 667.5 and 697.4 m (2190 and 2288 ft.) in the West Parkin C-33 well. It is highly variable in thickness, ranging from about 6 m (20 ft.) in the East Porcupine I-13 and K-56 wells to 204.2 m (670 ft.) in the Molar P-34 well (Fig. 22). In general, the Sandstone member thickens to the west and northwest (Fig. 22).

Lithologically, the Sandstone member varies from a clean, very fine to coarse grained, locally pebbly sandstone, to a silty, argillaceous, very fine grained sandstone. These lithological variations are readily seen on the gamma-ray logs; the former tends to have a prominent log response, the latter tends to produce a

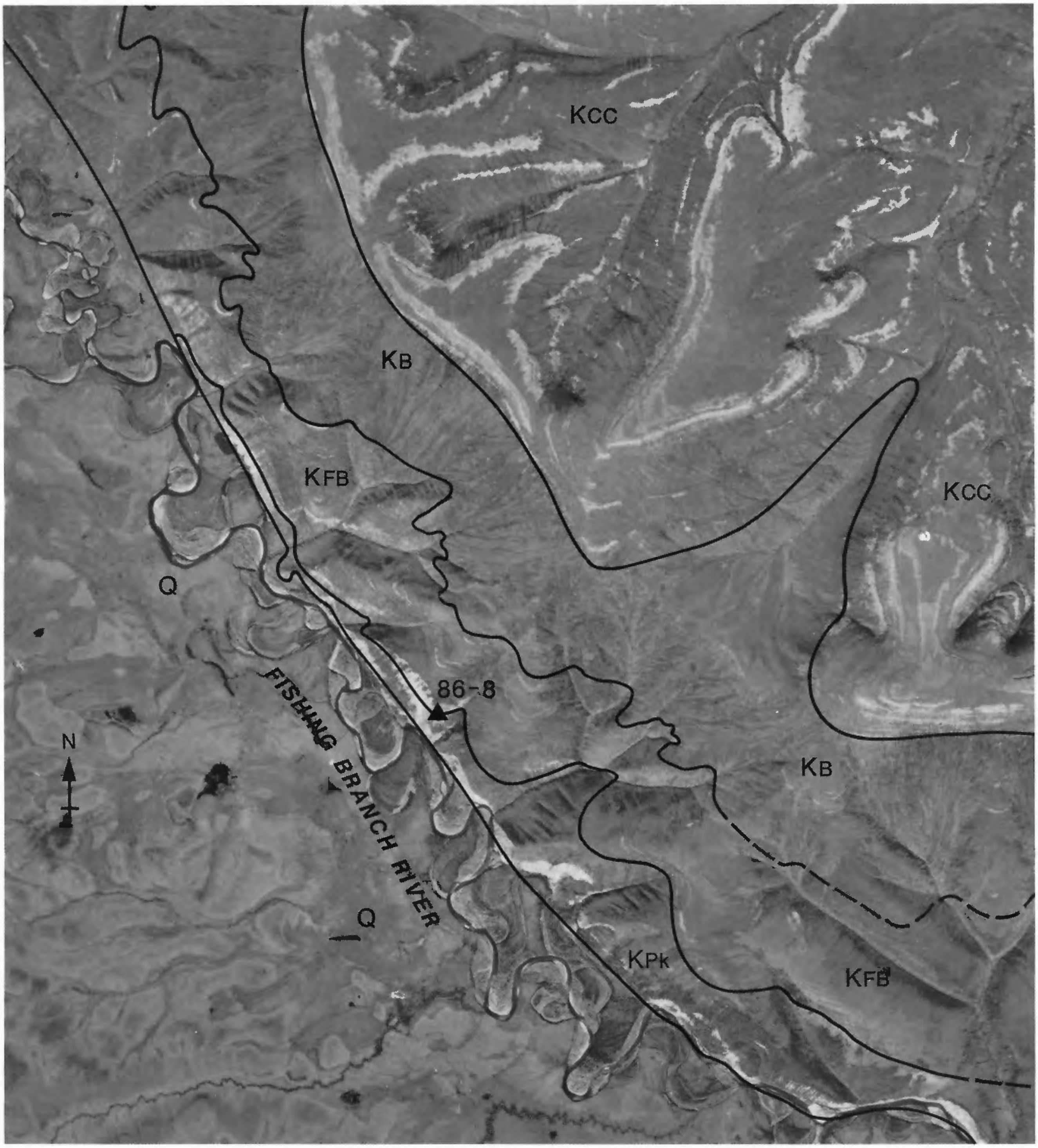


Figure 19. Aerial photograph of type area for Mountjoy's (1967) Eagle Plain Formation (National Air Photo Library number A13470-199); field locality number 86-8. Revised stratigraphy: KPk, Parkin Formation; KFB, Fishing Branch Formation; KB, Burnthill Creek Formation; KCC, Cody Creek Formation; Q, Quaternary.

subdued gamma-ray response. Nowhere has the Sandstone member been identified in outcrop, due to the poor exposure along the scarp slopes of Eagle Plain.

Core was cut in the Sandstone member at the West Parkin C-33, North Parkin D-61, and Molar P-34 wells. In the C-33 well, core 1 intersects the basal contact, and in the D-61 well, core 2 contains the contact between the Sandstone and Shale members. The C-33 core contains a 5.2 m (17 ft.) interval of fine to medium grained, pebbly sandstone, that abruptly overlies shale of the Whitestone River Formation. The sandstone interval consists of several depositional units, each separated by a scour surface. Most of the depositional units contain a 1 to 15 cm thick layer of pebbles above a basal scour, in turn overlain by massive appearing, or indistinctly stratified, fine to medium grained sandstone in which floating pebbles may be present (Fig. 23A). Overlying the basal 5.2 m, are 1.4 m of small-pebble conglomerate. The conglomerate is clast-supported, has a sand matrix, and has no apparent stratification (Fig. 23B). A slight variation in pebble size suggests the possible presence of two depositional units. At the Molar P-34 well, the core consists of mudstone with wavy and lenticular beds of current-ripple laminated, very fine grained sandstone and siltstone.

Figure 20. Transition between Parkin and Fishing Branch formations. Field locality number 86-8 (Fig. 19). Base of first prominent sandstone unit is chosen as the base of the Fishing Branch Formation. (ISPG photo. 2619–18.)

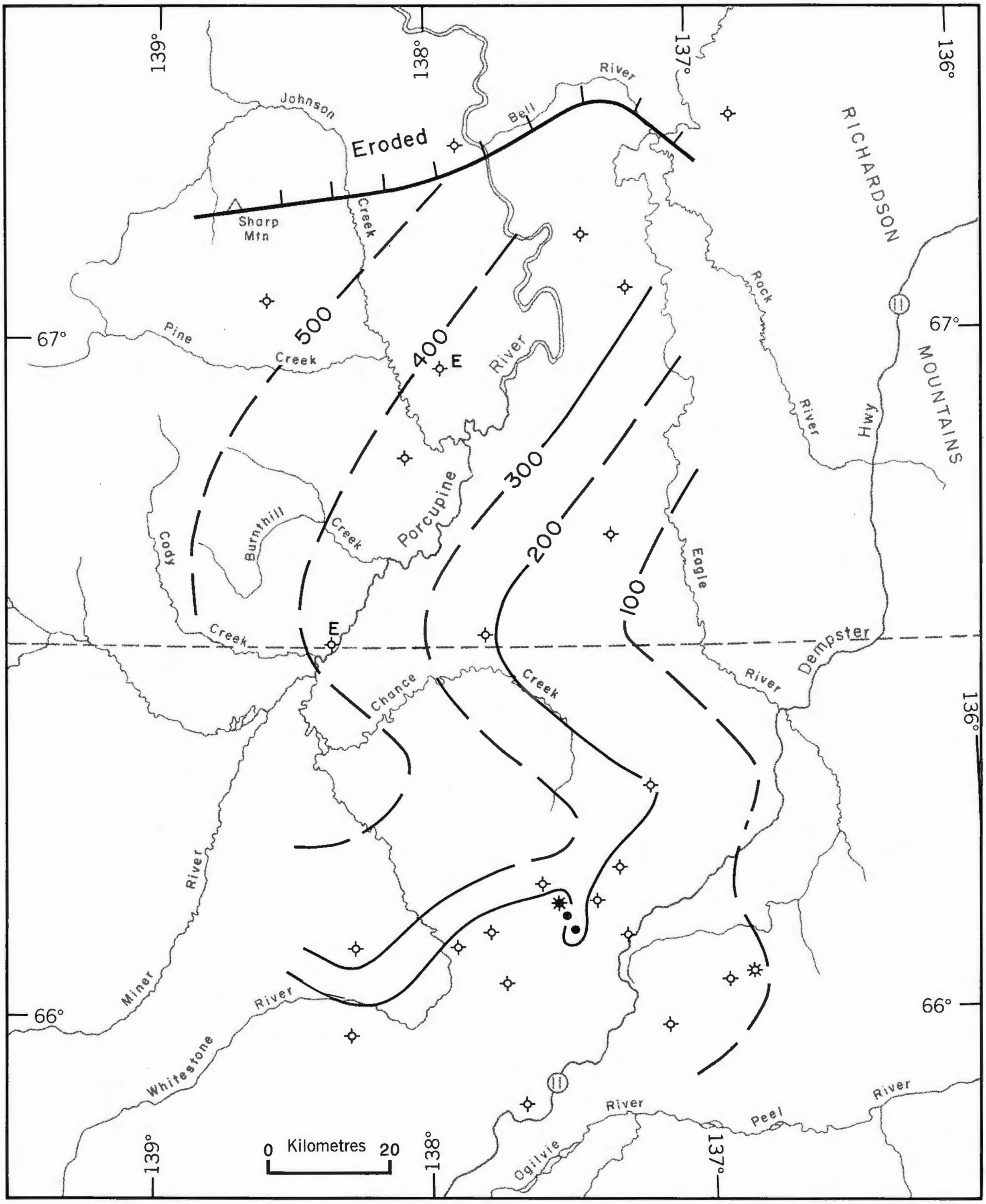


Figure 21. Isopach map of the Parkin Formation. Contour interval 100 m. P, partial section; E, eroded (Recent).

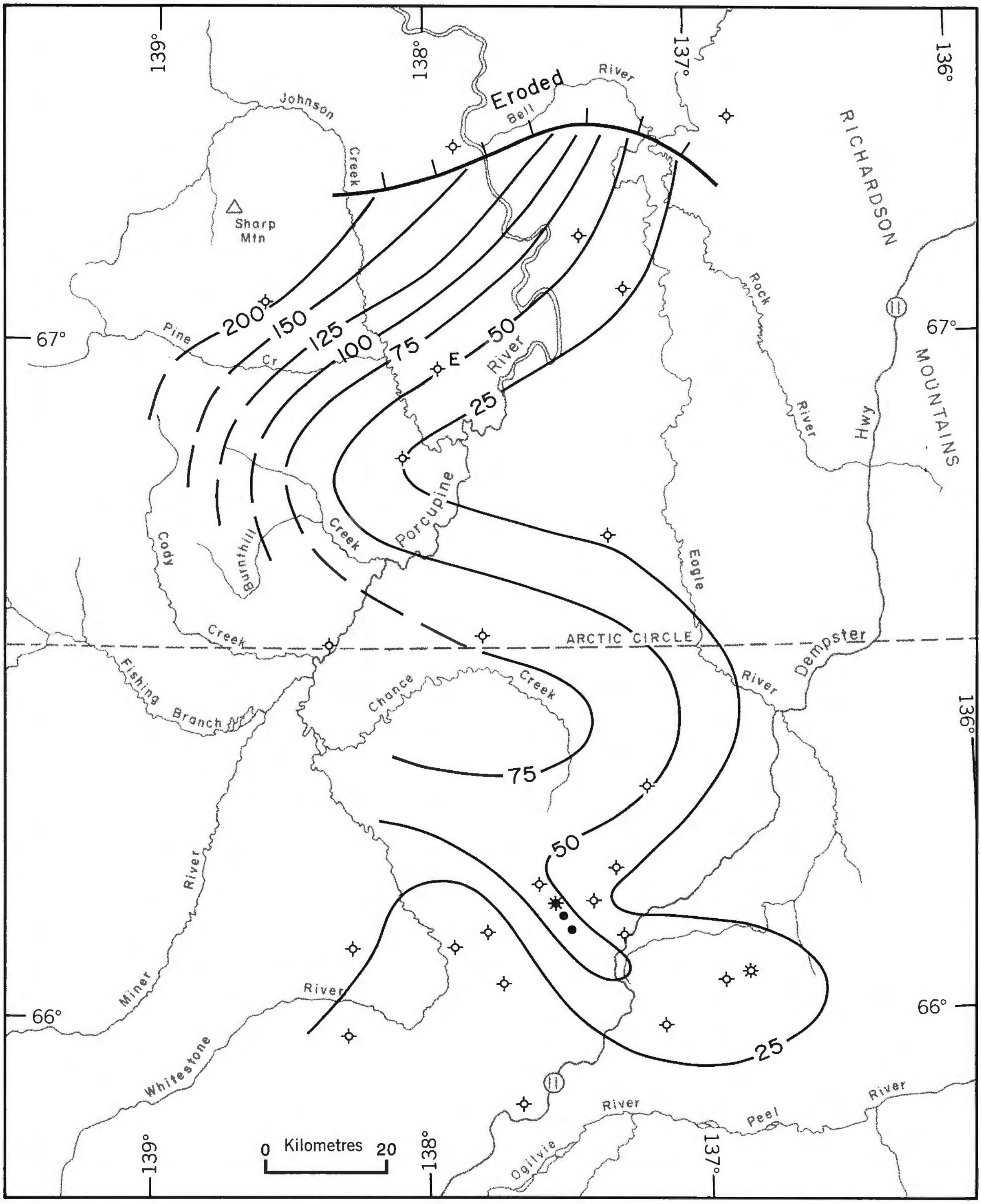


Figure 22. Isopach map of the Sandstone member, Parkin Formation. Contour interval 25 m. E, eroded (Recent).

The contact between the Sandstone and Shale members in the Parkin D-61 core is abrupt and marked by a 4 cm thick layer of pebbles in a silt and clay matrix resting on a scour surface (Fig. 24). Underlying the pebble layer is bioturbated, medium grained sandstone that has a greenish tint (possibly due to the presence of glauconite).

These cores represent the only known, directly observable examples of the Sandstone member. Data from these cores are not sufficient for a definitive sedimentological analysis, but the common occurrence of bioturbation indicates a marine realm, and the fact that the sandstone occurs above an unconformity indicates that it represents deposition during a transgression.

Shale member. The Shale member occurs between log depths of 548.6 and 667.5 m (1800 and 2190 ft.) in the West Parkin C-33 well. It abruptly overlies the Sandstone member and is gradationally overlain by sandstone of the Fishing Branch Formation. It consists of dark grey to black shale with some thin interbeds of siltstone and very fine grained sandstone, the latter tending to become more common in the upper part of the formation. In an isolated exposure on the southern escarpment (locality 84-24, Figs. 3, 25) adjacent to the Dempster Highway, and at locality 86-13 (Fig. 3), the Shale member contains an abundance of 1 mm thick bentonite beds that weather yellow or white. At the

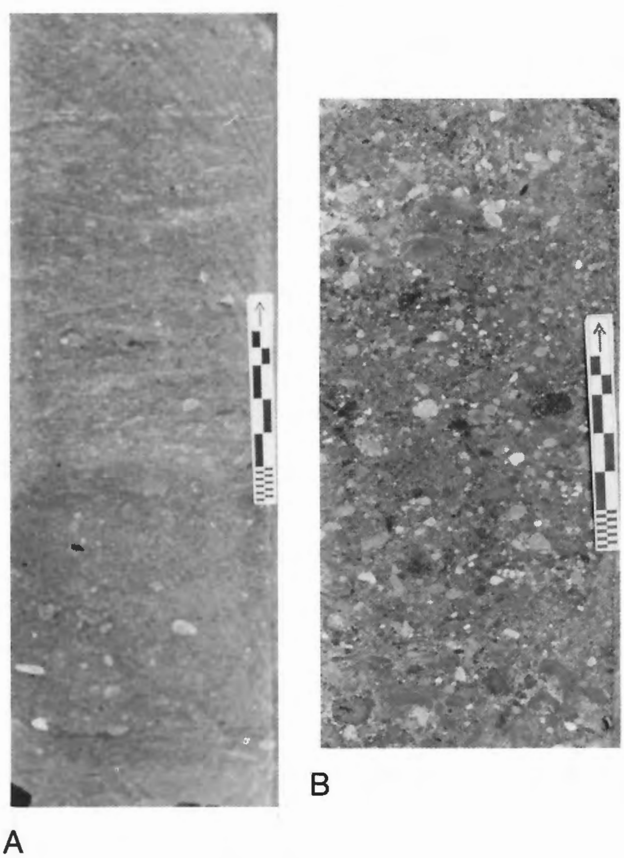


Figure 23. Sandstone member, Parkin Formation, core no. 1, West Parkin C-33 well. A, bioturbated pebbly sandstone unit (ISPG photo. 2801-20); B, conglomerate unit. (ISPG photo. 2801-26).

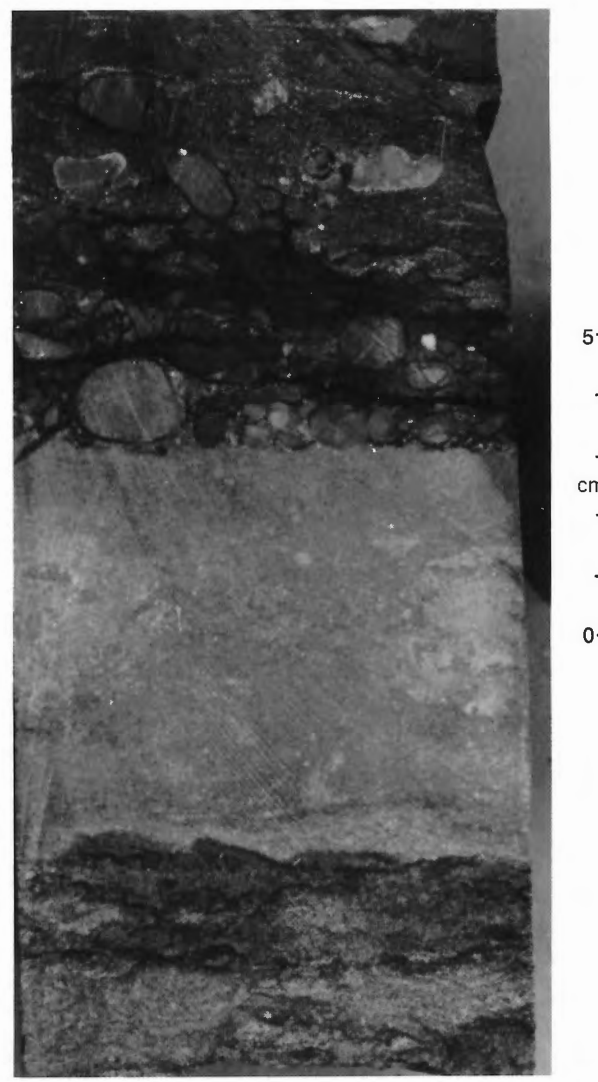


Figure 24. Contact between Sandstone and Shale members, Parkin Formation, core no. 2, North Parkin D-61 well. Pebbly mudstone of the Shale member overlying sandstone strata of the Sandstone member. (ISPG photo. 2801-8.)

Figure 25. Shale member, Parkin Formation, field locality number 84-24, southern Eagle Plain. (ISPG photo. 2619-27.)

original type section of the Eagle Plain Formation (locality 86-8, Figs. 3, 18, 20), the Parkin Formation shale member consists of well indurated shale, in contrast to the softer, less indurated shale in the south. Also at locality 86-8, the Parkin Formation contains intervals in which beds of siltstone and very fine grained sandstone are common. These silt/sand beds are generally a few centimetres thick, although they can be as thick as 40 cm, and contain subparallel or current-ripple laminae. Burrows are commonly present on the bases of the siltstone/sandstone beds, and bioturbated beds are locally present. Cores from the Shale member in the North Parkin D-61 and Ellen C-24 wells consist of dark grey to black, blocky to fissile shale. In the North Parkin D-61 core, there are some burrowed zones.

Thickness trends of the Shale member are similar to the formational trends — thickest in the northwest and a general thickening to the west and northwest. The thickest known section of the Shale member is at the Molar P-34 well, where there are 317 m (1040 ft.).

The Shale member is interpreted as a shelf deposit and is part of a large-scale, coarsening-upward, prograding deposit that includes the overlying Fishing Branch Formation. The contact between the Sandstone and Shale members is interpreted as representing a period of slow deposition after the main transgressive phase, as is evident from the presence of a lag conglomerate in the North Parkin D-61 well.

Age. The age of the Parkin Formation is Cenomanian, based on palynomorphs and dinoflagellates recovered from the few exposures of the Shale member (D.J. McIntyre, unpublished Geological Survey of Canada paleontological report number 4-DJM-1987). Parkin shales tend to contain an abundance of reworked Devonian, Carboniferous, Jurassic and Lower Cretaceous material. At the Molar P-34 well, Chamney (*in* Norford et al., 1971) indicated that some of the upper Parkin Formation would be within his probable Campanian interval, and the lower Parkin within the Cenomanian/early Senonian. Chamney's interpretation implies that the Turonian and Coniacian are absent or exceedingly condensed in the Parkin Formation, which, from the depositional setting, seems highly unlikely. In general, Parkin strata tend to be barren of indigenous foraminifers; only one field sample from Parkin shales (locality 86-13) contained indigenous foraminifers. This sample contained a low-diversity assemblage comparable to one found in the Cenomanian to Turonian Boundary Creek Formation of the northern Yukon (D.H. McNeil, unpublished Geological Survey of Canada paleontological report number 2-DHM-1987).

Fishing Branch Formation (new name)

Definition. The Fishing Branch Formation is a succession of interbedded sandstone, siltstone and shale, gradationally overlying the Parkin Formation and abruptly overlain by the Burnthill Creek Formation. Its type section is in the Socony SOBC Western Minerals West Parkin YT C-33 well between log depths of 484.6 and 548.6 m (1590 and 1800 ft.). The West Parkin C-33 well is located at 66°12′04″N, 137°21′56″W, has a kelly bushing elevation of 520 m (1706 ft.), a ground elevation of 514.5 m (1688 ft.), was spudded on 29th of November, 1971 and completed on 15th of January, 1972 to a total depth of 1256.7 m (4123 ft.). Good exposures are few, and the succession generally is incomplete. At locality 86-8, only the lowermost beds are well exposed (Fig. 20), and at locality 84-23 (Figs. 3, 26), a roadcut on the Dempster Highway, there is a readily accessible, incomplete succession of the Fishing Branch Formation. The formation is named after Fishing Branch, a major northern tributary of Porcupine River. It is equivalent to Norris's (1981a, b, c, d, 1982a, b) map unit Kfb and to the informal "Blackie sandstone" used by some of the petroleum companies in well history reports. The name "Blackie" has been used by Pugh (1983) for a Paleozoic formation in the Yukon and cannot be applied to the Upper Cretaceous sandstone.

The basal contact is chosen at the base of the first thick sandstone unit (Fig. 20) above which sandstone beds compose more than 30 per cent of the succession. In the subsurface, the contact is chosen where the gamma-ray log trace begins to deflect to the left (lower API values), reflecting the increase in sandstone content (Figs. 8, 12, 13). The upper contact is at the top of the last thick sandstone unit that is abruptly overlain by the shale-dominant succession of the Burnthill Creek Formation. In some of the Parkin and Chance wells, a thick sandstone unit occurs within 30 to 40 m of the chosen upper boundary (Figs. 12, 13) but is herein placed within the Burnthill Creek Formation. From a regional perspective, it is apparent that the contact between the Fishing Branch and Burnthill Creek formations is a fundamental stratigraphic boundary that is correlatable between all wells. The small-scale coarsening-upward cycles within the Fishing Branch Formation are easily correlated between closely spaced wells, and this clearly shows that the uppermost thick sandstone seen in a few wells belongs to the overlying depositional succession (Fig. 12). In these wells, simple lithological criteria are inappropriate to define the upper contact.

The thickest known occurrence is in northern Eagle Plain at the Molar P-34 well, where there is an incomplete section 293 m (961 ft.) thick (Fig. 27). There is a westerly thickening trend (Fig. 27), which is depositional in nature.

Lithology. Sandstones within the Fishing Branch Formation are mostly very fine to fine grained, locally medium grained. The sandstones are the uppermost beds in medium-scale coarsening-upward cycles that are up to 30 m thick. The sandstones can constitute up to 60 per cent of a cycle, but generally make up 40 per cent or less (Figs. 8, 12, 13, 20). The sandstone intervals are composed of amalgamated, fining-upward depositional units ranging in thickness from a few centimetres up to 1 m (Figs. 28, 29). An "ideal" unit consists of a basal scour overlain by very fine to fine grained sandstone with subparallel to broadly undulose laminae, which, in some beds, can be identified as hummocky cross-stratification. Shale clasts are present

Figure 26. Fishing Branch Formation (along roadcut) at field locality number 84-23, looking to the north along the Dempster Highway, southwestern Eagle Plain. (ISPG photo. 2619-26.)

above the scour in some beds. The laminated zone is gradationally succeeded by ripple laminated sandstone (Figs. 29, 30), in which current ripples are the dominant bedform. The synoptic relief of these current ripples shows that the final form was wave modified. The ripple laminae can occur as a simple single set, or low-angle climbing ripples, or complex bundles of micro-festoon laminae. Mud drapes may be present

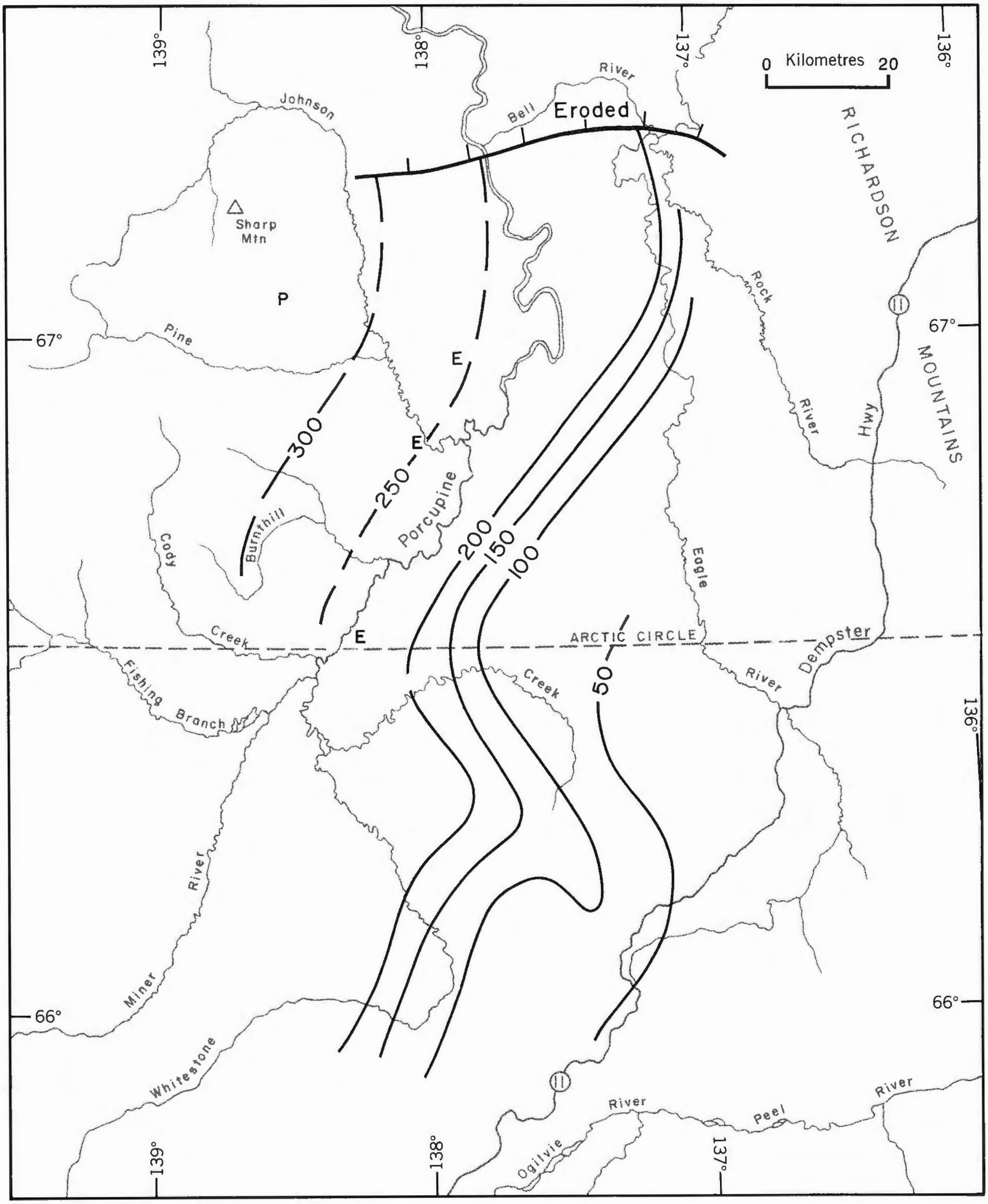


Figure 27. Isopach map of Fishing Branch strata. Contour interval 50 m. P, partial section; E, eroded (Recent).

between rippled beds. Overlying the rippled beds is a shale-dominant interval in which ripple laminated sands are present as lenticular or wavy beds. The transition from sandstone to shale takes place over a millimetre- to centimetre-thick interval. The shale interval may be absent or may be represented by a thin mud drape at the top of a cycle. Horizontal burrows are locally common, especially on the bases of sandstone beds. These fining-upward units are seen in outcrop and in the two available cores (Chance G-08 and East Porcupine I-13).

Depositional setting. The presence of hummocky cross-stratification and wave and current ripples indicates deposition on a storm-dominated shelf. A westward to northwestward increase in the amount of interbedded shale, and the change from well defined hummocky cross-stratification in the southern outcrop (locality 84-23) to subparallel laminae in the sandstones at locality 86-8, in the west, indicate a westerly to northwesterly deepening of the paleoshelf.

Age. Age-diagnostic fossils from the Fishing Branch Formation are not common. A few dinoflagellates that indicate a probable Cenomanian age were collected from section 86-23 (D.J. McIntyre, unpublished Geological Survey of Canada paleontological report number 4-DJM-1987). The bulk of the contained pollens and spores are reworked material from older strata. Chamney (*in* Norford et al., 1971) indicated that strata in the Molar P-34 well within the Fishing Branch Formation were probably Campanian in age, but this seems too young in light of the Cenomanian age of the underlying Parkin Formation and the probable Cenomanian dinoflagellates in some Fishing Branch strata. The immediately overlying strata have not been accurately dated; consequently, the youngest age is not known.

***Figure 28.** Interbedded sandstone and shale of the Fishing Branch Formation at field locality number 84-23, southwestern Eagle Plain. (ISPG photo. 2619-25.)*

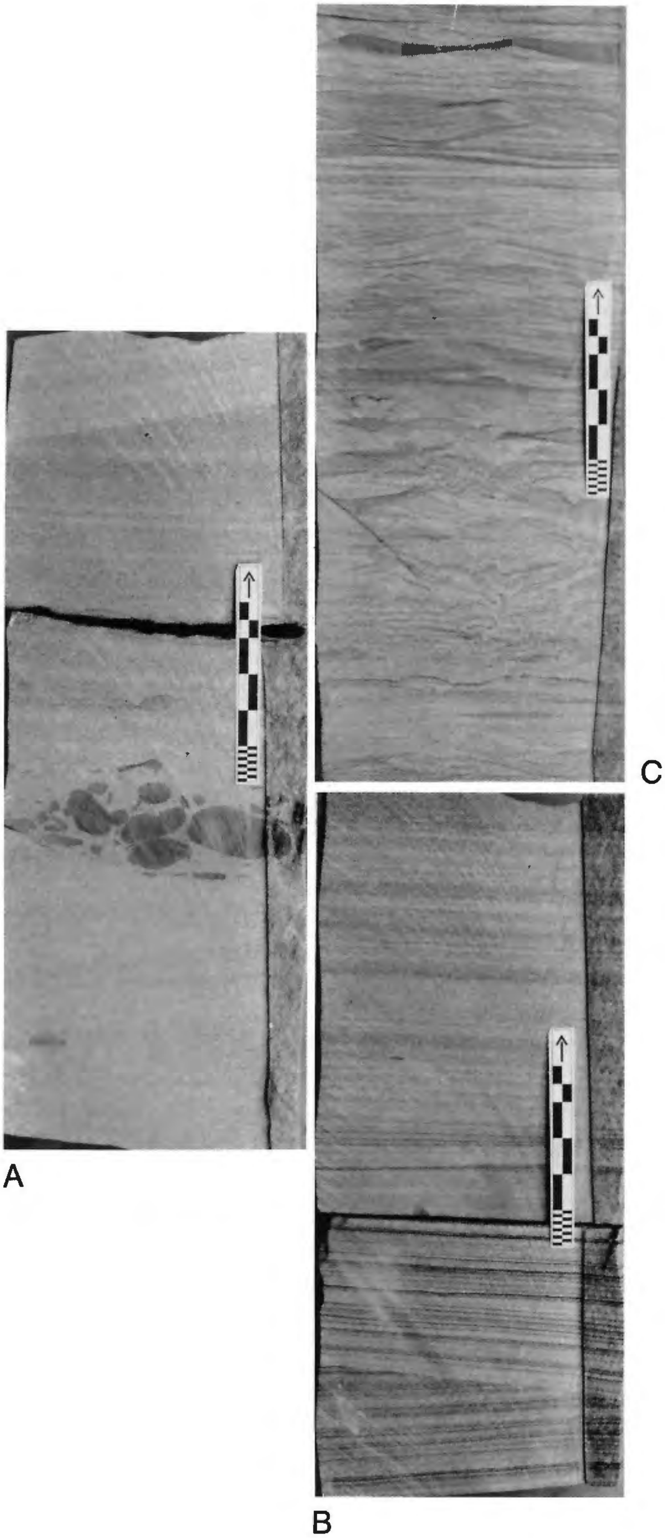


Figure 29. Subfacies within a fining-upward depositional unit of the Fishing Branch Formation, Chance G-08 well, core no. 1. A, basal scour overlain by mudclasts. (ISPG photo. 2801-31.) B, finely laminated sandstone with a low-angle truncation surface (possibly hummocky cross-stratification). (ISPG photo. 2801-32.) C, wave-modified current ripples and deformed laminae. (ISPG photo. 2801-28.)

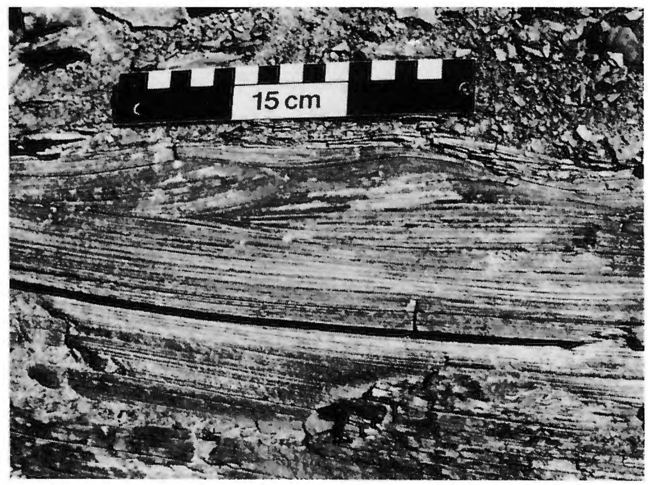


Figure 30. Hummocky cross-stratification and ripple lamination in Fishing Branch strata at field locality number 84-23, southwestern Eagle Plain. (ISPG photo. 2619-24.)

Burnthill Creek Formation (new name)

Definition. The Burnthill Creek Formation is a shale-dominant succession that abruptly overlies Fishing Branch strata and is gradationally succeeded by the Cody Creek Formation. Good quality, continuous exposures are very uncommon; consequently, strata between log depths of 485.5 and 676 m (1593 and 2218 ft.) in the Socony Mobil Western Minerals West Parkin YT D-51 well are designated as the type section. The D-51 well is located at 66°10′8.5″N, 137°26′4.5″W, has a kelly bushing elevation of 475.5 m (1560 ft.), a ground elevation of 470.6 m (1544 ft.), was spudded on the 24th February, 1965, and completed on the 3rd April, 1965 to a total depth of 1508 m (4950 ft.). The Burnthill Creek Formation is equivalent to Norris's (1981a, b, c, d, 1982a, b) map unit Kb. The formation name is derived from Burnthill Creek, a small northern tributary of Porcupine River.

The lower contact is abrupt, with shale resting on Fishing Branch sandstone. The upper contact is defined as the base of the first thick, prominent sandstone unit (interpreted from gamma-ray logs), above which sandstones make up more than 40 per cent of the succession and occur in units generally thicker than 6 m. The base of the sandstone forming the lowest bed of the Cody Creek Formation may be abrupt at any one locality. The basal sandstone bed can be correlated between closely spaced wells, but on a regional scale, the first prominent sandstone can occur at different stratigraphic levels (Figs. 8, 12, 13). Consequently, the upper contact of the Burnthill Creek Formation is a facies boundary when viewed on a larger scale.

The thickest complete section (432 m/1417 ft.) is at the Whitestone N-26 well (Fig. 31). Cody Creek strata thicken to the west and northwest.

Lithology. Lithological data are available only from cutting samples and two cores (Ellen C-24 and Whitestone N-26 wells). The bulk of the succession consists of dark grey to black shale, which contain fine laminae of silt, some of which may be contorted. Although the Burnthill Creek Formation is a shale-dominant succession, there is a considerable amount of interbedded sandstone. Most of the sandstone units are thin, but locally, such as at the West Parkin D-51 well and nearby wells, sandstone units up to 15 m thick are present (Fig. 13). In west and northwest Eagle Plain, the formation contains fewer prominent sandstones.

Depositional setting. The lack of observed sedimentary structures limits the sedimentological interpretation of the Burnthill Creek beds. The bulk of the formation is interpreted as marine; it forms the shale part of a transgressive–regressive, large-scale, coarsening-upward cycle that includes the overlying Cody Creek Formation. However, on the southern margin of Eagle Plain, lowermost beds in the Cody Creek Formation are nonmarine; consequently, some of the upper beds of the Burnthill Creek Formation could contain nonmarine strata in southern areas.

Age. The age of the Burnthill Creek Formation is poorly known from indigenous fossils. The underlying Parkin and Fishing Branch formations are Cenomanian and the overlying Cody Creek Formation may be as young as Santonian; therefore, the Burnthill Creek Formation could be as old as Turonian and as young as Santonian.

Cody Creek Formation (new name)

Definition. The Cody Creek Formation is the youngest unit of the Eagle Plain Group and immediately underlies much of Eagle Plain. It consists of intercalated sandstone and shale intervals that form a distinct ridge and bench topography, giving the unit a striped appearance on aerial photographs (Fig. 19). It gradationally overlies Burnthill Creek strata and is the youngest exposed unit on Eagle Plain. Norris's (1981a, b, c, d, 1982a, b) map unit Kcc and Mountjoy's (1967) original Eagle Plain Formation are equivalent to the Cody Creek Formation. The formation name is derived from Cody Creek, a northern tributary of Porcupine River that dissects the northwest part of Eagle Plain, where most of the better exposures of the formation occur.

The type section is designated at Socony Mobil Western Minerals West Parkin YT D-51 between the surface and a log depth of 485.5 m (1593 ft.) (Fig. 13). The West Parkin D-51 well is located at 66°10′8.5″N, 137°26′4.5″W, has a kelly bushing elevation of 475.5 m (1560 ft.), a ground elevation of 470.6 m (1544 ft.), and was spudded on the 24th of February, 1965, and completed on the 3rd of April, 1965 to a total depth of 1508 m (4950 ft.). Cody Creek strata are moderately well exposed in northwest Eagle Plain, and Mountjoy's (1967) original type section of the Eagle Plain Formation is designated as the surface reference section of the Cody Creek Formation (Figs. 18, 19). At Mountjoy's original section, the base of the Cody Creek Formation is defined as the base of the first prominent, cliff- or ridge-forming sandstone, above which other sandstone ledges/cliffs are very common.

The thickest known section is at the East Porcupine F-18 well, where there are 878 m of strata. The present-day thickness trends (Fig. 32) reflect recent levels of erosion. An incomplete, 670 m (2198 ft.) thick section of Cody Creek strata was measured in northwest Eagle Plain (locality 85-18, Fig. 3), above which was a considerable amount of remaining section, estimated to be at least double the measured thickness. This latter observation indicates that Cody Creek strata are probably thickest under northwest Eagle Plain, a feature consistent with thickness trends seen in the other formation of the Eagle Plain Group.

Lithology. The Cody Creek succession consists of intercalated sandstone- and shale-dominant intervals. Individual intervals range in thickness from 10 to

200 m at section 85-18. In the south the intercalated units are thinner, generally less than 60 m. Sandstones range from very fine grained to conglomeratic, and there is a trend to less pebbly and granular material toward the northwest. Shale units are poorly exposed but the log character and cutting samples indicate that they contain an abundance of thin sandstone and siltstone beds.

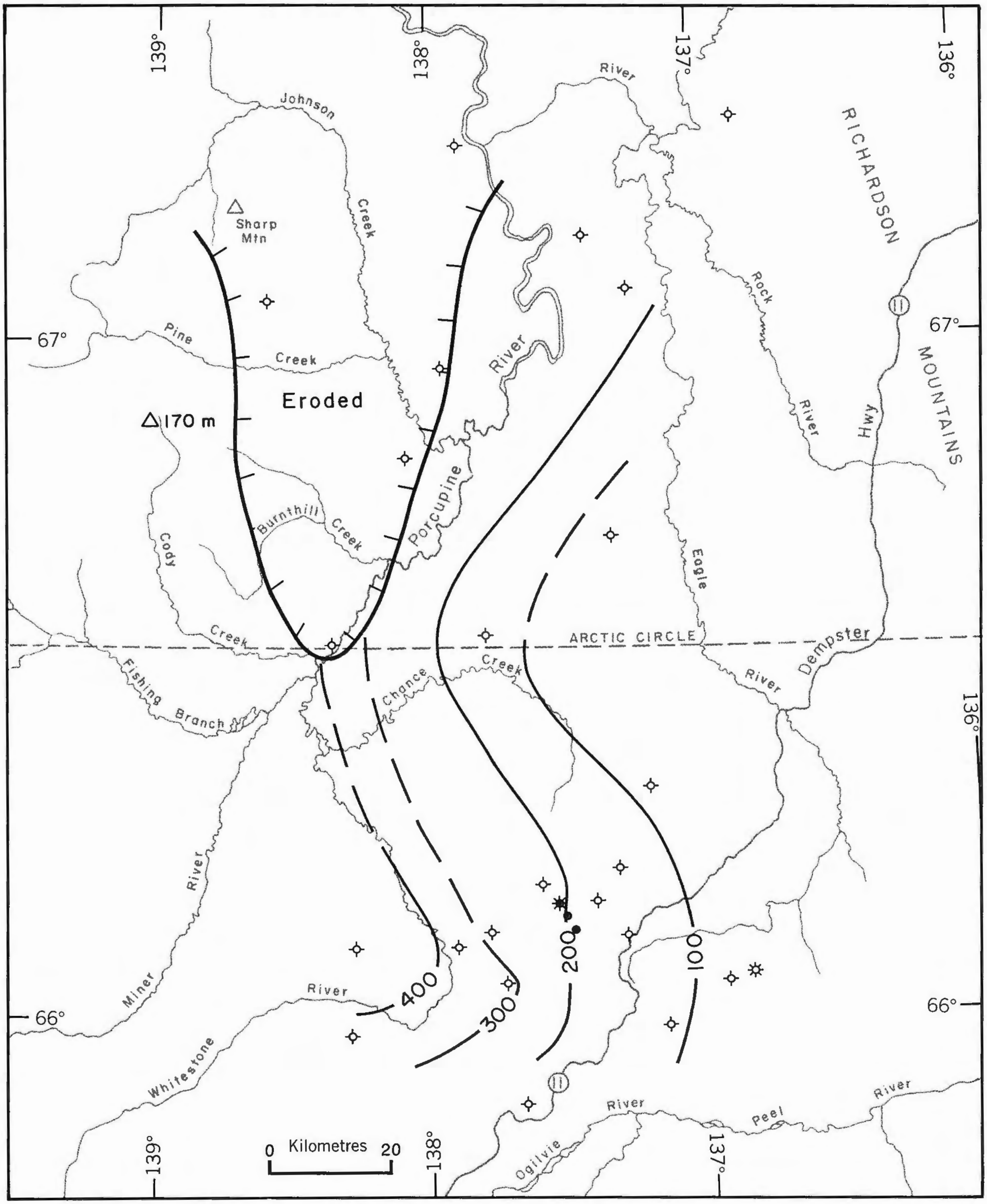


Figure 31. Isopach map of Burnthill Creek strata. Contour interval 100 m.

Along the Dempster Highway there are roadcuts and quarries in which Cody Creek strata may readily be examined; unfortunately, most of the artificially created outcrops have very little vertical expression. Pebbly sandstone, granulestone and medium to coarse grained sandstone are the dominant rock types. They have a typical "salt and pepper" appearance due to the abundance of black and brown chert grains. At locality

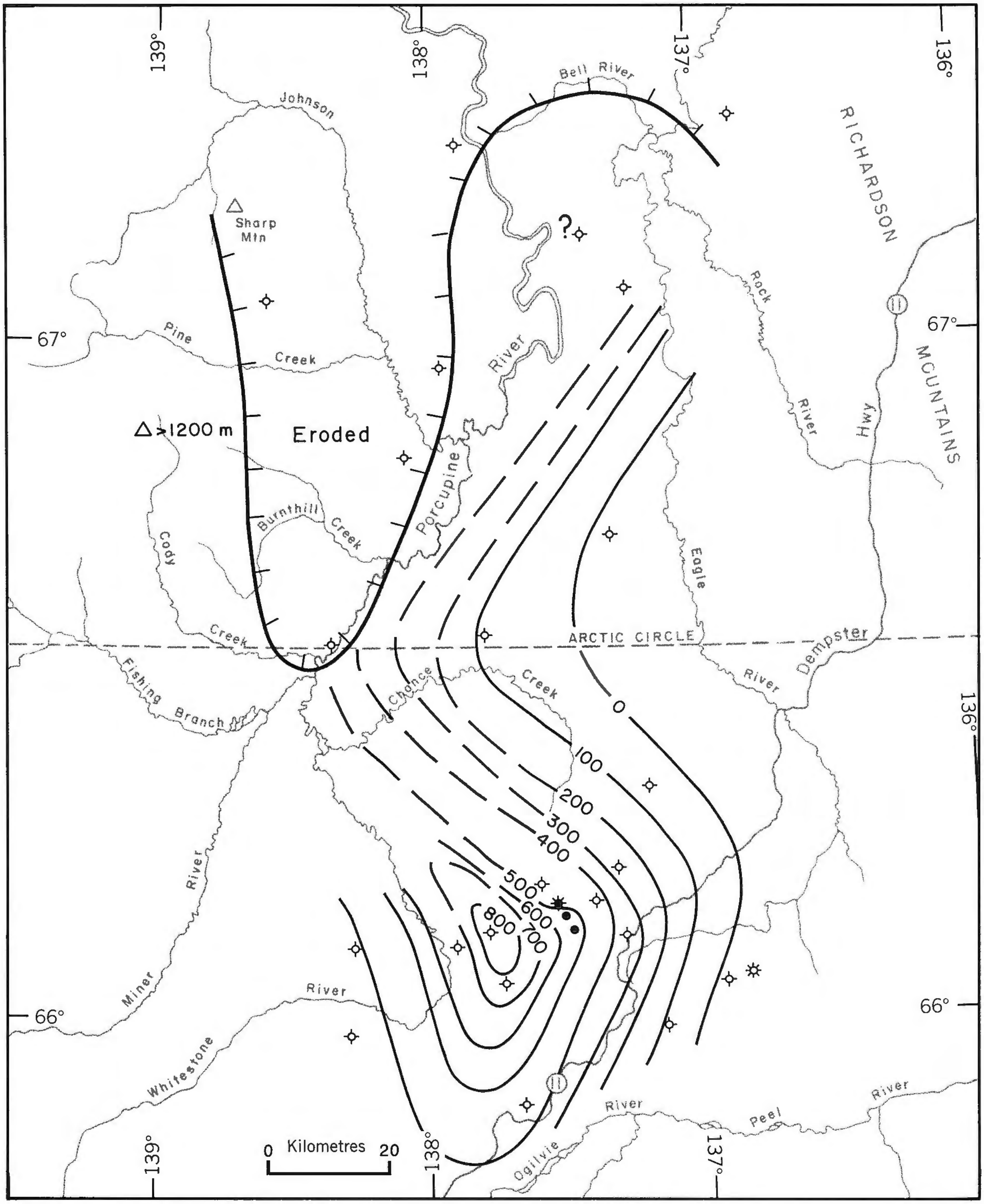


Figure 32. Isopach map of Cody Creek strata. Contour interval 100 m.

86-7 (Fig. 3), a small quarry on the north side of the highway, 13 m of section are well exposed and consist of an excellent example of an incomplete fining-upward unit. The quarry floor is a carbonaceous, silty mudstone. Abruptly overlying the mudstone is a sandstone unit. Large blocks of sandstone bulldozed from the contact show that the lowest beds are pebbly and coarse grained, and contain an abundance of mudstone clasts and impressions of logs (Fig. 33). The bulk of the remaining exposure consists of medium to coarse grained sandstone containing large-scale trough crossbeds (Fig. 34). This locality was the only place where measurements of crossbed orientation were possible. The troughs are oriented toward azimuth 304° (20 readings, standard deviation 12.7°).

Two cores were cut in Cody Creek strata, at the Chance M-08 and Porcupine K-56 wells. The M-08 core consists of a fine to medium grained sandstone erosionally overlying interbedded and interlaminated mudstone and sandstone. The sandstone unit contains mudclasts up to 2 cm in diameter immediately overlying the basal scour. Overlying the basal clast-rich zone is planar laminated sandstone, in turn overlain by current-ripple laminated sand. The uppermost part of the core contains another planar laminated sandstone resting erosionally on the underlying ripple laminated beds. Sandstone beds in the interbedded sandstone-mudstone interval contain planar and current-ripple laminae, and some of the beds are contorted. In the K-56 well, the core is predominantly mudstone, with 30 cm of sandstone at the top. Laminated beds of silt and sand are present in the mudstone, some of which are contorted. Plant impressions and carbonized plant debris are very common.

In northwest Eagle Plain (localities 85-14 and 85-18), Cody Creek sandstones tend to be fine to medium grained, although coarse grained sandstone and granulestone are locally present. Mudclasts occur in many of the medium grained and coarser beds. Although there is considerable exposure in the northwest, the outcrop quality is poor, generally consisting of weathered, frost-heaved felsenmeer with little in situ material. Sedimentary structures consist mostly of subparallel lamination and hummocky cross-stratification. Beds with planar cross-stratification are present, but not common.

Depositional setting. Cody Creek strata in the southern areas of Eagle Plain appear to be predominantly nonmarine. The exposure at locality 86-7 is interpreted as a fluvial channel deposit. Log characteristics of thick sandstone units in southern Eagle Plain indicate a fining-upward trend, consistent with a channel interpretation. In northwest Eagle Plain, the presence of hummocky cross-stratification indicates deposition on a marine shelf. However, the coarse grained character of associated beds and the presence of some planar crossbedding suggests that conditions fluctuated between inner shelf and shoreface deposition.

Age. The age of Cody Creek strata is not well defined. Mountjoy (1967) collected some plant fossils that were dated as possibly Cenomanian, pelecypods that were possibly Cenomanian but could equally be Albian, and pollen and spores (identified by G. Rouse) that are

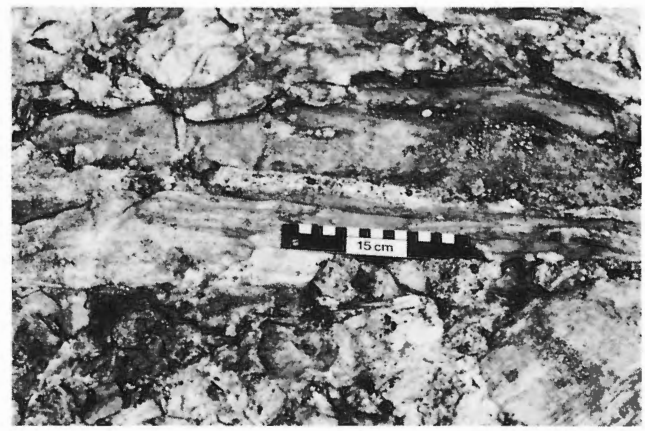


Figure 33. *Log impressions in a pebbly, coarse grained sandstone from a fluvial channel deposit, Cody Creek Formation. Field locality number 86-7, southern Eagle Plain. (ISPG photo. 2619-21.)*

Figure 34. *Trough crossbedding in fluvial channel deposit, Cody Creek Formation. Field locality number 86-7, southern Eagle Plain. (ISPG photo. 2619-23.)*

typical of the Cenomanian to Santonian. Because Cody Creek strata are the youngest beds in the Eagle Plain Group, in which only the Parkin Formation has been adequately dated from indigenous fossils (i.e. Cenomanian), it is reasonable to assume that a Turonian to Santonian age is possible.

Comments on the age of the Eagle Plain Group

The only reliable paleontological data on the age of the formations in the Eagle Plain Group are from a few surface samples collected from the Shale member of the Parkin Formation, from which the dinoflagellates indicate a Cenomanian age (D.J. McIntyre, unpublished Geological Survey of Canada paleontological report number 1-DJM-1987). A probable Cenomanian age is also indicated for some of the Fishing Branch strata (D.J. McIntyre, op. cit.). Indigenous foraminifers are rare, and in several wells processed for microfossils none were found, although there was an abundance of reworked fossils (D.H. McNeil, pers. comm., 1987). Other paleontological data are ambiguous or too broad in age assignments. Chamney's (*in* Norford et al., 1971) assignment of some Parkin and Fishing Branch strata within the Campanian is untenable in light of the more recent palynological data.

The four formations contain two, large-scale transgressive–regressive (TR) cycles. The oldest cycle consists of the Parkin and Fishing Branch formations and the youngest, the Burnthill Creek and Cody Creek formations. These two TR cycles could be represented in northern Yukon and adjacent N.W.T. by two Late Cretaceous depositional cycles, the Boundary Creek and Smoking Hills formations (Dixon, 1986b). The Boundary Creek Formation is Cenomanian to Turonian, and the Smoking Hills Formation Santonian to Campanian. These northern units are separated by a regional unconformity, or hiatal surface (sensu Frazier, 1974). The two TR cycles in the Eagle Plain Group also are separated by a regionally extensive hiatal surface that could correspond to that seen in the northern formations. The Parkin Formation, and possibly the Fishing Branch Formation, are coeval with at least part of Boundary Creek Formation, and it is reasonable to assume that the Parkin-Fishing Branch TR cycle could extend into the Turonian. If the Burnthill Creek-Cody Creek TR cycle is coeval with the Smoking Hills Formation cycle, a Santonian to Campanian age could be inferred for the former.

MESOZOIC DEPOSITIONAL HISTORY

The Jurassic and Early Cretaceous history of the Eagle Plain area is difficult to unravel because of the amount of strata that has been removed by multiple periods of erosion. It is to the north, west and northeast of Eagle Plain that the most complete sections are present (Young et al., 1976; Poulton et al., 1982; Dixon, 1986b). Jurassic and Lower Cretaceous strata are present along the northern edge of Eagle Plain, generally on the north side of Eagle Arch (Figs. 2, 18). Moorhouse (1966) identified Eagle Arch, and recognized its beginnings in the Triassic and its continuing influence on sedimentation until the beginning of the Albian. This interpretation was continued and expanded upon by Young (1975) and Young et al. (1976). Jeletzky (1975b), on the other hand, interpreted a north-south depositional trough (Porcupine Plain–Richardson Mountains Trough) extending through Eagle Plain and across Eagle Arch during the Jurassic and Early Cretaceous. Jeletzky's (op. cit.) model did not find favour with other workers, who cited evidence and interpretations opposed to Jeletzky's views (e.g. Poulton, 1982; Dixon, 1986b). The interpretations of Moorhouse (1966), Young (1975), Young et al. (1976) and Poulton (1982, 1984) suggest that there was progressive southward onlap of Jurassic to Aptian strata across Eagle Arch, such that by the Albian the arch was finally inundated and overlapped. This scenario is probably valid for Early to Late Jurassic time, when nearshore and inner shelf facies of the Lower to Middle Jurassic Bug Creek Group were overlapped by Porcupine River strata. However, the absence of Berriasian to Aptian strata, except on the northeastern flank of Eagle Plain, does not necessarily imply that some of these strata were not deposited over Eagle Plain, or at least part of the plain.

At the west end of Keele Range and on the west side of northern Richardson Mountains, Berriasian strata (Martin Creek Formation) are thick and contain shelf-type deposits lacking any indicators of shoreline or nonmarine conditions (Dixon, 1986b). The absence of Berriasian strata along Eagle Arch may have been due entirely to pre-McGuire erosion (if the identification of McGuire strata to the west of Salmon Cache Canyon is correct), and/or pre-Mount Goodenough erosion. In the nearby Rat Uplift, to the northeast (Fig. 2), Jeletzky (1980) identified a major erosional unconformity at the base of the McGuire Formation, indicating that the erosional event was of considerable magnitude and of regional extent on the Aklavik Arch Complex.

Valanginian to Hauterivian strata (McGuire and Kamik formations, Fig. 5) also may have been removed from Eagle Arch when the sub-Mount Goodenough unconformity developed. Thick marine successions of McGuire and Kamik strata are present immediately to the west and northeast of Eagle Arch, with few indicators of nearshore or nonmarine beds to suggest proximity to a positive feature in the Eagle Arch area (Dixon, 1986b).

The presence of Mount Goodenough marine shales in an outlier southeast of Eagle Plain indicates that Mount Goodenough strata probably extended across Eagle Plain during the Barremian and possibly into the Aptian. Thick marine shale successions of the Mount Goodenough Formation occur to the west and northeast of Eagle Plain and there are no known nearshore or nonmarine sediments to indicate that Eagle Arch was a subaerial, positive element during the Barremian (Young et al., 1976; Dixon, 1986b).

The only Lower Cretaceous strata that presently underlie all of Eagle Plain are those of the Albian Whitestone River Formation, and they rest with marked unconformity on older strata. In the earliest Albian, a deep-water trough, part of the Albian Keele–Kandik Trough (Fig. 35) (Young et al., 1976), was present along northern Eagle Plain. Coarse sediments of the Sharp Mountain Formation were deposited during this time and appear to have been derived principally from a northwestern source area (Young et al.'s Brooks Range Geanticline, 1976) (Fig. 35). To the south of Keele Trough, there was a broad shelf on which fine grained sediments were being deposited. However, it is not apparent from the available data whether or not the Sharp Mountain Formation is coeval with the lower part of the Whitestone River Formation, or if it represents an earlier phase of sedimentation in the Keele Trough, with subsequent expansion of depositional limits to produce a broad shelf. Until at least Middle Albian time, Eagle Plain was the site of shelf to possibly slope deposition.

Correlation of log markers within the Whitestone River Formation (Figs. 8, 12, 13) indicate that the paleoslope was to the northwest and west, consistent with the interpreted regional setting of deep-water depositional troughs to the north and west (Young et al., 1976; Dixon, 1986b). The presence of a broad shelf prevented coarse sediments from being transported into the deep-water troughs, and the troughs became the sites of mud deposition during the late-Early and Middle Albian. During the Albian, Eagle Arch foundered and was inactive throughout the Late Cretaceous.

In Late Albian and/or early Cenomanian, there was another period of uplift and extensive erosion. Subsequent sedimentation was dominated by southerly derived clastic material and their northward progradation across a broad shelf (Figs. 36, 37) (Dixon, 1986b). Late Cretaceous sedimentation was typical of deposition in a foreland basin; the sediment was derived from the rising Cordillera to the south and deposited in a depression fronting the orogen. Thickness and facies trends suggest a local northwesterly to northerly paleoslope during deposition of the Eagle Plain Group (Figs. 36, 37, 38). The thickness trends suggest that the southern end of Richardson Anticlinorium may have been a positive element, as is evident from general southeastward thinning of depositional units in the Eagle Plain Group (illustrated by the Parkin-to-Fishing Branch interval, Fig. 38).

The Eagle Plain Group contains two large-scale transgressive–regressive depositional cycles, the lower consisting of the Parkin and Fishing Branch formations, and the upper consisting of the Burnthill Creek and Cody Creek formations. The lower cycle contains only marine strata in the Eagle Plain area, but an age-equivalent unit, the Monster Formation, located about 100 km west-southwest of Eagle Plain, contains nonmarine beds (Fig. 36) (Ricketts, 1988). In this area, a Cenomanian marine shale at the base of the formation is gradationally overlain by nonmarine, coarse clastic rocks. Strata of the Monster Formation could represent the terrestrial facies of the oldest transgressive–regressive cycle. However, because of the lack of intervening, age-equivalent strata, it is not possible to prove that the two areas were part of a depositional continuum. In Bonnet Plume Basin, southeast of Eagle Plain, Upper Cretaceous nonmarine beds equivalent to the Eagle Plain Group are present (Fig. 36). Along the banks of Porcupine River, between Old Crow and its junction with Driftwood River, are isolated exposures of Cenomanian–Turonian strata that mostly consist of thoroughly bioturbated, argillaceous sandstone and some crossbedded, very fine to fine grained sandstone. These are interpreted as mid-shelf deposits. On the Yukon coastal plain, northern Richardson Mountains, and under parts of Tuktoyaktuk Peninsula, coeval strata of the organic-rich Boundary Creek Formation were deposited on the outer shelf and slope (Fig. 36). In a regional context, the Parkin–Fishing Branch succession was part of a larger depositional setting, representing the more proximal, sandy fill of an extensive foreland basin.

In the Burnthill Creek–Cody Creek depositional cycle, nonmarine strata grade northward into marine, inner shelf strata (Fig. 37). Under Tuktoyaktuk Peninsula and Anderson Plain, coeval strata of the Smoking Hills Formation consist of outer shelf and slope deposits (Fig. 37) (Dixon, 1986b). If some of the Bonnet Plume strata are equivalent to Burnthill Creek–Cody Creek strata and formed part of a continuous depositional system, a major trunk river probably flowed from the southeast into Eagle Plain (Fig. 37). The Burnthill Creek–Cody Creek succession represents a younger proximal fill of the Late Cretaceous foreland basin; the nonmarine deposits prograding farther basinward than during the Cenomanian–Turonian depositional cycle.

Sedimentation and tectonics

Jurassic to Late Cretaceous sedimentation in the northern Yukon, inclusive of Eagle Plain, is intimately linked to orogeny in the Cordillera and plate tectonic

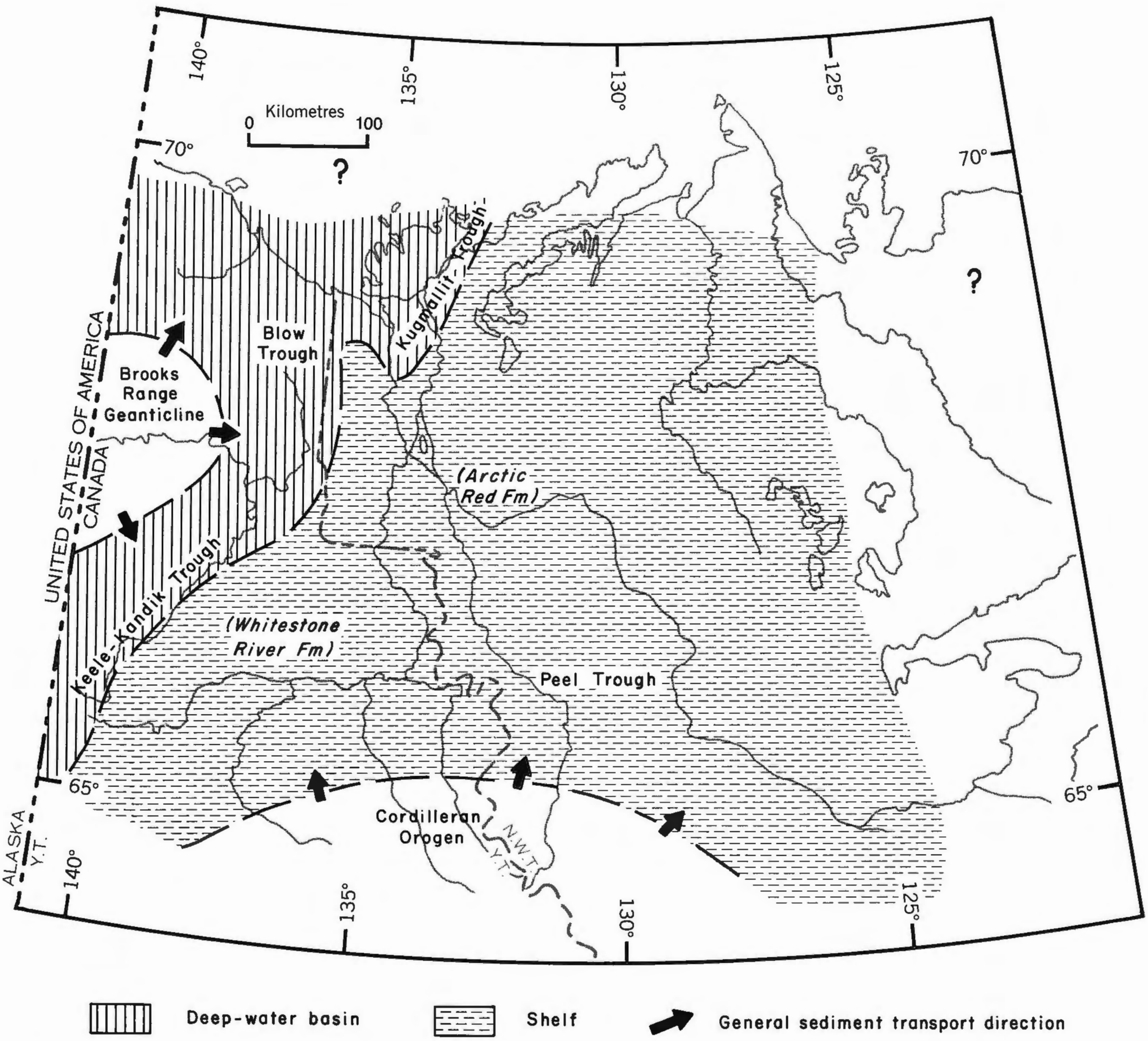


Figure 35. Interpretation of Early Albian paleogeography, northern Yukon and adjacent Northwest Territories. (Modified from Dixon, 1986b.) No palinspastic restoration has been attempted because of the lack of a widely accepted plate tectonic model for the area.

motions in the Canada Basin of the Arctic Ocean. In the northern Yukon and adjacent Northwest Territories, Mesozoic to Tertiary time was characterized by three deformational phases (Dixon, in press). From Jurassic to Aptian time, extensional tectonics related to continental breakup prior to the formation of the Canada Basin were prevalent. During the Albian, sediments from the Cordilleran Orogen were shed northward into a foreland basin, and at the same time, rifting was occurring in the area that would become the Canada Basin. During the Late Cretaceous and Tertiary, compressional tectonics were dominant in northern Yukon, whilst in the Canada Basin, the continental margins were drifting apart and thermally subsiding.

In the Eagle Plain area, the phase of extensional tectonics was characterized by repeated uplift and erosion on Eagle Arch, which is part of the much more regionally extensive Aklavik Arch Complex. These episodes are reflected in the numerous unconformities merging on the arch. This phase of tectonics and

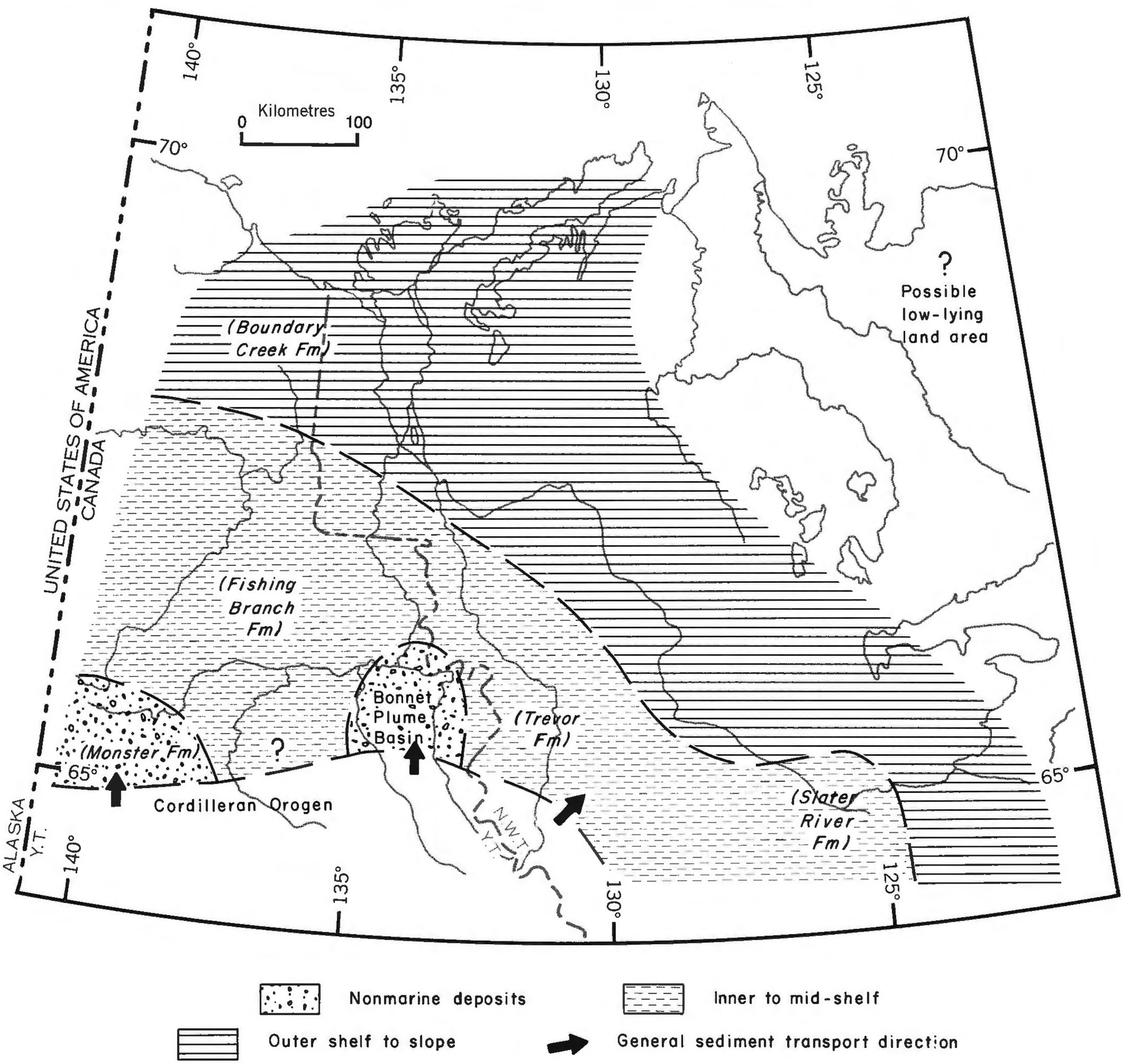


Figure 36. Interpretation of Cenomanian–Turonian paleogeography, northern Yukon and adjacent Northwest Territories.

sedimentation was characterized by deposition of quartz-rich sandstones derived from the east and southeast (Dixon, 1986b).

The first indications of the influence of compressional tectonics occur in Albian strata. During this time a foredeep on the north flank of the Cordilleran orogenic belt developed (the Peel Trough; Fig. 35). At the same time, a belt of narrow, bathymetric depressions, which filled with sediment-gravity flow deposits, extended from the northernmost Yukon southward along the north side of Eagle Arch, and then swung southwestward into the Kandik area at the Yukon–Alaska border (Fig. 35). These troughs occur between major fold belts — the Brooks Range belt to the west and the Canadian Cordillera to the south. The northernmost trough, the Blow Trough (Fig. 35) (Young et al., 1976), fans out northward into Canada Basin. These troughs may have originated as rifted zones extending into the craton from the precursor

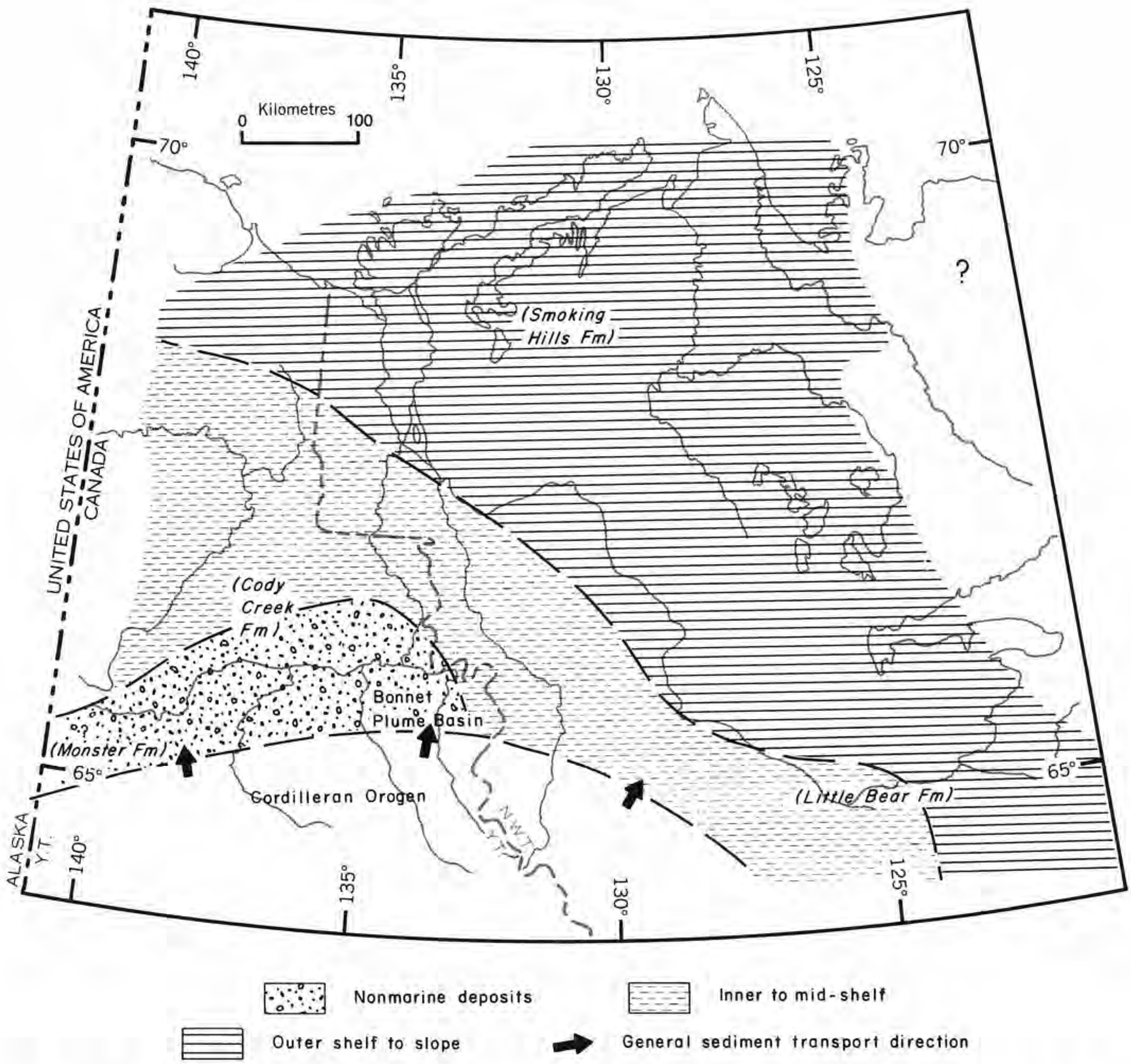


Figure 37. Interpretation of Santonian-Campanian paleogeography, northern Yukon and adjacent Northwest Territories. (Modified from Dixon, 1986b.)

Canada Basin. The sediment-fill of these troughs appears to have been derived from an orogen to the west and northwest, in Alaska.

During the Late Cretaceous and Tertiary, a foredeep associated with the Canadian Cordilleran Orogeny migrated northward, and the Albian troughs, with

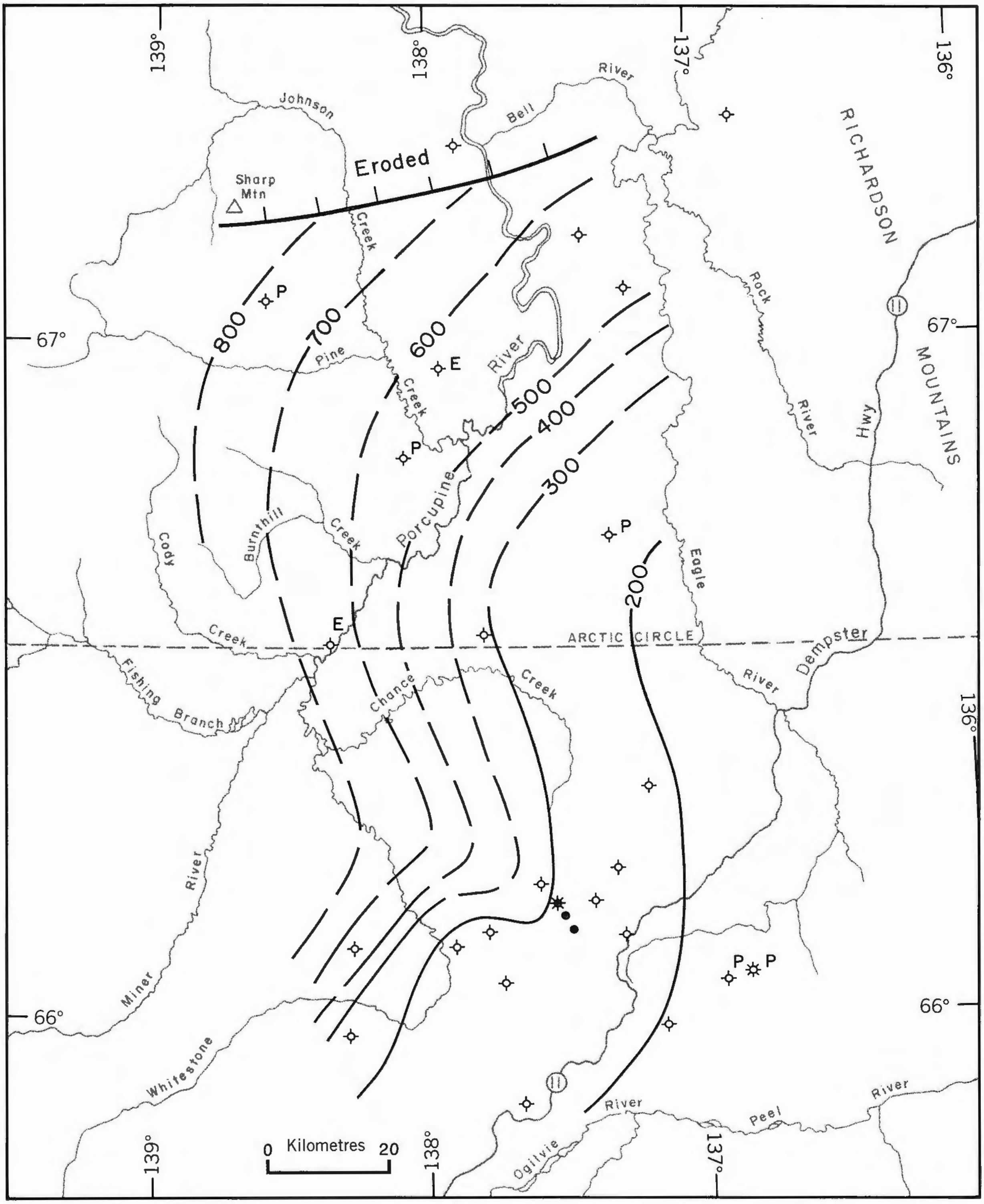


Figure 38. Isopach map of the Parkin and Fishing Branch formations. These strata represent a single, transgressive-regressive depositional cycle. Contour interval 100 m. P, partial section; E, eroded (Recent).

their deep-water facies, were infilled and overlain by younger, coarser shelf sediments. Upper Cretaceous and Tertiary sediments were derived from the south and southwest (Figs. 36, 37) and the sandstones generally are litharenites in which volcanic rock fragments are common. Bentonite beds also are common in Upper Cretaceous and lower Tertiary strata.

There is a lack of data from the Eagle Plain area that can be used to date the youngest deformation; consequently, results from work in the Beaufort–Mackenzie Basin (Dixon et al., 1985) have been used. In the Beaufort–Mackenzie Basin, a period of compressional deformation in the western part of the basin culminated in Middle Eocene time. The Middle Eocene deformation appears to have been associated with some right-lateral strike-slip motion along the Kaltag–Rapid Fault Array (Simpson and Collot, 1986) that is situated just to the north of Eagle Arch. This period of compression/strike-slip is assumed to have produced the folds and thrust faults seen today under Eagle Plain. Subsequent deformation cannot be documented for the Eagle Plain area, although reduced deformation continued in the Beaufort–Mackenzie Basin until at least the Late Miocene and may have affected the whole of the northern Cordillera.

ECONOMIC GEOLOGY

Hydrocarbons are the principal potential economic resource of Eagle Plain; economically exploitable mineral occurrences do not appear to be present in Mesozoic strata. In order to assess the hydrocarbon potential, Rock-Eval and total organic carbon (TOC) analyses were undertaken on samples from eight wells on Eagle Plain (Birch B-34, Chance L-08, East Porcupine F-18, Ellen C-24, Molar P-34, Ridge F-48, Whitefish J-70, and Whitestone N-58), plus another two wells adjacent to the plains but which were spudded in Paleozoic strata (Blackstone D-77 and South Tuttle N-05; L.R. Snowdon, pers. comm., 1987). Rock-Eval data from the Chance no. 1 L-08 well is illustrated as an example of the data set from Mesozoic strata (Fig. 39) (data supplied by L.R. Snowdon, Geological Survey of Canada, Calgary).

The following general characteristics of Mesozoic strata under Eagle Plain were derived from the Rock-Eval data:

1. Mesozoic strata generally have low TOC values (less than 2%), and few potential source rocks have been identified. Only in the upper part of the Whitestone River Formation, in the Ellen C-24 well, was a potential Mesozoic source rock identified (between log depths of 1063.8 and 1082 m/3490 and 3550 ft.).

2. Type III (terrestrial dominant) organic matter is prevalent in Mesozoic strata. This is consistent with the observed abundance of plant debris, especially in Upper Cretaceous strata.

3. Tmax values generally indicate low levels of maturity in Mesozoic strata, although at the Molar P-34 well, maturity is generally higher. This finding is consistent with the thicker succession at P-34. Anomalously high values of maturity in Mesozoic strata, inconsistent with the regional trends and possibly due to drilling contaminants, were noted at the Birch B-34 well (L.R. Snowdon, pers. comm., 1987).

The analyses indicate that Mesozoic strata are unlikely to have generated much hydrocarbon, and, if they did, gas would have been the most likely product.

Although the Mesozoic succession does not look prospective, the underlying upper Paleozoic strata contain two potential oil sources, in the Ford Lake and Blackie shales (L.R. Snowdon, pers. comm., 1987). One or both of these may have been the source for the oil discoveries in the upper Paleozoic Chance Sandstone Member of Eagle Plain. Vertical migration from the potential source rocks into Mesozoic reservoir strata is a possible exploration play concept and there are minor indications that this may have occurred. Gassy, oil-flecked drilling mud, and gas in amounts too small to measure were recovered from Fishing Branch sandstones in the Chance D-22 and G-08 wells, respectively. These two tests are not particularly encouraging with respect to reservoir quality, in that the recoveries and pressures indicate poor porosity and permeability. Sandstones in the Burnthill Creek and Cody Creek formations have good porosity, but their wide surface exposure and potential for freshwater recharge reduces their trapping potential. The Sandstone member of the Parkin Formation has a much better potential as a reservoir, being sealed above and below by shale. However, the thickness and reservoir quality of the Sandstone member is highly variable.

If the oil-prone upper Paleozoic formations are the source rocks for the recovered hydrocarbons, their potential to have generated large volumes of hydrocarbons may have been limited due to their restricted area of subcrop under Eagle Plain (Fig. 16). Migration into younger strata also may have been of a similar, limited extent.

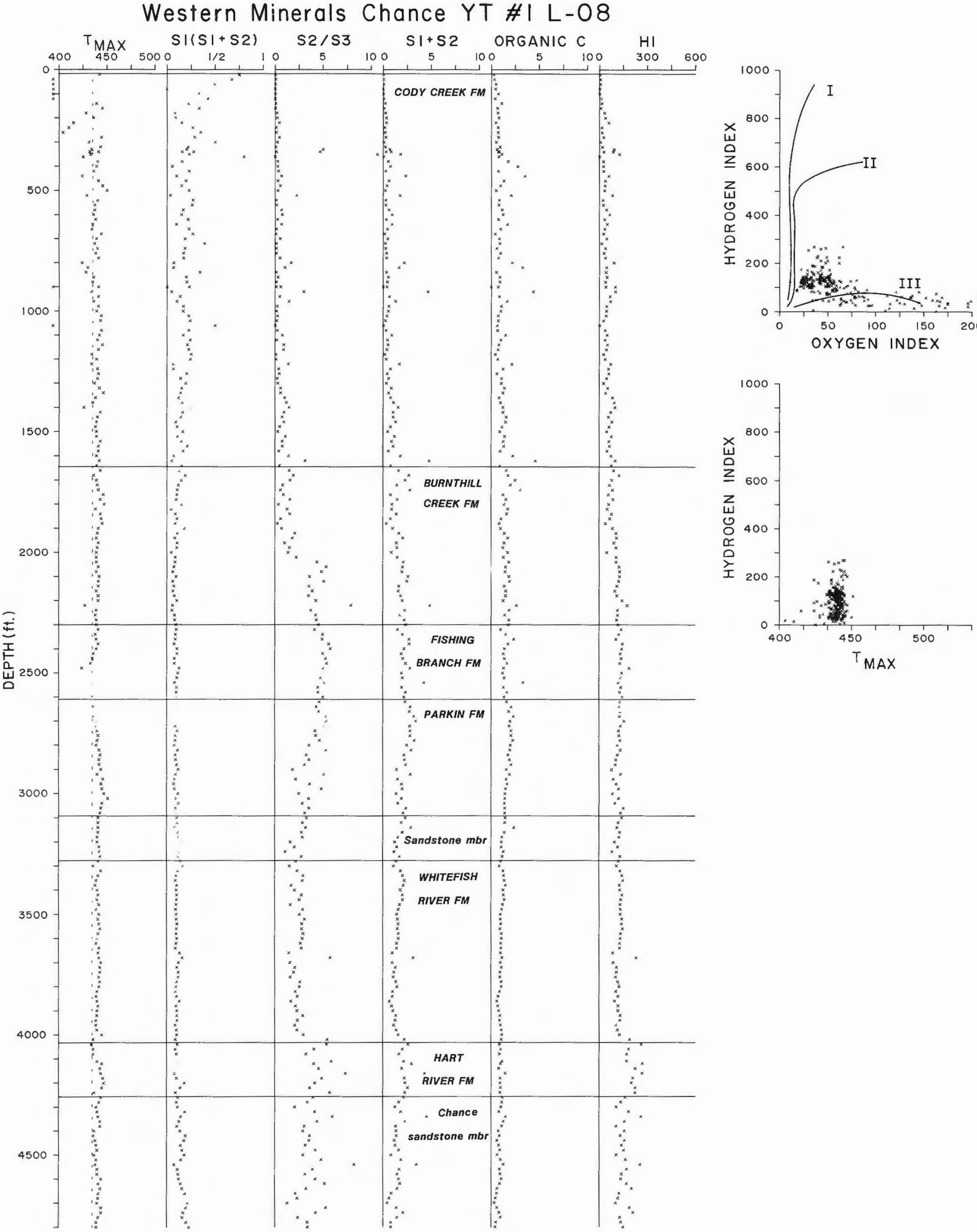


Figure 39. Rock-Eval analysis of strata in the Chance no. 1 L-08 well, northern Eagle Plain. (Data supplied by L.R. Snowdon, Geological Survey of Canada, Calgary. The data set continues to 2635.9 m/8648 ft.; only data for the Mesozoic and uppermost Paleozoic strata are illustrated.)

In conclusion, it seems unlikely that the Mesozoic succession will be a primary exploration target, although as a secondary target it may have some merit. Unless we invoke widespread lateral migration of hydrocarbons from the upper Paleozoic source rocks, the target area for Mesozoic reservoirs would be limited to the immediate area of upper Paleozoic subcrop, on southern Eagle Plain.

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APPENDIX 1

Formation tops (log depth) and cored intervals (reported depths). Tops chosen by J. Dixon

Amerada et al. Crown Bell River YT No. 1 N-50

Group, formation, or unit	Depth feet	Depth metres
(?)Rat River Fm.	surface	
(?)Mount Goodenough Fm.	1852	564.5
unknown sandstone unit	2840	865.6
unknown shale unit	3345	1019.6
unknown sandstone unit	3710	1130.8
unknown shale unit	5640	1719.1
unknown sandstone unit	6120	1865.4
(?)Imperial Fm.	6585	2007.1

(Possible repeat section between 2840 and 6585 ft.).

Core 1: 4195-4208 ft./1278.6-1282.6 m; unknown formation

Socony Mobil Western Minerals Birch YT B-34

Group, formation, or unit	Depth feet	Depth metres
Eagle Plain Group	surface	
Parkin Fm.	surface	
Sandstone member	260	79.25
Whitestone River Fm.	390	118.9
Permian	950	289.6

Core 1: 944-964 ft./287.7-293.8 m; Whitestone River Formation overlying Permian conglomerate

Chevron SOBC Western Minerals Birch YT E-53

Group, formation, or unit	Depth feet	Depth metres
Eagle Plain Group	surface	
Most of the Eagle Plain units are behind surface casing and it is impossible to give accurate formation depths		
Whitestone River Fm.	810	246.9
Permian	1310	399.3

Socony Mobil Western Minerals Blackie YT No. 1 M-59

Group, formation, or unit	Depth feet	Depth metres
Eagle Plain Group	surface	
Cody Creek Fm.	surface	
Burnthill Creek Fm.	370	112.8
Fishing Branch Fm.	870	265.2
Parkin Fm.	975	297.2
Sandstone member	1375	419.1
Whitestone River Fm.	1408	429.2
Permian	1890	576.1

Canoe River Exploration East Chance YT C-18

Group, formation, or unit	Depth feet	Depth metres
Eagle Plain Group	surface	
Cody Creek Fm.	surface	
Burnthill Creek Fm.	1120	341.4
Fishing Branch Fm.	1691	515.4
Parkin Fm.	1952	595.0
Sandstone member	2319	706.8
Whitestone River Fm.	2433	741.6
Paleozoic	2900	883.9

Exco et al. North Chance YT D-22

Group, formation, or unit	Depth feet	Depth metres
Eagle Plain Group	surface	
Cody Creek Fm.	surface	
Burnthill Creek Fm.	1772	540.0
Fishing Branch Fm.	2576	785.0
Parkin Fm.	2913	888.0
Sandstone member	3347	1020.0
Whitestone River Fm.	3474	1059.0
Carboniferous	4331	1320.0

Chevron SOCB Imperial South South Chance YT D-63

Group, formation, or unit	Depth feet	Depth metres
Eagle Plain Group	surface	
Cody Creek Fm.	surface	
Burnthill Creek Fm.	1492	454.8
Fishing Branch Fm.	2007	611.7
Parkin Fm.	2273	692.8
Sandstone member	2736	833.9
Whitestone River Fm.	2780	847.3
Permian	4325	1318.3

Socony Mobil Western Minerals Chance YT G-08

Group, formation, or unit	Depth feet	Depth metres
Eagle Plain Group	surface	
Cody Creek Fm.	surface	
Burnthill Creek Fm.	1505	458.7
Fishing Branch Fm.	2219	676.4
Parkin Fm.	2520	768.1
Sandstone member	3000	914.4
Whitestone River Fm.	3186	971.1
Carboniferous	3920	1194.8

Group, formation, or unit	Depth feet	metres

Core 1: 2283–2324 ft./695.9–708.4 m; Fishing Branch Fm.
Core 2: 3613–3623 ft./1101.2–1104.3 m; Whitestone River Fm.

Western Minerals Canoe River Exploration Chance YT J-19

Eagle Plain Group	surface	
Cody Creek Fm.	surface	
Burnthill Creek Fm.	1420	432.8
Fishing Branch Fm.	2320	707.1
Parkin Fm.	2628	801.0
Sandstone member	3101	945.2
Whitestone River Fm.	3270	996.7
Carboniferous	4060	1237.5

Western Minerals Chance YT No. 1 L-08

Eagle Plain Group	surface	
Cody Creek Fm.	surface	
Burnthill Creek Fm.	1645	501.4
Fishing Branch Fm.	2300	701.0
Parkin Fm.	2610	795.5
Sandstone member	3092	942.4
Whitestone River Fm.	3278	999.1
Carboniferous	4033	1229.3

Core 1: 1255–1279 ft./382.5–389.8 m; Cody Creek Fm.

Western Minerals Eagle Plains YT No. 1 N-49

Eagle Plain Group	surface	
Parkin Fm.	312	95.1
Sandstone member	395	120.4
Whitestone River Fm.	2355	717.8
Upper Devonian		

Core 1.: 2101–2122 ft./640.0–646.8 m; Whitestone River Fm.

Socony Mobil Western Minerals Ellen YT C-24

Eagle Plain Group	surface	
Cody Creek Fm.	surface	
Burnthill Creek Fm.	1902	579.7
Fishing Branch Fm.	2368	721.8
Parkin Fm.	2680	816.9
Sandstone member	3130	954.0
Whitestone River Fm.	3363	1025.0
Carboniferous	4402	1341.7

Group, formation, or unit	Depth feet	metres

Core 1: 3065–3074 ft./934.2–937 m; Fishing Branch Fm.
Core 2: 4212–4221 ft./1283.8–1286.6 m; Whitestone River Fm.

Western Minerals North Hope YT N-23

Whitestone River Fm.	surface	
Carboniferous	2418	737.0

Socony Mobil Western Minerals Molar YT P-34

Eagle Plain Group	surface	
Fishing Branch Fm.	surface	
Parkin Fm.	(?)960	(?)292.6
Sandstone member	1900	579.1
Whitestone River Fm.	2570	783.3
Porcupine River Fm.	7804	2378.7
Upper Devonian	7990	2435.4

Core 1: 1352–1361 ft./412.1–414.8 m; Fishing Branch Fm.
Core 2: 1986–1998 ft./605.3–609.0 m; Parkin Fm., sandstone member
Core 3: 2171–2189 ft./661.7–667.2 m; Parkin Fm., sandstone member
Core 4: 3085–3094.3 ft./940.3–943.1 m; Whitestone River Fm.
Core 5: 4101–4119 ft./1250–1255.5 m; Whitestone River Fm.
Core 6: 4967–4977 ft./1513.9–1517 m; Whitestone River Fm.
Core 7: 5983–5996 ft./1823.6–1827.6 m; Whitestone River Fm.
Core 8: 6196–6202 ft./1888.51891 m; Whitestone River Fm.
Core 9: 7119–7129 ft./2169.9–2172.9 m; Whitestone River Fm.
Core 10: 7395–7403 ft./2254–2256.4 m; Whitestone River Fm.
Core 11: 7480–7490 ft./2280–2283 m; Whitestone River Fm.
Core 12: 7879.5–7890 ft./2401.7–2404.9 m; Porcupine River Fm.
Core 13: 7952.2–7968 ft./2423.9–2428.6 m; Porcupine River Fm.

Chevron SOBC Western Minerals West Parkin YT C-33

Eagle Plain Group	surface	
Cody Creek Fm.	surface	

Group, formation, or unit	Depth feet	metres
Burnthill Creek Fm.	970	295.7
Fishing Branch Fm.	1590	484.6
Parkin Fm.	1800	548.6
Sandstone member	2190	667.5
Whitestone River Fm.	2288	697.4
Carboniferous	2870	874.8

Core 1: 2268-2286 ft./691.3-696.8 m; Parkin Formation, Sandstone member overlying Whitestone River Fm.
Core 2: 2287-2317 ft./697.1-706.2 m; Whitestone River Fm.

Socony Mobil Western Minerals West Parkin YT D-51

Eagle Plain Group	surface	
Cody Creek Fm.	surface	
Burnthill Creek Fm.	1593	485.5
Fishing Branch Fm.	2218	676.0
Parkin Fm.	2550	777.2
Sandstone member	2902	884.5
Whitestone River Fm.	2998	913.8
Carboniferous	3715	1132.3

Chevron SOBC Western Minerals North Parkin YT 61

Eagle Plain Group	surface	
Cody Creek Fm.	surface	
Burnthill Creek Fm.	(?)125	(?)38.1
Fishing Branch Fm.	425	129.5
Parkin Fm.	565	172.2
Sandstone member	1060	323.1
Whitestone River Fm.	1230	374.9
Carboniferous	1802	549.2

Core 1: 995-1023 ft./303.3-311.8 m; Parkin Fm.

Chevron SOBC Western Minerals East Pine Creek YT O-78

Whitestone River Fm.	surface	
Upper Devonian	2550	777.2

Core 1: 2185-2245 ft./666-684.3 m; Whitestone River Fm.
Core 2: 2345-2405 ft./714.8-733 m; Whitestone River Fm.
Core 3: 2412-2472 ft./735.2-753.5 m; Whitestone River Fm.
Core 4: 2473-2501 ft./753.8-762.3 m; Whitestone River Fm.
Core 5: 2501-2536 ft./762.3-773 m; Whitestone River Fm.

Group, formation, or unit	Depth feet	metres

Core 6: 2536-2596 ft./773-791.3 m; Whitestone River Fm., overlying Upper Devonian strata

Chevron SOBC Western Minerals East Porcupine YT-18

Eagle Plain Group	surface	
Cody Creek Fm.	surface	
Burnthill Creek Fm.	2935	94.6
Fishing Branch Fm.	3815	1162.8
Parkin Fm.	4104	1250.9
Sandstone member	4622	1408.8
Whitestone River Fm.	4641	1414.6
Carboniferous	6150	1874.5

Chevron SOBC Western Minerals East Porcupine YT I-18

Eagle Plain Group	surface	
Cody Creek Fm.	surface	
Burnthill Creek Fm.	2550	777.2
Fishing Branch Fm.	3629	1106.1
Parkin Fm.	3932	1198.5
Sandstone member	4428	1349.7
Whitestone River Fm.	4450	1356.4
Carboniferous	5980	1822.7

Core 1: 3658-3718 ft./111.5-113.2 m; Fishing Branch Fm.

Socony Mobil Western Minerals East Porcupine YT K-56

Eagle Plain Group	surface	
Cody Creek Fm.	surface	
Burnthill Creek Fm.	2100	640.1
Fishing Branch Fm.	3400	1036.3
Parkin Fm.	3740	1140.0
Sandstone member	4250	1295.4
Whitestone River Fm.	4270	1301.5
Carboniferous	5892	1796.9

Core 1: 957-965 ft./291.7-294.1 m; Cody Creek Fm.

Chevron SOBC Gulf Ridge YT F-48

Whitestone River Fm.	surface	
Porcupine River Fm.	3908	1191.2
Upper Devonian	5370	1636.8

Core 1: 4647-4674 ft./1416.4-1424.6 m; Porcupine River Fm.
Core 2: 4679-4699 ft./1426.2-1432.3 m; Porcupine River Fm.

SOBC Western Minerals
Shaeffer Creek YT O-22

Group, formation, or unit	Depth feet	Depth metres
Eagle Plain Group	surface	
Formations of Eagle Plain Group are behind surface casing, it is, therefore, impossible to accurately judge depths		
Parkin Fm.		
Sandstone member	1872	570.6
Whitestone River Fm.	1950	594.4
Upper Devonian	2226	678.5

Chevron SOBC Western Minerals
Whitefish YT I-05

Group, formation, or unit	Depth feet	Depth metres
Eagle Plain Group	surface	
Cody Creek Fm.	surface	
Burnthill Creek Fm.	1230	374.9
Fishing Branch Fm.	2132	649.8
Parkin Fm.	2900	883.9
Sandstone member	3888	1185.1
Mount Goodenough Fm.	3990	1216.2
Basal sandstone	4692	1430.1
Upper Devonian	4760	1450.8

Core 1: 3986-4046 ft./1214.9-1233.2 m; Mount Goodenough Fm. [Core depth is probably too shallow by about four to six feet (1.2-1.8 m) relative to log depths]
Core 2: 4047-4071 ft./1233.5-1240.8 m; Mount Goodenough Fm.
Core 3: 4456-4480 ft./1358.2-1365.5 m; Mount Goodenough Fm.
Core 4: 4696-4758 ft./1431.3-1450.2 m; Mount Goodenough Fm., basal sandstone

Chevron SOBC Western Minerals
Whitefish YT J-70

Group, formation, or unit	Depth feet	Depth metres
Eagle Plain Group	surface	
Cody Creek Fm.	surface	
Burnthill Creek Fm.	undetermined	
Fishing Branch Fm.	2865	873.3
Parkin Fm.	3620	1103.4
Sandstone member	4720	1438.6
Whitestone River Fm.	4770	1453.9
Rat River Fm.	5172	1576.4
Mount Goodenough Fm.	6595	2010.2
Porcupine River (possibly Paleozoic)	6848	2087.3

Core 1: 6714-6721 ft./2046.4-2048.6 m; Mount Goodenough Fm.

Socony Mobil Western Minerals
Whitefish YT N-26

Group, formation, or unit	Depth feet	Depth metres
Eagle Plain Group	surface	
Cody Creek Fm.	surface	
Burnthill Creek Fm.	1293	394.1
Fishing Branch Fm.	2713	826.9
Parkin Fm.	3533	1076.9
Sandstone member	4560	1389.9
Whitestone River Fm.	4670	1423.4
Carboniferous	6330	1929.4

Core 1: 3512-3521 ft./1070.5-1073.2 m; Fishing Branch Fm.
Core 2: 5073-5082 ft./1546.3-1549 m; Whitestone River Fm.

Murphy Mesa BP
South Whitestone YT N-58

Group, formation, or unit	Depth feet	Depth metres
Eagle Plain Group	surface	
Cody Creek Fm.	surface	
Burnthill Creek Fm.	behind casing	
Fishing Branch Fm.	2355	717.8
Parkin Fm.	3030	920.5
Sandstone member	3430	1045.5
Whitestone River Fm.	3503	1067.7
Permian	5899	1798.0